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NCYCLOPÆDIA BRITANNICA

NINTH EDITION

THE

ENCYCLOPÆDIA BRITANNIC

DICTIONARY

OF

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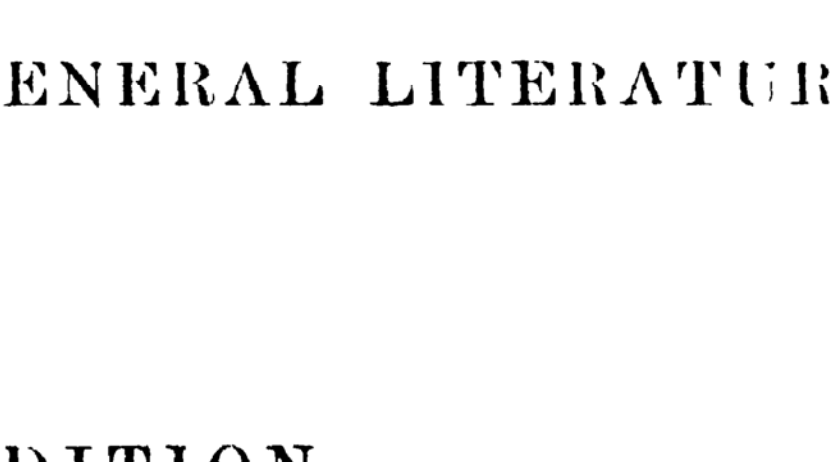

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ENCYCLOPÆDIA BRITANNICA.

NA, Juan de, one of the Italianizing Spanish poets of the 15th century, was born at Cordova about We are informed by Romero, to whom we are d for almost all we know about his life, that he had l the age of twenty-three before he began to give to "the sweet labour of good learning," pursuing a course of study at Salamanca and afterwards at It was at the latter city that he first became ted with the writings of Dante and Petrarch, which rds so powerfully influenced his own style. Having l to Spain, he became a "ventriquatro," or magis f his native town, and was received as a poet with vour at the court of John II., being made Latin secre the king and historiographer of Castile. He died y, in consequence of a fall from his mule, in 1456, elaguna, where the marquis of Santillana, his friend tron, erected his monument and wrote his epitaph. a's principal work, *El Laberinto* ("The Labyrinth"), nes called *Las Trescientas* ("The Three Hundred") he original number of its stanzas, is a didactic y on the duties and destinies of man, obviously con l on the lines of the *Divina Commedia* of Dante. et, while wandering in a wood and exposed to the of various beasts of prey, is met by Providence in ise of a beautiful woman, who offers to guide him hrough the dangers which surround him, and at the me to explain- "as far as they may be grasped by understanding" the dark mysteries of life that upon his spirit. He is then led to the spherical of the five zones, where he sees the three wheels of , the past, the future, and the present, and the men ng to each, arranged in the seven circles of planetary re. Opportunity i. thus afforded for a vast quan- mythological and historical portraiture: the best s are those of the poet's own contemporaries, but rk in general is much disfigured with all sorts of y, and hardly ever attains to mediocrity as a poem. *laberinto* was first printed at Seville in 1496; Nunez anchez accompanied it with commentaries in 1499 82 respectively; and it is still regarded with a good reverence by the Spaniards as the "magnum opus" r "Ennius." De Mena was the author of a number or poems or "vers de société," written merely for court circles, and having neither general interest nor manent value, most of them are to be found in *Cancionero General*. He also wrote a poem entitled *Coronation*, the subject being the "crowning" of marquis of Santillana by the Muses and the Virtues Mount Parnassus. Finally, his *Siete Pecados Mor* ("Seven Deadly Sins") is a dull allegory on the antago between reason and the will of man. Complete edit of the poems of De Mena appeared in 1528, 1801, 1840.

MENAGE, Gilles (1613–1692), described by Bayl "one of the most learned men of his time, and the V of the 17th century, was the son of Guillaume Mén king's advocate at Angers, and was born in that cit August 15, 1613. A tenacious memory and an e developed enthusiasm for learning carried him spee through his literary and professional studies, and we of him practising at the bar at Angers as early as 1 In the same year he pleaded several causes before parlement of Paris, and soon afterwards he attended "Grand Tours" at Poitiers, but after having been aside by a severe illness he abandoned the legal profe and declared his intention of entering the church. succeeded in obtaining some sinecure benefices, and l for some years in the household of Cardinal De Retz (only coadjutor to the archbishop of Paris), where he ample leisure for his favourite literary pursuits. S time after 1648 he withdrew to a house of his own n cloister of Notre Dame, where his remarkable conversati powers enabled him to gather round him on Wedne evenings those much frequented literary assemblies w he called "Mercuriales." His learning procured for admission to the Della Crusean Academy of Florence, his irrepressible tendency to caustic sarcasm led to remorseless exclusion from the French Academy. He at Paris on July 23, 1692. Of the voluminous w of Menage (fully enumerated in the *Dictionnaire* Chauffepie) the following may be mentioned: *Ori de la Langue Française* (1650; greatly enlarged in 16 *Diogenes Laertius Græce et Latine, cum Commentario* (1 and again much improved in 1692); *Poemata La Gallica, Græca, et Italica* (1656, 8th ed., 1687). *Or della Lingua Italiana* (1669); and *Anti-Baillet* (1

…h death a volume of *Monostica* was published; it …terwards expanded into two and with great addi… into four in the Paris edition of 1710.

NANDER, the most famous Greek poet of the …omedy which prevailed from about the death of …nder the Great (323 B.C.) to 250. He was born at … in 342, and died, it was said by drowning in the …r of that city (Piraeus) in 291. His social tastes …d him to write plays rather for the upper classes, … raise comedy to a gentility which it had hardly …ed in the hands of the preceding comic poets. He …e associate, if not the pupil, of Theophrastus, who …f had been a disciple of Plato and Aristotle, and he …e intimate friend and admirer of Epicurus, but he …joyed the more distinguished patronage of Demetrius …ter, (who was likewise a pupil of Theophrastus), and …lemy the son of Lagus. His principal rival in the art …ilemon, who appears to have been more popular with …ultitude, and for that reason probably more success…ful …aid that out of a hundred comedies Menander gained …e with but eight. All the extant plays of Terence, …the exception of the *Phormio*, are avowedly taken …Menander, but some of them appear to have been …ations and combinations of more than one plot, …gh Terence himself says in the prologue to the …*lo* (11) that he copied the Greek model closely, …um de verbo expressum extulit." Julius Caesar …Terence *dimidiatus Menander*, as if two halves of …nt plays had been fitted into one."

Attic New Comedy, says De Wagner,[1] "may be …ated as essentially domestic, i.e., as opposed to …e discussion of the politics of the day which gave Old Comedy the place which is held by the "leading …" of a modern newspaper. "The stock characters …ch as the fond or weak father, the son whose …are sounded by a slave or a hungry parasite, the …ager, active in raising up law suits, and the gaseous …older of fortune." These and cognate subjects, …formed the stock in trade of Menander's plays, are …ed up in two well known lines of Ovid

"Dant tibi Lydorum damni pater improba lena
Vivet dum meretrix blanda Menandri erit."

…good remark of De Wagner's that the last mentioned …ese, the *meretrix blanda* (which probably refers …ally to the *Thais*) "heads the most important and …erous part in the New Attic Comedy, while married …en are continually represented as the plague and bore …n husband lives. Intrigues with these, generally …h the medium of a clever confidential slave, are for …ost part the very point or pivot on which the plot …

…e more literary Romans greatly admired Menander …ace. Pliny (*N. H.*, xxxv. 1, 7) speaks of him as …andri litterarum obtritatis aemulo generis." …itus, contemplating a visit to Athens,[6] anticipates …easure of reading Menander in his native city

"Persequar et tenuis Menandri Deliathis arma,
Labitaque tum, scite Menandre, tibi."

…llusion to the Plays to which *N. H.* xxxv. 50, § 111: "Magnam …andro in comoedia scribendi famam Epicuri et Mario… …onti at clarissimi poetae tribuere, magnique apud …regre… praelata litterarum consensu." "Pliny seems to say that …er had been invited to the court of Alexander and Ptolemy, …pide had been to that of Archelaus king of Macedonia, but …ferred to write comedies for the Attic stage."

…s the *Eunuch*, *Heauton timorumenos* and *Hecyra* are described …n the *Argts* prefixed as *fere totae de Graeco Menandri …ecchi* and *Terentius* are each based on two plays of …er, and the *Adelphi* was compiled partly from Menander and …om Diphilus.

…oduction to Terence, p. 6 (Bell, 1869).

…tes-co Jebb, *Primer of Greek Literature*, p. 101.

…up., p. 7. [6] *Ep.*, iv. 21, 27.

He elsewhere speaks of him as "Menandrus Men… neat, terse, and urbane," and his skill in depicti… character of a fascinating Thais is alluded to be… in ii. 6, 3:

"Turba Menandrea foedat ne Thaidos olim
Tanta, in qua populus lusit Erechthonius."

Of this comedy, the *Thais*, Professor Mahaffy re… that perhaps it was the most brilliant of Menander's … "the manners and characters of the personage being … with thorough experience as well as genius." Never… only five verses of this play have been preserved to … of which is that quoted by St Paul (1 Cor. xv. 33), … communications corrupt good manners." The same … in praising Menander's style as the purest model … New Attic, observes that a remarkable feature of th… Comedy was "its utter avoidance of rhetoric" (p… The influence which this art had on Euripides … known. Sophocles was not wholly exempt from a … rhetorical pedantry, and the speeches in Thucydi… so many exercises of the author in that art. … rhetoric pertained essentially to public life, it was … to have a much less scope in scenes borrowed almos… from social and domestic experiences.

Menander, however, did not neglect the other br… a liberal Attic education, philosophy. A followe… friend of Epicurus, whose *summum bonum* was the g… amount of enjoyment to be got out of life, he carr… in practice what he advocated by precept, for … essentially the well to do gentleman,[8] and moved … upper circles of Athenian society. "The philosop… the day" (*i.e.*, the schools and universities in our … systems of teaching) "were still," says Professor Ma… viz., even during the period of the New Comedy, "t… stant butt of the dramatists." He adds that, "… still stranger, political attacks on living personag… exceptme Alexander the Great, were freely and … made."

On the whole, our estimate of the spirit and object of M… must be formed rather from his imitator and copyist Teren… from the fragments which remain, about 2400 verses in al… lected by Meineke in his *Fragmenta Comicorum Graecorum*… as Professor Mahaffy well observes,[10] the extracts m… Athenaeus, our principal authority, have reference chiefly … archaeology of cooks and cookery," while Stobaeus was a col… γνῶμαι or wise maxims, "the most unfortunate and worthl… of citation." It follows that no sound conclusions as to … genius, or of the knowledge of human nature, can be dra… detached verses preserved without the least reference to th… tricular points. The extraordinary popularity of Menand… have been due to literary merit, if not to great originali… Mahaffy observes on this[11] that "there is so much of a cal… manly morality about his fragments, he is so excellent a… of the ordinary world wisdom—resignation, good temper, … tion—friendliness—that we can well understand this po… Copies of his plays continued long in existence, and were … known to Suidas and Eustathius as late as the 11th and 1… turies, if they did not survive to a yet later period.[12]

In respect of language, Menander occupies the same pos… poetry which his contemporary Demosthenes does in prose. … the New Attic is elaborated with great finish, and with much … grammatical precision than we find in writers of the Old At… as Sophocles and Thucydides. A considerable addition … vocabulary of every day life had now been made, as wa… inevitable from the versatile character of the language … genius of the people who used it. Many new verb forms, e… the perfect active,[13] now occur, and indeed form a chara… innovation of the style of Plato. The earlier prose wa… general vocabulary to a considerable extent poetical, and … concurrence of short syllables as in the Platonic ἀπυδεδυκ…

[8] *Hist. Class. Gr. Lit.*, i. p. 488.

[8] Pliny calls Menander "diligentissimus luxuriae interpres," … xxvi. 5.

[9] *Hist. Class. Gr. Lit.*, i. p. 480. [10] *Ibid.*, p. 4…

[11] *Ibid.*, p. 487. [12] *Ibid.*, p. 4…

[13] A curious example is ἀπεκτάγκασι, the transitive p… ἀποκτείνειν. Similarly we have the unusual forms κέχρη… 559), ἐψόφηκα (727), συγκέχυκα (810).

καμάζειν) is ill suited even to choral metre. The Old Comedy rked by men of real genius, who "were indeed giants, while a of Menander's day only showed how strong and thorough h culture which in art and literature outlived the decadence nation."[1]

ll, we have, as collected by Meineke, 1015 fragments of ler, of which 515 can be referred to known plays, the of those quoted from amounting to ninety, and including entian *Andria*, *Adelphi*, *Eunuchus*, *Heautontimorumenos* fragments contain about 1650 verses or parts of verses, ng a considerable number of words quoted expressly as from ler by the old lexicographers. Besides all these there are er than 758 monostich verses separately preserved in MSS., some of these are met with in the other and longer frag-

Many of the fragments are obscure, some corrupt, and they en a fertile field for critical acumen from the time of Bentley. frequently we come upon the shrewd or original remark of erver. Thus (frag. 7) "A poor man has no relation, for no knowledges him, lest he should beg." Frag. 115: "Every that takes place is brought about by law, necessity, or " 237: "The gods do not give men through any human (prayer or sacrifices); if they did, the human would have ower than the divine." 270: "Poverty is the most costly of all evils, any friend can do it by merely putting his hand pocket." 397, "A poor man who lives in a large town needs t more wretched than he need, for he cannot help comparing n own the luxurious lives of the rich." 476, "No man s the extent of a sin when he commits it; it is afterwards e sees it." 560, "A man is convinced not so much by what as by the manner of saying it." 474, "There is one thing at hides vulgarity, villainy, and every other fault—wealth thing but that is carped at and criticized." 517: "People ve no merit of their own generally boast of their birth and ncestors. But every living man has some, or he would a living man." 578, "Wealth acts on a man as wind does on it often forces him out of his proper course." 663: "Many g lady says a great deal in her own favour by saying nothing." 688, "A man who abuses his own father is practising emy against the gods." In fact, Menander is characteristic sententious writer, like Euripides, with whom in the general f his writings, though not of course in his somewhat loose egular versification, he is sometimes compared. (F. A. P.)

ENCIUS, the Latinized form of Mâng tsze, "Mr ," or "Mâng the philosopher," a name in China only l as a moral teacher to that of Confucius. His statue irit-tablet (as the case may be) has occupied, in the es of the sage, since our 11th century, a place among four assessors"; and since 1530 A.D. his title has "the philosopher Mâng, sage of the second degree."

e Mângs or Mâng sung had been in the time of Con- s one of the three great clans of Lu (all descended the marquis Hwan, 711–694 B.C.), which he had en- ured to curb. Their power had subsequently been n, and the branch to which Mencius belonged had d in Tsâu, a small adjacent principality, the name ich still remains in Tsau hien, a district of Yenchâu tung. A magnificent temple to Mencius is the chief tion of the district city. The present writer visited 1873, and was struck by a large marble statue of him courtyard in front. It shows much artistic skill, and the impression of a man strong in body and mind, ghtful and fearless. His lineal representative lives e city, and thousands of Mangs are to be found in eighbourhood.

e dates of some of the principal events in Mencius's re fixed by a combination of evidence, and his death erred by common consent to the year 289 B.C. He had to a great age, some say to his eighty fourth year, ng his birth in 372 B.C., and others to his ninety th, placing it in 385. All that we are told of his r is that he died in the third year of the child, who hus left to the care of his mother. She was a lady perior character, and well discharged her trust. Her es and dealings with her son were celebrated by a writer in the first century before our era, and for two sand years she has been the model mother of China.

We have no accounts of Mencius for many years his boyhood, and he is more than forty years old w comes before us as a public character. He must hav much time in study, investigating the questions whi rite as to the fundamental principles of moral and and brooding over the condition of the country. T tory, the poetry, the institutions, and the great men past had received his careful attention. He intimat he had been in communication with men who ha disciples of Confucius. That sage had become to l duct of mortal men, the object of his untiring admi and in the doctrines which he had taught Mencius nized the truth for want of an appreciation of wh bonds of order all round him were being relaxed, a kingdom hastening to a general anarchy.

When he first comes forth from Tsau, he is accom by several eminent disciples. He had probably n Confucius to become the master of a school, a couraging the resort to it of inquiring minds t might resolve their doubts and unfold to them th methods of government. One of his sayings is would be a greater delight to the superior man to youth of brightest promise around him and to te train them than to enjoy the revenues of the ki His intercourse with his followers was not contin that of Confucius had been with the members selected circle, and, while he maintained his dignity them, he was not able to secure from them th homage and reverent admiration.

More than a century had elapsed since the d Confucius, and during that period the feudal king Châu had been showing more and more of th of dissolution, and portentous crimes that threate upset all social order were widely disseminated sentiment of loyalty to the dynasty had disap Several of the marquises and other feudal princes o times had usurped the title of king. The smaller s been absorbed by the larger ones, or reduced to a helpless dependence on them. Tsin, after greatly ing its territory, had broken up into three powerful dom, each about as large as England. Meanwhi the nation nominally one, and with the tradition thousand years affirming its essential unity, but divided into seven monarchies, each seeking to sub others under itself. The consequences were contin fare and chronic misery.

In Confucius's time we meet with recluses w withdrawn in disgust from the world, and it turne these had now given place to a class of men wh forth from their retirements provided with arts of chemes of policy which they recommended to the ruling chiefs, ever ready to change their allegiance were moved by whim or interest. Mencius was one about two of them. "Are they not really great men them be angry, and all the princes are afraid. L live quietly, and the flames of trouble are everywh extinguished." He looked on them as little no delighted to proclaim his ideal of the great man language as the following:

"To dwell in love, the wide house of the world to propriety, the correct seat of the world, and to walk in right the great path of the world; when he obtains his desire to practise his principles for the good of the people, and w desires to deny himself to practise them alone; to be a power of riches and honours to make himself poor, of pov mean condition to make him swerve from the right, and of p force to make him bend—these characteristics constitute t man."

Most vivid are the pictures which Mencius gives condition of the people in consequence of the wa states. "The royal ordinances were violated; th

[1] Mahaffy, *Ibid.*, p. 490.

ere oppressed, the supplies of food and drink
way like water.' It is not wonderful that, when
ndations of government were thus overthrown,
ons should have arisen that threatened to over
hat he considered to be the foundation of truth
social order. "A shrill-tongued barbarian from
h,' as Mencius called him, proclaimed the dissolu
anks, and advocated a return to the primitive
y.

"When Adam delved and Eve span,

his followers maintained that learning was
y, and statesmanship craft and oppression, that
nd peasant should be on the same level, and every
everything for himself. Another, called Yang chu,
he difference between virtue and vice, glory and
The tyrants of the past, he said, were now but so
tten bones, and the heroes and sages were no more.
he same with all at death, after that there was but
putridity and rottenness. The conclusion of the
natter therefore was—"Let us eat and drink; let
ty the ear and eye, get servants and maidens,
music, wine, when the day is insufficient, carry it
gh the night. Each one for himself." Against a
research, of a very different stamp, Mencius felt
indignation. This was Mo Ti, who found the
f all the evils of the time and of all time in the
mutual love. He taught, therefore, that men
love others as themselves; princes, the states of
nces as much as their own, children, the parents
s as much as their own. Mo, in his gropings, had
l of a noble principle, but he did not apprehend
rectly nor set it forth with discrimination. To
losopher the doctrine appeared contrary to the
an orthodoxy about the five relations of society,
attacked it without mercy and with an equal
n of thought. "Yang's principle," he said, "is
ne for himself,' which does not acknowledge the
t the sovereign. Mo's is 'to love all equally,'
oes not acknowledge the peculiar affection due to
But to acknowledge neither king nor father is
n the state of a beast. The way of benevolence
nteousness is stopped up."

this seething ocean of lawlessness, wickedness,
, and misery Mencius looked out from the quiet of
od, and his spirit was stirred within him to attempt
ne of the people from the misrule and error. It
e that he would prove the instrument for this pur

"If Heaven," he said, "wishes that the kingdom
enjoy tranquillity and good order, who is there
me to bring it about?" He formed his plan, and
ed to put it in execution. He would go about
the different kings till he should find one among
ho would follow his counsels and commit to him the
dminis tration of his government. That obtained,
not doubt that in a few years there would be a
n so strong and so good that all rulers would
ledge its superiority, and the people hasten from all
s to crown its sovereign as monarch of the whole of
This plan was much the same as that of Confucius
en, but, with the bolder character that belonged to
encius took in one respect a position from which
aster" would have shrunk. The former was always
o Châu, and thought he could save the country by
mation, the latter saw the day of Chau was
d the time was come for a revolution. Mencius's
as the more correct, but he was not wiser
e sage in forecasting for the future. They could
nly of a reformed dynasty or of a changed dynasty,
according to the model principles of a feudal com-
n, which they described in glowing language. They

desired a repetition of the golden age in the remote
but soon after Mencius disappeared from the stage
there came the sovereign of Chin, and solved the q
with fire and sword, introducing the despotic empire
has since prevailed.

An inquiry here occurs: "How, in the execution
plan, was Mencius, a scholar, without wealth or stat
find admission to the courts of lawless and unprin
kings, and acquire the influence over them wh
expected?" It can only be met by our bearing in
the position accorded from the earliest times in Ch
men of virtue and ability. The same written ch
denotes both scholar and officers. They are at the
the social scale, the first of the four classes into wh
population has always been divided. This appreciat
learning or culture has exercised a most powerful in
over the government under both conditions of its
ence, and out of it grew the system, which was org
and consolidated more than a thousand years ago, of
literary merit the passport to official employment
ancient doctrine was that the scholar's privilege wa
Heaven as much as the sovereign's right, the
system is a device of the despotic rule to put it
Heaven's place, and have the making of the schola
own hands. The feeling and conviction out of whi
system grew prevailed in the time of Mencius
dynasties that had successively ruled over the kingd
owed their establishment not more to the military go
their founder, than to the wisdom and organizing
of the learned men, the statesmen, who were their
friends and trusted counsellors. Why should
become to one of the princes of his day what I Y
been to Thang, and Thâi kung Wang to King Wa
the duke of Chau to Wû and Ch'ang? But, though M
might be the equal of any of those worthies, he kne
prince like Thang and the others, of noble aim an
who would welcome and adopt his lessons. In his
ness he overlooked this condition of success for his
prise. He might meet with such a ruler as he loo
or he might reform a bad one, and make him the co
that he required. On the strength of these petadve
and attended by several of his disciples, Mencius w
more than twenty years from one court to another,
baffled, and always ready to try again. He was r
with great respect by kings and princes. He
not enter into the service of any of them, but h
ionally accepted honorary offices of distinction; and
not scruple to receive large gifts which enabled him
and move about as a man of wealth. In deliver
message he was as fearless and outspoken as John
He lectured great men, and ridiculed them. He u
the ways of the old sage kings, and pointed out th
to universal sway; but it was all in vain. He could
any one to honourable action. He confronted here
strong arguments and exposed it with withering sa
but he could work no deliverance in the earth. T
court at which we find him was that of Lû, prob
310 B.C. The marquis of that state had given o
Yo-chang, one of Mencius's disciples, and he hope
This might be the means of a favourable hear
himself. So it had nearly happened. On the sug
of Yo-chang the marquis had ordered his carriage
yoked, and was about to step into it, and proceed t
Mencius to his palace, when an unworthy favourite
in and diverted him from his purpose. The disciple
master what had occurred, reproaching the favourite
ill-timed intervention; Mencius, however, said to h
man's advancement or the arresting of it may see
effected by others, but is really beyond their powe
not finding in the marquis of Lû a ruler who would

and put my lessons in practice is from Heaven." He
d this incident as a final intimation to him of the
Heaven. He had striven long against adverse cir
nces, but now he bowed in submission. We lo-e
f him. He withdrew from court and the public

We have to think of him, according to tradition,
the last twenty years of his life in the congenial
of his disciples, discoursing to them, and giving the
ng touches to the record of his conversations and
ns, which were afterwards edited by them, and con
his works. Living, he may have been a failure,
yet speaking in them, he has been a great power
the ever-multiplying millions of his countrymen.
will any thinker of the West refer to them without
st and benefit. Mencius was not so oracular, not
contained, as Confucius; but his teachings have a
y and sparkle of which we never weary, and which
heir own.

will now attempt to indicate briefly the more important
les which our philosopher thought would have been effectual
merate his country, and make an end of misery and heresy
its borders.

first as to his views on government and the work to be
y rulers for their subjects. Mencius held with Confucius
was a doctrine which had descended to them both from the
st antiquity that royal government is an institution of God
ient sovereign had said that "Heaven, having produced the
appointed for them rulers, and appointed for them teachers
ould be assisting to God. Our philosopher, adopting this
e, was led by the manifest incompetency of all the rulers of
e to ask how it could be known on what individual the
tment of Heaven had fallen or ought to fall, and he concluded
is could be ascertained only from his personal character and
duct of affairs. The people must find out the will of Heaven
ho should be their ruler for themselves. There was another
ng which delighted Mencius. "Heaven sees as the people
eaven hears as the people hear." He taught accordingly
hole government is from God, the governors are from the
, *vox populi vox Dei*.

laim then of a "divine right" should be allowed to a sovereign
re not exercising a rule for the good of the people. "The
are the most important element in a nation; the altars to
its of the land and grain are the second, the sovereign is
htest." Mencius was not afraid to follow this utterance to
sequences. The monarch whose rule is injurious to the
and who is deaf to remonstrance and counsel, should be
ed. In such a case "killing is no murder."

who is to remove the sovereign that thus ought to be removed?
is had three answers to this difficult question. First, he
have the members of the royal house perform the task. Let
lisown their unworthy head, and appoint some better man
al of their number in his room. If they could not or would
this, he thought, secondly, that any high minister, though
ied to the royal house, might take summary measures with
vereign, assuming that he acted purely with a view to the
weal. His third and grand device was what he called "the
er of Heaven." When the sovereign had become a pest
l of a blessing, he believed that Heaven would raise up some
r the help of the people, some one who should so conduct
f in his original subordinate position as to draw all eyes and
to himself. Let him then raise the standard not of rebel-
t of righteousness, and he could not help attaining to the
t dignity. Mencius hoped to find one among the rulers
day who might be made into such a minister, and he
lled one and another to adopt measures with that object.
in fact counselling rebellion, but he held that the house of
ad forfeited its title to the throne.

t now were the attributes which Mencius considered necessary
stitute a good government according to his ideal of it? It
be animated by a spirit of benevolence, and ever pursue a
of righteousness. Its aims must be, first, to make the people
f, and next, to educate them. No one was fit to occupy the
who could be happy while any of the people were miserable,
elighted in war, who could indulge in palaces and parks
the poorest did not in a measure share with him. Game
eceived his emphatic condemnation. Taxes should be light,
l the regulations for agriculture and commerce of a character
note and encourage them. The rules which he suggested to
those objects had reference to the existing condition of his
y, but they are susceptible of wide application. They carry
n schemes of drainage and irrigation for land, and of free
commerce. But it must be, he contended, that a sufficient
and certain livelihood be secured for all the people. Without
their minds would be unsettled and they would proceed to
form of wild license. They would break the laws, and the
would punish them—punish those whom his neglect of his
duties had plunged into poverty, of which crime was the conse
He would be, not their ruler, but their "trapper."

Supposing the people to be made well off, Mencius taught
education should be provided for them all. He gave the m
of Thang a programme of four kinds of educational institu
which he wished him to establish in his state—in the villa
the towns, for the poor as well as the rich, so that none m
remorant of their duties in the various relations of society
after all, unless the people could get food and clothing b
labour, he had not much faith in the power of education to
them virtuous. Give him, however, a government fulfilli
conditions that he laid down, and he was confident there
soon be a people, all contented, all virtuous. And he saw
to prevent the realization of such a government. Any ruler
become, *if he would*, "the minister of Heaven," who was hi
and the influence of his example and administration would
powerful. The people would flock to him as their priest, a
him to do justice on the foes of truth and happiness. Pu
grains would be abundant as water and fire, and the mult
well clothed and well principled, would sit under the s
their mulberry trees, and hail the ruler "King by the g
Heaven."

Secondly, as to Mencius' view about human nature. H
viction of the goodness of that encouraged him to hope fo
grand results from good government, and his direction to
object gives his principal title to a place among philos
thinkers.

Opinions were much divided about it among his contemp
Some held that the nature of man is neither good nor bad,
be made to do good and also to do evil. Others held t
nature of some men is good, and that of others bad; that m
the best of men sometimes have bad sons, and the worst
good sons. It was also maintained that the nature of man
and whatever good appears in it is the result of cultivatio
opposition to all these views Mencius contended that the n
man is good. "Water," he said, "will flow indifferently
east or west; but will it flow indifferently up or down
tendency of man's nature to goodness is like the tendency
to flow downward. By striking water you may make it le
your forehead, and by damming and leading it you may
go up a hill. But such movements are not according to the
of water, it is the force applied which causes them. Wh
do what is not good, their nature has been dealt with
way."

Mencius had no stronger language than this—as indeed
be difficult to find any stronger, to declare his belief of the g
of human nature. With various, but equally felicitous, illu
he replied to his different opponents. Sometimes he may
express himself too strongly, but an attentive study of his
how that he is speaking of our nature in its ideal, and n
actually is, as we may ascertain, by an analysis of it, tha
intended to be, and not as it has been made to become.
his doctrine of human nature is hardly to be distinguish
that of Bishop Butler, while the Christian prelate is left far
as the charm of style is concerned.

Our author insists on the constituents of human nature, e
especially on the principle of benevolence, righteousness, pr
and wisdom or knowledge the last including the judg
conscience. "These," said he, "are not infused into
without. Men have these principles just as they have th
limbs." But man has also instincts and appetites which se
own gratification without reference to righteousness or an
control. He met this difficulty by contending that human
is a constitution, in which the higher principles are des
rule the lower. "Some constituents of it are noble and
ignoble, some great and some small. The great must
injured for the small, not the noble for the ignoble."

One of his most vigorous vindications of his doctrine
following. "For the mouth to desire flavours, the eye
the ear sounds, and the four limbs ease and rest belong t
nature. An individual's lot may restrict him from the enjo
of them, and in such a case the superior man will not s
nature demands that pleasure, and I *will get it*. On th
hand, there are love between father and son, righteousness
ruler and minister, the rules of ceremony between host an
and knowledge seen in recognizing the able and virtuous,
the sage's fulfilling the heavenly course—these are appoin
Heaven. But they also belong to our nature and the
man will not say, The circumstances of my lot require
them." In his preliminary dissertation to the 7th edition
encyclopedia, Sir James Mackintosh has said that in his
on human nature Butler taught to the more worthy of th
of discovery than any in the whole department of inqui

e an acquainted; if we ought not to except the first steps
ecian philosophers toward a theory of moral. Menemus
or to Zeno, the one of those philosophers to whom Butler
adamity, and it does not appear that he had left anything
n of them to discover.

he proceeded from his ideal of human nature to account
phenomena of conduct so different from what they ought
cording to that ideal, he was necessarily less successful
zzled him and they made him indignant and angry. "There
g good," he said "that a man cannot do, he only does
t." But why does he not do it? Against the stubborn
ems beat his wing and shatters his weapons all in vain
tions a few ancient worthies who, he conceived, had always
who had become, perfectly virtuous. Above them all he
ontheus, taking no notice of that ego's confession that he
attained to conformity to his own rule of doing to others
could have them do to him. No such acknowledgment
himself ever came from Menedemus. Therein he was inferior to
Socrates. He had a subtler faculty of reproof, and a much
ved interpretation; but he did not know himself nor his
ubject of human nature as well.

mus will not allow us to go into a detail of his views on
ecial subjects. A few passages illustrative of his style and
technique will complete all that can be said of him here.
ughts, noted were seldom condensed like those of "the
into aphorism," and should be read in their connection:
have from him many words of wisdom that have been as
millions for more than two thousand years. For in

ough a man may be wicked yet, if he adjust his thoughts,
l battle, he may sacrifice to God."

en Heaven is about to confer a great office on any man, it
rcises his mind with suffering, and his sinews and bones
It exposes his body to hunger, subjects him to extreme
, and confounds his undertakings. In all these ways it
es his mind, strengthens his nature, and supplies his in
ncies."

great man is he who does not lose his child heart."

ense of shame is to a man of great importance. When one
ed of having been without shame, he will afterwards not
casion for shame."

nourish the heart there is nothing better than to keep the
w. Here is a man whose desires are few, in some things
not be able to keep his heart, but they will be few. Here
n who e desires are many, in some things he may be able
his heart, but they will be few."

nevolence is the distinguishing characteristic of man. As
d in his conduct, it may be called the path of duty."

re is an ordination for everything, and a man should receive
ively what may be correctly ascribed thereto. He who has
ot order of what Heaven's ordination is will not stand
a tottering wall. Death sustained in the discharge of one's
may be correctly ascribed to Heaven. Death under handcuffs
ers cannot be correctly so ascribed."

hen one by force subdues men they do not submit to him
When he subdues them by virtue, in their hearts' core
e pleased, and sincerely submits."

ublications of the work of Mencius are within the reach of European
that by the late Stanislas Julien in Latin, Paris, 1824-29, and that
he second volume of Legge's *Chinese Classics*, Hong Kong, 1862. The
been published at London (1875) without the Chinese text. See also E.
The Mind of Mencius, or Political Economy founded upon a Moral Philosophy,
from the German by A. R. Hutchinson (London, 1892). (J. LE.)

NDELSSOHN, FELIX (1809–1847). Jakob Ludwig
Mendelssohn Bartholdy, one of the greatest com-
of this century, was the grandson of Moses Men-
se noticed below, and was born in Hamburg on
ary 3, 1809.

onsequence of the troubles caused by the French
tion of Hamburg, Abraham Mendelssohn, his father,
ed in 1811 to Berlin, where his grandmother,
t, then in the twenty fifth year of her widowhood,
d the whole family into her house, No. 7 Neue
nade. Here the little Felix and his sister Fanny
d their first instruction in music from their mother,
whose care they progressed so rapidly that the
her exceptional character of their talent soon
unmistakably apparent. Their next teacher was
ie Bigot, who, during the temporary residence of the
in Paris in 1816, gave them some valuable instruc
On their return to Berlin they took lessons in
glass and composition from Zelter, in pianoforte-
g from Ludwig Berger, and in violin playing from
Henning, the care of their general education being
trusted to the father of the novelist Paul Heyse.

Felix first played in public on the 24th of Oc
1818, taking the pianoforte part in a trio by Woelffl.
April 11, 1819, he entered the Berlin Singakademie
alto, and in the following year began to compose
extraordinary rapidity. His earliest dated work is a ca
In ruhrend feierlichen Tonen, completed on Januar
1820. During that year alone he produced nearly
movements, including songs, pianoforte sonatas, a
for pianoforte, violin, and violoncello, a sonata for
and pianoforte, pieces for the organ, and even a
dramatic piece in three scenes. In 1821 he wrot
symphonies for stringed instruments, each in three
ments, motetts for four voices; an opera, in on
called *Soldatenliebschaft*; another, called *Die beiden*
gegen; part of a third, called *Die wandernde Comedi*
and an immense quantity of other music of different
some of which, thought worthy of publication b
editors of his posthumous works, now stands befo
world in evidence of the precocity of his genius.
original autograph copies of these early productio
now preserved in the Berlin Library, where they for
of a collection which fills forty-four large volum
written with infinite neatness, and for the most
carefully dated a sufficient proof that the meth
habits which distinguished his later life were form
early childhood.

In 1821 Mendelssohn paid his first visit to Goethe
whom he spent sixteen days at Weimar, in company
Zelter. From this year also dates his first acquai
with Weber, who was then in Berlin superintendi
production of *Der Freischutz*; and from the summ
1822 his introduction, at Cassel, to another of the g
of his contemporaries, Ludwig Spohr. During thi
his pen was even more prolific than before, prod
among other works, an opera, in three acts, entitl
beiden Neffen, oder Der Onkel aus Boston, and a pian
concerto, which he played in public at a concert
by Frau Anna Milder.

It had long been a custom with the Mendelssohn
to give musical performances on alternate Sunday mo
in their dining room, with a small orchestra, which
always conducted, even when he was not tall enou
be seen without standing upon a stool. For each o
occasions he produced some new work, playing the
forte pieces himself, or entrusting them to Fanny,
his sister Rebecka sang, and his brother Paul play
violoncello. In this way *Die beiden Neffen* wa
privately performed, on the fifteenth anniversary
birthday, February 3, 1824. Between the 3d and th
of March, in this year, he composed his fine symph
C minor, now known as Op. 10, and soon afterwar
quartett in B minor, Op. 3, and the (posthumous)
forte sestett, Op. 110. In this year also began his
friendship with Moscheles, who, when asked to receiv
as a pupil, said, "If he wishes to take a hint fro
as to anything new to him, he can easily do so;
stands in no need of lessons."

In 1825 Abraham Mendelssohn took Felix to
where among other musicians then resident in the
apital he met the two most popular dramatic com
of the age, Rossini and Meyerbeer, and lived on
of intimacy with Hummel, Kalkbrenner, Rode, B
Herz, and many other artists of European celebrity
this occasion, also, he made his first acquaintance
Cherubini, who, though he rarely praised any one, exp
a very high opinion of his talent, and recommende
to write a *Kyrie*, for five voices, with full orc
accompaniments, which he himself described as "exc

xless" anything he had attempted. From letters at this period we learn that Felix's estimate of the school of music was very far from a flattering nt he formed some friendships in Paris, which easantly renewed on later occasions. He returned in with his father in May 1825, taking leave of risian friends on the 19th of the month, and pting his journey at Weimar for the purpose of a second visit to Goethe, to whom he dedicated his t in B minor. On reaching home he must have to work with greater zeal than ever; for on the July in this same year he completed his pianoforte io in F sharp minor (Op. 5), and on the 10th of an opera, in two acts, called *Die Hochzeit des ho*, a work of considerable importance, concerning we shall presently have to speak more particularly ordinary boy could have escaped uninjured from ares attendant upon such a life as that which ssohn now lived. Notwithstanding his overwhelm sion for music, his general education had been so red for that he was able to hold his own, in the of his seniors, with the easy grace of an accomplished the world. He was already recognized as a leading irit by the artists with whom he associated, and rtists were men of acknowledged talent and position. mptations to egoism by which he was surrounded have rendered most clever students intolerable. But ural amiability of his disposition, and the healthy ce of his happy home life, counteracted all tendencies s inordinate self-assertion; and he is described by o knew him at this period as the most charming aginable. Even Zelter, though by nature no less ive than Cherubini, was not ashamed to show that proud of him; and Moscheles, whose name was famous, met him from the first on equal terms.

after his return from Paris, Abraham Mendelssohn d from his mother's residence to No. 3 Leipziger , a roomy, old-fashioned house, containing an t music-room, and in the grounds adjoining a enhaus" capable of accommodating several hundred at the Sunday performances.[1] In the autumn following year this "garden-house" witnessed a able private performance of the work by means of the greatness of Mendelssohn's genius was first d to the outer world—the overture to Shakespeare's *mmer Night's Dream*. The finished score of this composition is dated "Berlin, August 6, 1826,"

to say, three days after its author had attained the seventeen years and a half. Yet we may safely that in no later work does he exhibit more originality ght, more freshness of conception, or more perfect y over the details of technical construction, than delightful inspiration, which, though now nearly ears old, still holds its place at the head of the most t achievements of our modern schools. The overas first publicly performed at Stettin, in February under the direction of the young composer, who his bright patent of artistic nobility to support his was at once accepted as the leader of a new and characteristic manifestation of the spirit of modern ss. Henceforth therefore we must speak of him, not udent, but as a mature and experienced artist.

nwhile *Camacho's Wedding* had been submitted to General-Musik-Director Spontini, with a view to its tion at the opera. The libretto, founded upon an e in the history of Don Quixote, was written by manu, and Mendelssohn threw himself into the spirit of the romance with a keen perception of its humour. The work was put into rehearsal soon af composer's return from Stettin, produced on Ap 1827, and received with great apparent enthusiasm for some reason which it is now impossible to a a cabal was formed against it, and it never reached a performance. The critics abused it mercilessly, exhibits merits of a very high order. The solemn for the trombones, which heralds the first appear the knight of La Mancha, is conceived in a sp reverent appreciation of the idea of Cervantes, would have done honour to a composer of experience. Even the critics suborned to condem work could not refrain from expressing their adm of this—but it had been decreed that the opera not live—and it did not.

Mendelssohn was excessively annoyed at this m and some time elapsed before his mind recovered it bright tone, but he continued to work diligently cause of art. Among other serious undertakin formed a choir for the study of the great choral of Sebastian Bach, then entirely unknown to the and, in spite of Zelter's determined opposition, succeeded, in 1829, in inducing the Berlin Singak to give a public performance of the *Passion accor St Matthew*, under his direction, with a chorus of three and four hundred voices. The scheme su beyond his warmest hopes, and proved the me restoring to the world great compositions with wh are all now familiar, but which, at that time, had nev heard since the death of Bach. But the obstructiv were grievously offended; and at this period Mend was far from popular among the musicians of Berli

In April 1829 Mendelssohn paid his first v London. His reception was most enthusiastic. H his first appearance before an English audience at the Philharmonic Society's concerts—then held Argyll Rooms on the 25th of May, conduct symphony in C minor from the pianoforte, to which led by John Cramer. On the 30th he played *Concertstück*, from memory, a proceeding at tha extremely unusual. At a concert given by Dronet, 24th of June, he played Beethoven's pianoforte con E flat, which had never before been heard in the c and the overture to *A Midsummer Night's Dream* w for the first time, presented to a London audienc returning home from the concert, Mr. Attwood organist of St Paul's Cathedral, left the score overture in a hackney coach, whereupon Mend wrote out another, from memory, without an err another concert he played, with Moscheles, his s published concerto in E, for two pianofortes and or After the close of the London season he starte Klingemann on a tour through Scotland, where inspired with the first idea of his overture to *Fingal*, returning to Berlin at the end of No Except for an accident to his knee, which lamed some considerable time, his visit was a highly u one, and laid the foundation of many firm friendsh many prosperous negotiations in the time to come.

The visit to England formed in reality the firs only of a great scheme of travel which his father him to extend to all the most important art c Europe. After refusing the offer of a professo Berlin, he started again, in May 1830, for Italy, on his way at Weimar, where he spent a memorab night with Goethe, and reaching Rome, after many interruptions, on November 1. No possible excitement ever prevented him from devoting a time every day to composition, but he lost no oppo

[1] After Mendelssohn's death this house was sold to the Prussian ment; and the "Herrenhaus" now stands on the site of the house.

ing either the countless treasures which form the
ory of the great city or the manners and customs of
Romans. He attended, with insatiable curiosity,
ices in the Sistine Chapel; and his keen power of
tion enabled him to throw much interesting light
hem. His letters on this subject, however, lose
f their value through his incapacity to comprehend
e relation existing between the music of Pale-trina
s contemporaries and the ritual of the Roman
. His Lutheran education kept him in ignorance
the first principles of ordinary chanting, and it
ing to find him describing as enormities peculiar
papal choir customs familiar to every village singer
land, and as closely connected with the structure of
nglican chant' as with that of "Gregorian music."
hough he could not agree, in all points, with Baini,
atest ecclesiastical musician then living, he fully
his admiration for the *Improperia*, the *Miserere*, and
tus plenus of the *Lamentationes* and the *Exultet*,
sical beauty of which he could understand, apart
heir ritual significance.

assing through Munich on his return in October 1831,
posed and played his pianoforte concerto in G minor,
epted a commission (never fulfilled) to compose an
for the Munich theatre. Pausing for a time at
rt, Frankfort, and Düsseldorf, he arrived in Paris
ember, and passed four pleasant months in the
l of acquaintances formed in 1825, and in close
rse with Liszt and Chopin. On February 19,
the overture to *A Midsummer Night's Dream* was
at the Conservatoire, and many of his other com
ns were brought before the public, but he did not
her escape disappointments with regard to some of
especially the Reformation symphony, and the visit
ought to a premature close in March by an attack
ver, from which, however, he rapidly recovered.
the 23d of April 1832 he was again in London,
he twice played his G minor concerto at the
rmonic concerts, gave a performance on the organ
Paul's, and published his first book of *Lieder ohne*

He returned to Berlin in July, and during the
he gave public performances of his Reformation
ony, his concerto in G minor, and his *Walpur-
ht*. In the following spring he paid a third visit
ndon for the purpose of conducting his Italian
ony, which was played for the first time, by the
rmonic Society, on the 13th of May 1833. On the
f the same month he conducted the performances at
wer Rhine festival at Düsseldorf, with such brilliant
that he was at once invited to accept the appointment
neral music director to the town, an office which
ed the management of the music in the principal
es at the theatre and at the rooms of two musical
ations. This post he willingly accepted, and it formed
ping stone to a far more important one.

ore entering upon his new duties, Mendelssohn paid
rth visit to London, with his father, returning to
ldorf on the 27th of September 1833. His influence
ed an excellent effect upon the church music and in
ncert-room, but his relations with the management
theatre were not altogether pleasant; and it was
ly this circumstance which first led him to forsake
ltivation of the opera for that of sacred music. At
ldorf he first designed his famous oratorio *St Paul*,
onse to an application from the Cacilien-Verein at
fort, composed his overture to *Die schöne Melusine*,
anned some other works of importance. He liked his
tment, and would probably have retained it much
had he not been invited to undertake the permanent
on of the Gewandhaus concerts at Leipsic, and thus
raised to the highest position attainable in the G
musical world. To this new sphere of labour he re
in August 1835, opening the first concert at the Ge
haus, on the 4th of October, with his overture
Meeresstille, a work possessing great attractions, t
by no means on a level with the *Midsummer
Dream*, *The Isles of Fingal*, or *Melusine*.

Mendelssohn's reception in Leipsic was most enthus
and under their new director the Gewandhaus co
prospered exceedingly. Meanwhile *St Paul* steadi
gressed, and was first produced, with triumphant s
at the Lower Rhine festival at Düsseldorf, on M
1836. On October 3 it was first sung in Engl
Liverpool, under the direction of Sir George Smart
on March 16, 1837, Mendelssohn again directed
Leipsic.

The next great event in Mendelssohn's life was his
marriage, on March 28, 1837, to Cecile Charlotte
Jeanrenaud, whose amiable disposition, surpassing b
and indescribable charm of manner endeared her
who knew her. The honeymoon was scarcely over
he was again summoned to England to conduct *St*
at the Birmingham festival, on September 20th.
this visit he played on the organ at St Paul's
Christ Church, Newgate Street, with an effect
exercised a lasting influence upon English organis
was here also that he first contemplated the proc
of his second oratorio, *Elijah*.

Passing over the composition of the *Lobgesang* in
a sixth visit to England in the same year, the sche
the erection of a monument to Sebastian Bach, an
events on which space does not permit us to enlarge,
Mendelssohn in 1841 recalled to Berlin by the k
Prussia, with the title of Kapellmeister. Thoug
appointment resulted in the production of *Antigone*,
Colonos, *Athalie*, the incidental music to the *Mid
Night's Dream*, and other great works, it proved an
source of vexation, and certainly helped to shorten th
poser's life. In 1842 he came to England for the
time, accompanied by his wife, conducted his
symphony at the Philharmonic, again played the o
St Peter's, Cornhill, and Christ Church, Newgate
and was received with all possible honour by the qu
the prince consort. He did not, however, permit
engagements to interfere with the direction of the G
haus concerts; and in 1843 he founded in Leipsic th
conservatoire which soon became the best musical
in Europe, opening it on April 3, in the buildings
Gewandhaus. In 1844 he conducted six of the
monic concerts in London, producing his new *Mid
Night's Dream* music, and playing Beethoven's pia
concerto in G with extraordinary effect. He retu
his duties at Berlin in September, but happily su
in persuading the king to free him from his most
engagements, and his delight at this relief w
bounded.

After a brief residence in Frankfort, Mend
returned to Leipsic in September 1845, resum
old duties at the Gewandhaus, and teaching re
in the conservatoire. Here he remained, with li
terruption, during the winter,—introducing his
Jenny Lind, then at the height of her popula
the critical frequenters of the Gewandhaus, and
working at *Elijah*, the first performance of which
ducted at the Birmingham festival, on August 26
The enthusiastic reception of this great work is well
Unhappily, the excitement attendant upon its proc
added to the irritating effect of the worries at Berli
a serious inroad upon the composer's health.
return to Leipsic he worked on as usual, but

hat his health was seriously impaired. In 1847 he England for the tenth and last time, to conduct four nances of *Elijah* at Exeter Hall, on the 16th, 23d, and 30th of April, one at Manchester on the 20th, e at Birmingham on the 27th. Again the queen rince consort received him with marked respect,—ight almost venture to say, affection,—and all seemed rous and happy. But the necessary exertion was yond his strength. He witnessed Jenny Lind's first ance at Her Majesty's Theatre, on the 4th of May, and gland on the 9th, little anticipating the trial that d him in the tidings of the sudden death of his sister , which reached him only a few days after his arrival nkfort. The loss of his mother in 1842 had shaken uch, but the suddenness with which this last sad gence was communicated broke him down com . He fell to the ground insensible, and never fully red. In June he was so far himself again that he ble to travel, with his family, by short stages, to aken, where he stayed for some time, illustrating ourney by a series of water-colour drawings, but g no attempt at composition for many weeks. He ed to Leipsic in September, bringing with him nts of *Christus*, *Loreley*, and some other unfinished taking no part in the concerts, and living in the st privacy. On the 9th of October he called on ne Frege, and asked her to sing his latest set of songs. ft the room for lights, and on her return found him ent pain, and almost insensible. It was the begin- f the end. He lingered on, now better now worse, gh four weary weeks, and on the 4th of November ssed away, in the presence of his wife, his brother, is three dear friends, Moscheles, Schleinitz, and and David. A cross now marks the site of his in the Alte Dreifaltigkeits Kirchhof, at Berlin.

delssohn's title to a place among the greatest composers of tury is incontestable. His style, though differing but little nical arrangement from that of his classical predecessors, is erized by a vein of melody peculiarly his own, and easily nishable by those who have studied his works, not only e genuine effusions of contemporary writers, but from the uccessful of the servile imitations with which, even during time, the music-shops were deluged. In less judicious hands id symmetry of his phrasing might, perhaps, have palled e ear; but under his skilful management it serves only to an additional charm to thoughts which derive their chief from the evident spontaneity of their conception. In this, l other matters of a purely technical character, he regarded epted laws of art as the medium by which he might most ly attain the ends dictated by the inspiration of his genius. caring nothing for rules, except as means for producing effect, he scarcely ever violated them, and was never weary of sing their value upon the minds of his pupils. His method terpoint was modelled in close accordance with that practised astian Bach. This he used in combination with an elastic ment of the sonata-form, similar to that engrafted by ven upon the lines laid down by Haydn. The principles d in this arrangement were strictly conservative; yet they l him, at the very outset of his career, to invent a new style original than that of Schubert or Weber, and no less re- le as the embodiment of canons already consecrated by l authority than as a special manifestation of individual

It is thus that Mendelssohn stands before us as at the same champion of conservatism and an apostle of progress; and iefly by virtue of these two apparently incongruous though perfectly compatible phases of his artistic character that his ce and example have, for so many years, held in check the e of reactionary opinion which a little injudicious en- ement might easily have fanned into revolutionary fury. y, this wholesome influence is still at work among us; and oratorios, his symphonies, his overtures, his concertos, and naller pianoforte pieces Mendelssohn sets before us an ex the value of which is universally recognized, and not likely to forgotten.

cerning Mendelssohn's private character there have never vo opinions. As a man of the world, he was more than ordi- accomplished,—brilliant in conversation, and in his lighter ts overflowing with sparkling humour and ready pleasantry, loyal and unselfish in the more serious business of life, an weary of working for the general good. As a friend he varyingly kind, sympathetic, and as true as steel. His ca as a Christian needs no stronger testimony than that allo his own delineation of the character of St Paul; but it is much to say that his heart and life were pure as those of child.

A complete list of Mendelssohn's published compositions—one hundred teen in number, besides some five and twenty unnumbered works of co importance—will be found in the thematic catalogue published by Mes kopf and Härtel at Leipsic, and also in Grove's *Dictionary of M Musicians*, vol. II. pp. 308, 309. Among his miscellaneous writings, we tion a translation of the *Andria* of Terence, in German verse, and an collection of letters, posthumously printed, and calculated to give t a far closer acquaintance with his life and character than any biographer to convey. (W

MENDELSSOHN, Moses (1729–1786), philo and scholar, well known as Lessing's friend and the type of his "Nathan," was born on September 6, 1 Dessau on the Elbe, where his Jewish father made a livelihood by teaching a small school and trans copies of the "law." The leading events of Mendel career have been indicated elsewhere (see Jews, v p. 680). His numerous writings include *Ueber d in metaphysischen Wissenschaften* (1763), which the prize in a competition in which Immanuel Kan part; *Briefe über die Empfindungen* (1764); *Phaedo über die Unsterblichkeit der Seele* (1767), an argum immortality, founded on the nature of the soul as e ing it from the ordinary laws of change, which ha severely criticized by Kant; *Jerusalem, oder die r Macht und Judenthum* (1783), a specially importa tribution to the question of Jewish emancipat number of contributions to his friend Nicolai's *Li briefen* and *Bibliothek der schonen Wissenschaften*; two tracts in Hebrew; and some new German trans from the Old Testament. The controversy which the publication of his *Morgenstunden* (1785-86), to Jacobi's *Briefe über die Lehre Spinoza's*, is said been more or less directly the cause of his death, took place on January 4, 1786 (see Jacobi, vol. 537). Of Mendelssohn's three sons, the second, Ab settled as a banker in Hamburg and married a Jewe Salomon Bartholdy, who bore him four children; th advice of their mother's brother, himself a consci convert from Judaism, were educated as Christian thenceforth joined their mother's second surname t own. The second of them, Felix, is the subject preceding notice. In later life Abraham Mend was accustomed to say, "When I was young I w son of my father; now I am the father of my son. *The Mendelssohn Family*, 1882.

MENDOZA, a city of the Argentine Republic, t town of the province of Mendoza, lies 700 miles north-west of Buenos Ayres, at the foot of the Cord 2510 feet above the sea level, in 32° 53′ S. lat. and W. long. It was formerly a frequent stopping-place route across the Andes by the Uspallata Pass, and rank as one of the best built towns in the country, 1861 it was almost completely destroyed by an ap earthquake, in which the people, for the mos collected in the churches, perished to the num about 12,000. Bravard, a French geologist who ha predicted the catastrophe, was one of those who pe Extensive ruins still mark the site of the old tow new town, which has been built at a little distan grown rapidly. Situated in a richly cultivated Mendoza depends mainly on agriculture and fruit g

The city was founded in 1559 by Garcia de Mendoza, 1776 it was made the administrative centre of the vice-r La Plata. See Mulhall, *Handbook of the La Plata State* and Mrs Mulhall, *Between the Amazon and the Andes*, 188

MENDOZA, Diego Hurtado de (*c.* 1503 novelist, poet, diplomatist, and historian, was a youn of the member of the illustrious Mendoza family t

ernment of Granada was entrusted not long after its
r, and was born in that city about the year 1503.
rquis of Santillana, so prominent a figure at the court
n II. of Castile, was his great grandfather At an
ge Mendoza, who had been destined for the church,
nt to Salamanca, where he studied with success, and
me time between the years 1520 and 1525, produced
arillo de Tormes, the work upon which his literary
y largely rests. Having persuaded his father to
im to enter the army, he served with the Spanish
ot Charles V. in Italy, and also availed himself of
nities as they arose to hear the lectures of famous
ors at Bologna, Padua, and Rome In 1538 he was
nto the diplomatic service of the emperor and sent as
ador to Venice; there he cultivated friendly relations
he Aldi, and energetically set about collecting a
, not only procuring copies of many old MSS. in
blic library of the city, but also sending to Thessaly
ount Athos for new ones, it was from his collection
e complete text of Josephus was first printed. For
me he held the post of military governor of Siena;
fter having been present in an official capacity in
t the beginning of the oecumenical council, he was in
ent as special plenipotentiary to Rome, where he
ned to act for some years. In 1554, shortly before
dication of Charles, he was recalled to Spain, and his
career came to an end He was never a favourite
hilip II., and in consequence of a quarrel with a
r, in which he had lost his temper badly, he was
banished from court in 1568. The remaining years
ife, which were spent at Granada, he devoted partly
study of Arabic, partly to poetical composition, and
to the preparation of his history of the Moorish
ction of 1568 70 (*Guerra de Granada*). He died
drid (which he had obtained leave to visit on some
ss errand) in April 1575.

o.c.) *Lazarillo de Tormes*, though written during his
day, was not published until 1553, when it was printed
ously at Antwerp Next year it was reprinted at Burgos,
mately it was taken exception to by the Inquisition, and the
editions of 1573 and subsequent years are accordingly con-
y abridged It is a comparatively short fragment, written
ure and bright Castilian, and was the first example in modern
e of the "novela picaresca" of which Le Sage's *Gil Blas*
ks as the most perfect specimen. The continuations first
nymous author (1555) and afterwards by H. de Luna (1620),
very inferior interest Of Mendoza as a poet all that need
here is that he followed the modern Italian models quite as
as compatible with a due regard to his Castilian individu
His history, though of no great bulk, is, like his novel, a
remarkable literary execution It relates indeed only to a
atively brief episode in a chapter of events for which it is
impossible to claim much general attention, and it is often
ly erudite and sometimes provokingly obscure But as a
is singularly well-informed, dignified, and picturesque; "the
bold and abrupt, but true to the idiom of the language, and
ent of thought is deep and strong, easily carrying the reader
with its flood. Nothing in the old chronicling style of the
period is to be compared to it, and little in any subsequent
is equal to it for manliness, vigour, and truth" (Ticknor).
t edition of the *Guerra de Granada* did not appear until
nt was even then incomplete, the first perfect edition was
1730 The work has frequently been reprinted since.

NDOZA, Iñigo Lopez de. See Santillana.

NELAUS, king of Sparta, was the brother of
EMNON (*q.v.*) and the husband of Helena (*q.v.*). He
e of the heroes of the Trojan horse, and recovered
e at the sack of the city. On the voyage home-
his fleet was scattered off Malea by a storm which
him to Crete; after seven years' further wandering
prus, Phoenicia, Egypt, Ethiopia, Libya, and the
of the Erembi, he at last had an interview with
s and obtained a favourable wind which brought him
n the very day on which Orestes was holding the
feast over Ægisthus and Clytaemnestra. After a long and happy life in Lacedaemon, Menelaus, as the in law of Zeus, did not die but was translated to Ely

MENGS, Antony Raphael (1728 1779), was the celebrated representative of the eclectic school of pai in the 18th century, and played a great part in the days of the classic revival. He was born in 1728 at A in Bohemia, but his father, a Danish painter, establ himself finally at Dresden, whence in 1741 he conduct son to Rome. Mengs early showed that active intelli and large capacity for laborious study which secured the extraordinary distinction which he enjoyed throug His appointment in 1749 as first painter to the elec Saxony did not prevent his spending much time in I where he had married in 1748, and abjured the Prote faith, and where he became in 1754 director of the Va school of painting, nor did this hinder him on two occa from obeying the call of Charles III. of Spain to Ma There Mengs produced some of his best work, specially the ceiling of the banqueting hall, the subj which was the Triumph of Trajan and the Temple of C After the completion of this work in 1777, Mengs returned to Rome, and there he died, two years lat poor circumstances, leaving twenty children, seven of were pensioned by the king of Spain. Besides num paintings in the Madrid gallery, the Ascension at Dre Perseus and Andromeda at St Petersburg, and the c of the Villa Albani must be mentioned among his works. In England, the duke of Northumberland sesses a Holy Family, and the colleges of All Soul Magdalen, at Oxford, have altar-pieces by his hand his writings, in Spanish, Italian, and German, Meng put forth his eclectic theory of art, which treats of lection as attainable by a well schemed combinati diverse excellences,—Greek design, with the expr of Raphael, the chiaroscuro of Correggio, and the c of Titian. His close intimacy with Winkelmann— constantly wrote at his dictation - has greatly enh his historical importance, for he formed no scholars the critic must now concur in Goethe's judgment of M in *Winkelmann und seine Jahrhundert*; he must de that so much learning should have been allied to a want of initiative and utter poverty of invention embodied with a strained and artificial mannerism.

See *Opere di Antonio Raffaello Mengs*, Parma, 1780; *Werke, übersetzt v. C. F. Prange*, 1786, *Zeitschrift für bi Kunst*, 1880; Bianconi, *Elogio Storico di Mengs*, Milan, Nagler's *Kunstlerlexikon*.

MENHADEN, economically one of the most impo fishes of the United States, known by a great nu of local names, "menhaden" and "mossbunker" those most generally in use. In systematic works pears under the names of *Clupea menhaden* and *Br tus tyrannus*. It is allied to the European species of and pilchard, and, like the latter, approaches the coast wanderings in immense shoals, which are found throu the year in some part of the littoral waters between and Florida, the northern shoals retiring into deeper or to more southern latitudes with the approach of weather. The average size of the menhaden is abo inches. Although it was long known as a palatable fish, and largely used, when salted, for export to the Indies, and as bait for cod and mackerel, the menh fishery has been developed to its present importance within the last twenty years. A large fleet of ste and sailing vessels is engaged in it; and a great num large factories have sprung into existence to extract th which is used for tanning and currying, and for adul ing other more expensive oils, and to manufacture the into a very valuable guano. In the year 1877 2,42 gallons of oil and 55,444 tons of guano were prod

ensive business is also carried on in converting
en of a suitable size into "American sardines."
complete account of this fishery is given by G Brown
"The Natural and Economic History of the American
n," *United States Commission of Fish and Fisheries*, part
ington, 1879.

NIN, a small Belgian town, in the province of West
s; it is traversed by the river Lys, which there
he boundary between France and Belgium. The
ion in 1880 was 10,200. Commercially and
ially Menin ranks high for its size, possessing, as it
nportant manufactures of linen, oil, soap, &c., as
sugar refineries, breweries, and tanneries, and a
orn and cattle market. Tobacco is extensively
in the neighbourhood, and forms one of the main
f lawful trade, a good deal of illicit traffic also being
on across the French frontier.

does not appear to have been in any way worthy of note
e 14th century. Philip II caused it to be fortified in 1578.
taken by Turenne in 1658. Vauban subsequently sur
it with elaborate works, and made it one of the strongest
in France; but all its fortifications were razed in 1744.
ged to the Netherlands in 1815, and became part of Belgium

NINGITIS (from *μῆνιγξ*, a membrane), a term in
ne applied to inflammation affecting the membranes
brain (cerebral meningitis) or spinal cord (spinal
gitis) or both.

erebral meningitis there are two varieties:- (1) that
the presence of tubercle in the membranes of the
which gives rise to the disease known as tubercular
gitis, or acute hydrocephalus; and (2) simple or
meningitis, which may arise from various causes.
g the more common are injuries of the head, exten
f disease from contiguous parts, such as erysipelas of
alp or caries of the bones of the ear, exposure to
r to extreme heat, the presence of tumours in the
nce of the brain. It may likewise occur in the
of fevers, rheumatism, and inflammatory affections,
so as a result of mental overwork, sleeplessness, and
lic excess. This latter variety of meningitis is less
on than the former, but it is on the whole more
ble to treatment. The symptoms present such a
l resemblance to those already described in tubercular
gitis that it is unnecessary to refer to them in detail
(YDROCEPHALUS), and the treatment is essentially the
for both.

nal meningitis, or inflammation of the membranes
ing the spinal cord, generally results from causes of
ilar kind to those producing cerebral meningitis,—
es, exposure to cold or sudden changes of tempera
diseases affecting adjacent parts such as the vertebral
n or the spinal cord itself, or extension downwards
ammation of the membranes of the brain. It is said
most common in males. As in the case of the brain,
embranes become extremely congested; exudation of
and effusion of serum follow; and the spinal cord
oots of the nerves become more or less involved in
orbid process.

e chief symptoms are fever, with severe pain in the
or loins shooting downwards into the limbs (which
he seat of frequent painful involuntary startings),
panied with a feeling of tightness round the body.
ocal symptoms bear reference to the portion of the
the membranes of which are involved. Thus when
nflammation is located in the cervical portion the
es of the arms and chest are spasmodically contracted.
here may be difficulty of swallowing or breathing, or
rrassed heart's action, while when the disease is seated
lower portion, the lower limbs and the bladder and
n are the parts affected in this way. At first there
is excited sensibility (hyperæsthesia) in the parts o
surface of the body in relation with the portion of
affected. As the disease advances these symptoms
place to those of partial loss of power in the aff
muscles, and also partial anæsthesia. These va
phenomena may entirely pass away, and the patient
some weeks or months recover; or, on the other hand,
may increase, and end in permanent paralysis.

The treatment is directed to allaying the pain
inflammatory action by opiates. Ergot of rye is str
recommended by many physicians. The patient s
have perfect rest in the recumbent, or better still i
prone, position. Cold applications to the spine may
use, while scrupulous attention to the functions o
bladder and bowels, and to the condition of the skin
the view of preventing bed-sores, is all important.

Epidemic Cerebro-spinal Meningitis.- This name, as w
cerebro spinal fever, is applied to a disease defined in the *Nom
tion of Diseases* as "a malignant epidemic fever, attended by p
contractions of the muscles of the neck and retraction of the
In certain epidemics it is frequently accompanied by a profus
purpuric eruption, and occasionally by secondary effusions into
joints. Lesions of the brain and spinal cord are found on disse
This disease appears to have been first distinctly recognized
year 1837, when it prevailed as an epidemic in the south-e
France, chiefly among troops in garrison. For several years
quently it existed in various other localities in France, and
among soldiers. At the same time in other countries in w
and central Europe the disease was observed in epidemic outb
both among civil and military populations. In 1846 it first s
itself in Ireland, chiefly among the inmates of workhouses in
and Dublin. Numerous outbreaks occurred also about thi
period in many parts of the United States. In more recen
the disease has repeatedly appeared both in Europe and A
but it has seldom prevailed extensively in any one tract of co
the outbreaks affecting for the most part limited communitie
as garrisons or camps, schools, workhouses, and prisons.

Little is known regarding the causation of this disease. A
seem liable to suffer, and, as regards sex, males are affecte
commonly than females. Occupation and condition of life
to exercise no influence. It has been observed to occu
frequently in cold seasons. The question of the contagio
of cerebro spinal fever remains still unsettled, but the we
authority appears to be in favour of the theory of the comm
bility of the disease. It cannot, however, be regarded as com
in the same degree as some other specific fevers, such as typhu
small-pox, or scarlatina.

The following are the more prominent symptoms. Afte
days of general discomfort the attack comes on sharply with
intense headache, giddiness, and vomiting. Neuralgic p
the abdomen, and pain with spasmodic contractions in the
of the extremities, occur at an early stage. The headache co
with great severity, and restlessness and delirium supervene,
panied with periods of somnolence. The pains and spasms
increase, the muscles of the neck, spine, and limbs being sp
affected. The patient's head is drawn backwards and rigidl
the spine arched, and the arms and legs powerfully flex
whole condition bearing a considerable resemblance to t
For a time there is greatly increased sensibility of the ski
being excited by the slightest contact. There is more or le
present. About the fourth day of the disease an eruption
skin both of the face and body frequently appears, in th
either of purpuric spots or small clear vesicles. Death m
place in from a few hours to eight or ten days. Should the
survive the immediate shock of the attack, serious compl
are apt to appear in the form of destructive inflammation
eyes or ears, inflammation with effusion into certain join
paralysis of limbs; or, again, recovery may take place afte
longed convalescence. The mortality appears to vary in d
epidemics, in some being as high as 80 per cent., in othe
about 20 per cent. Certain forms of the disease are of ma
character from the first, and very rapidly fatal.

The changes found after death in cerebro-spinal fever are
inflammation of the membrane of the brain and spinal co
effusion of serum or pus into the ventricular and arachnoid

The treatment is similar to that of other febrile conditio
for the special symptoms of pain, spasm, &c., opium seems
been found of eminent service, while quinine and ergot of
also recommended.

MENNONITES is a name borne by certain Ch
communities in Europe and America, denoting
adherence to a type of doctrine of which Menno S

ndeed the originator, but the chief exponent at when the anti-pædo-baptism of the congregations he laboured took permanent form in opposition ary Protestantism on the one hand and to the c ideas of the Munster type of anabaptism on the The original home of the views afterwards called te was in Zurich, where, as early as 1525, Grebel nz founded a community having for its most dismark baptism upon confession of faith. The chief s of these Zürich Baptists have been already stated ticle BAPTISTS, vol. iii. p. 353. The main interest ect lay not in dogma but in discipline. Within munities evangelical life was reduced to a law of on from the world, and this separation enforced ngent use of excommunication and the prohibition age beyond the brotherhood involved not only e from worldly vanities but refusal of civic duties te being held to be un Christian)—refusal to take o use the sword. In their revolt against the cor- of the mediæval church the Reformers neither he continuity of the church as an organization nor d the Christian character of the state. The new both, and their position thus appeared so radically ve of the foundations of society that it is not sur under the imperfect views of toleration then current, y became the objects of bitter persecution from nts as well as from Catholics. But the Grebelians lesire, like the fanatics of Münster, to found a new y in opposition to the anti Christian state. They nly to withdraw from what their conscience con content to live as strangers upon earth, and devot their energy to preserve the purity of their own nities. The mediæval conception of separation from ld as the true path of Christian perfection had l all middle class society in Europe, and prepared accept separatist views of the church as soon as re reached by the impulse of revolt against Roman ism; the pursuit of holiness in a society protected ct discipline is an ideal which experience has shown a great attraction for one class of earnest minds; spite of persecutions incomparably fiercer than the larger Protestant bodies ever underwent, the trine and praxis rapidly spread from Switzerland nany, Holland, and even to France. Each com- was quite independent, united to the rest only by a love. There was no sort of hierarchy, but only ers" chosen by the congregation, of whom the ominent were also "elders" entrusted with the ration of the sacraments—an organization so easily ve of reproduced that the movement could hardly ted by any persecution short of the total annihila ch at length was actually the fate of many of the mmunities. The remnants of the Swiss Mennonites 1620 into two parties, the stricter of which, the tes or Upland Mennonites, were distinguished from land Mennonites by holding that excommunication arty dissolved marriage, and by their rejection of and the use of the razor. Their persecution lasted 0; a few congregations still remain and keep es quite distinct from Baptist bodies of more origin. In Germany the Mennonites are some- ore numerous; more important are the German te colonies in southern Russia, brought thither in the empress Catherine, which in turn have recently ny emigrants to America. America indeed, and y Pennsylvania, early became a refuge for the tes of Switzerland, the Palatinate, and Holland, now the chief home of the body (175,000 in the States and 25,000 in Canada). The oldest con- is that of Germantown (since 1683); the most numerous of several divisions are the Old Mennonites, corresponding to the less strict of the Swiss sections.

All these communities in Europe and America are distinguished by an antique simplicity combined with antique prejudices, by indifference to the interests of the greater world, while at the same time their industry and self-concentration have made them generally well-to-do. Their religious type has varied very little in the course of centuries, as indeed is not surprising, their theology being ascetic rather than dogmatic or speculative. The Mennonites of Holland, on the other hand, have passed through an interesting and progressive history.

It was in Holland and the adjoining parts of Low Germany that the personal influence of Menno Simons (1492–1559) was mainly felt. He was originally a priest, and was pastor at his native place Witmarsum in Friesland from 1531 to 1536, when convictions long ripening in his mind compelled him to resign his cure. At this time the anti-pædo-baptist societies in the Low Countries were much agitated. The views which had just before received their political deathblow at Munster (see ANABAPTISTS) were not extinct, and even those who did not share them were by no means at one. Menno attached himself to the Obbenites, who held that on earth true Christians had no prospect but to suffer persecution, refused to use the sword, and looked for no millennium on earth. Menno became one of their elders, and by his wanderings among the scattered and oppressed communities, and especially by the natural eloquence and religious power of his numerous writings, did much to sustain the faith of his associates, to confirm the type of their religious life, and to prevent startling aberrations in doctrine or discipline. He was not an original thinker; but the love which all felt for the man, and which was kept alive for generations by his writings, gave him the place which the name of Mennonites expresses.

It may be ascribed to the influence of Menno's writings that the Dutch Mennonites, though for a time (since 1554) they broke into fractions on questions of discipline, and especially on the effect of excommunication upon marriage, never fell so far apart as regards the type of their religious life as to preclude the possibility of reunion. The Waterlanders in North Holland, who held the least strict doctrine of excommunication, soon moved farther in the direction of liberality, and exchanged the name Mennonites for that of Doopsgezinden (Baptist persuasion). In 1579 they refused to condemn any one for opinions, even on the incarnation, which the word of Scripture did not pronounce necessary to salvation. They aided William the Silent with money, and from 1581 to 1618 even accepted civil office. Meantime the stricter party had undergone various divisions, which, however, in 1627–32 were reunited on the basis of confessions essentially embodying Menno's teachings. They too had learned moderation, at least in their views of excommunication, and their antithesis to the state was softened since the cessation of persecution in 1581, but especially since in 1672 they were recognized as citizens. On the other hand, the adoption of a confession had deepened the separation between them and the liberal Doopsgezinden; but doctrine was never the fundamental principle of the Mennonite communities, confessionalism took no firm root, and the two sections gradually approached, and through a series of partial fusions became at length finally united when the Amsterdam congregations came together in 1801. The persuasion declined much in numbers in the 18th century; since then it has increased, and has now 127 congregations with nearly 50,000 members. The objection to hold civil office disappeared in 1795; that to carry arms in the war of freedom against Napoleon. Baptism on profession of faith and the refusal of the oath, tolerance in matters of doctrine without religious indifference, are the chief marks of the body, which in point of theological culture and general enlightenment, philanthropic zeal and social importance, has long stood very high.

Authorities. The best life of Menno Simons is Cramer's, 1837. De Hoop Scheffer's article in Herzog-Plitt, *R. E.*, is excellent; only one point of consequence in his account seems to call for modification,—the book against John of Leyden said to have been published before Menno joined the Obbenites, is almost certainly spurious. See Sepp, *Geschiedkundige Nasporingen*, 1. (1872) p. 128 *sq.* The completest edition of Menno's works is that in folio, 1686. Many of them are known only in bad Dutch versions; Menno himself wrote in the "Oostersch" or East Sea Dialect of Low German. For the literature on the Mennonites in general, see De Hoop Scheffer, on whom the foregoing sketch is mainly dependent.

MENSHIKOFF, ALEXANDER DANILOVICH (1672–1729), born at Moscow on the 17th of November (o.s.) 1672, was the son of a poor man, who employed him to sell cakes about the streets of that city. In this humble occupation he attracted the attention of Lefort, one of Peter the Great's most active co-operators, who was pleased with his sprightliness, and took him into his service. Peter, soon afterwards

the youn at Lefort's, was also delighted with him, ok him to be his page. Menshikoff soon became nsable to the czar, assisting him in his workshop, playing signal bravery in the company of his master siege of Azoff. He formed one of the suite of Peter his travels, and worked with him at Saardam and rd. Throughout his wars with the Swedes, Men- was the companion of the czar, and greatly distin- l himself. For his gallantry at the battle of the on the 7th of May (o.s.) 1703, he received the order Andrew. In 1704 he was made general, and at the of the czar created a prince of the Holy Roman e. His house on the Vasilii-Ostroff was magnificent; mbassadors were received, and banquets were given us with gold and silver plate. Unfortunately there rk side to the picture, and the favourite was guilty rtion to such an extent as to bring him under his 's censure. On the death of Peter the position of ikoff became very perilous; his successes had raised him a host of enemies eager for his downfall. The ns, Dolgoroukis, and all those who formed what may ed the Old Russian party, wished to proclaim the Alexis emperor. Those, however, whose aggrandize- was bound up with Peter's reforms—Menshikoff, sin, Bontourlin, Goloffkin, and others— were in favour ng the crown to Peter's widow, who accordingly ed the throne as Catherine I. During her reign the ce of Menshikoff was unbounded, and he virtually ed the country; but the empress died in 1727, reign of two years. She had made a will, no at the instigation of the favourite, to the effect eter, her grandson, was to be czar under the guardian- Menshikoff, whose daughter Mary was to be married youthful sovereign. Under pretence of taking care young czar, Menshikoff caused him to be removed house and surrounded him with his creatures. He w at the height of his power; foreign ambassadors ed that even the great Peter himself was never so much. The young czar, however, showed no on for Mary Menshikoff, and the girl was equally tic towards her betrothed, being in love with a r of the family of Sapieha at the time her father orced her into the engagement. The Dolgoroukis he aversion of the young prince to his *fiancée* as a means of creating dislike to the father. A chain of e was gradually leading to the downfall of the favo He was soon refused admittance to the summer p whither the young czar had retired. Next he was arr and so overpowered was he at his disgrace tha had an apoplectic stroke. In vain did he address l both to the emperor and his sister. Shortly atte order of the czar, the fallen magnate departed St Petersburg, but more like a nobleman retiring t estate than a culprit going into exile. The people reg him with dislike, and most of them rejoiced over hi On his way a courier arrived with orders to tak czar's ring of betrothal from his daughter Mary an her back her own, which had been worn by Pet Menshikoff was not permitted to pass through Mo but was conducted to Oranienburg, in the govern Riazan, and there placed under strict surveillance. afterwards the whole family was banished to Siberia arrived at Berezoff towards the end of 1727. Menshi wife died on the journey, and was buried near Kazan. the arrival of the prisoners they were lodged in a w house, consisting of four rooms. But Menshikoff di long endure the horrors of exile in this inclement re According to Mannstein, he died (November 12, 1729) of an apoplectic stroke, because there was n at Berezoff, as he himself remarked, who understood to open a vein. The young czar ordered the release exile of the two remaining children of Menshikoff, daughter Mary had died at Berezoff in the same as her father, and restored some of their proper them.

MENSHIKOFF, Alexander Sergeievich (1787–1 great-grandson of Peter's favourite, born in 1787, e the Russian service as attaché to the embassy at Vienna accompanied the emperor Alexander throughout his paigns against Napoleon, and attained the rank of ge but retired from active service in 1823. He then de himself to naval matters, and put the Russian n which had fallen into decay during the reign of Alex on an efficient footing. On the outbreak of the Cr War he was appointed commander in chief, and suff severe defeat at the Alma. On the death of the em Nicholas in 1855 he was recalled, ostensibly on ac of failing health. He died in 1869.

MENSURATION

ENSURATION, or the art of measuring, involves the construction of measures, the methods of using and the investigation of rules by which magnitudes it may be difficult or impossible to measure directly lculated from the ascertained value of some associated tude. It is usual, however, to employ the term ration in the last of these senses; and we may ore define it to be that department of mathematical e by which the various dimensions of bodies are ated from the simplest possible measurements.

determination of the lengths and directions of nt lines, including what are familiarly known as ms in heights and distances, generally depends on olution of triangles, and will be discussed in the s Trigonometry and Surveying. The remaining ns of the subject are the determinations of the s of curves, the areas of plane or other figures, and olumes and surfaces of solids; and it is of mensura s thus restricted that the present article will discuss of the more important problems.

Units of Length, Area, and Volume.—In measuring agnitude we select some standard or "unit" to measure by. Thus in measuring length we take for u inch, a foot, or a yard. From the unit of length we the units of area and volume. Thus we define the u area to be the area of the square described upon th of length, and the unit of volume to be the volume cube whose edge is the unit of length or whose side unit of area. For example, if an inch be taken as th of length, the square whose side is 1 inch is the u area, and the cube whose edge is 1 inch is the u volume. The length of a line, the area of a surfac the volume of a solid are then expressed by the nu whole or fractional, of units of length, area, and v which they respectively contain. Hence, if l deno linear unit, the length of a line which contains a units or simply a since l is unity; similarly the area of a s which contains b units of area is bm, or simply b, m is the unit of area.

§ 2. *Commensurable and Incommensurable Magnitu* When two magnitudes have a common measure, t when another magnitude can be found which is co in each an exact number of times, they are said "commensurable." Thus a line 4½ and another 3½

e commensurable; for, if $\frac{1}{9}$ inch be taken as unit of the former contains the unit nine times and the seven times. If no common measure can be found, o magnitudes are said to be "incommensurable" stance, 1 and $\sqrt{2}$ have no common measure; for ·1112 . . . an interminable decimal, and hence no owever small, can be found which will be contained an exact number of times. If, however, we take ·1, the error will be less than $\frac{1}{10}$, if $\sqrt{2}$ 1·111, ror will be less than $\frac{1}{10000}$, &c. Hence, by taking a nt number of figures, we can find a fraction which ffer from $\sqrt{2}$ by less than any assignable quantity, herefore we can always find two commensurable ades that will represent two incommensurable ones degree of accuracy we please. In what follows we herefore only consider commensurable lines.

Area of a Rectangle.—Let the side AB (fig. 1) con units and the side BC b units of length. If we AB into a equal parts, qual to the unit of length, milarly BC into b equal nd it through the points ision we draw lines l to the sides of the gle, these lines will di e rectangle into a series angles, each of which t of area, since each is are whose sides are of ngth. As we have a rows of these rectangles, and ch row, the whole number of rectangles will be ab. ore

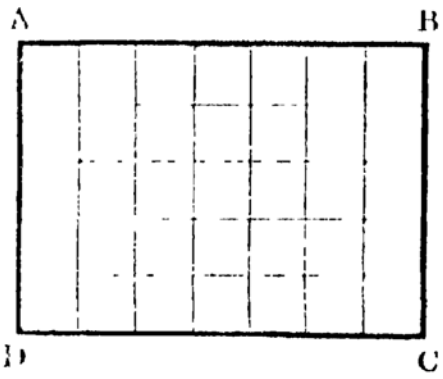


Fig. 1

area of ABCD ab units of area
ab

PART I.—PLANE FIGURES.

ON I. PLANE FIGURES CONTAINED BY STRAIGHT LINES.

A. *The Rectangle.*

Let ABCD (fig. 2) be a rectangle, and let AB = CD = a, = b, AC = c, and the angle ; it is required to find its area. rectangle is completely de- d when two independent data, which at least is a length, are onnecting its parts, we can de its area in the following cases.

When its length a and its breadth b are given.—It has already been proved

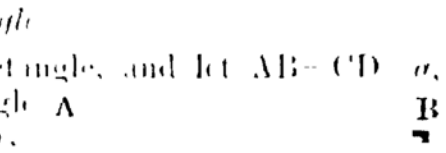


Fig. 2.

area of ABCD $= ab$;

rea of a rectangle is equal to its length multiplied by its

ple.—Let a = 12 feet 6 inches and b = 9 inches, then

area of ABCD = 12·5 × ·75 = 9·375 square feet.

ake use of logarithms in the above calculation we have

$$\log \text{area} = \log a + \log b,$$

$\log a$	$\log 12{\cdot}5$	1·0969100
$\log b$	$\log\ {\cdot}75$	1·8750613
$\log \text{area}$		
area		9·375

When a side a and the diagonal c are given.—By Euclid have

$$b^2 = c^2 - a^2, \text{ or } b = \sqrt{c^2 - a^2},$$

$$\text{area of ABCD} = ab = a\sqrt{c^2 - a^2},$$

$$\log \text{area} = \log a + \tfrac{1}{2}\log(c^2 - a^2) + \tfrac{1}{2}\log(c + a).$$

ple.—Let a = 238 and c = 456, then

$\log a$	$\log 238$	2·3765770
$\frac{1}{2}\log(c+a)$	$\frac{1}{2}\log 694$	1·4206797
$\frac{1}{2}\log(c-a)$	$\frac{1}{2}\log 218$	1·1692282
$\log \text{area}$		4·9664849;
area		= 92573·1.

(γ) When a side a and α its inclination to the diagonal are given.—Since

$$\frac{b}{a} = \tan\alpha, \quad b = a\tan\alpha,$$

and therefore area of ABCD = $ab = a^2\tan\alpha$;

or $\log \text{area} = 2\log a + \text{L}\tan\alpha - 10$.

Example. Let a = 36 and α = 32° 25′ 15″, then

$2\log a = 2\log 36 = 3{\cdot}1126050$

$\text{L}\tan\alpha = \text{L}\tan 32° 25′ 15″ = 9{\cdot}8028622$

therefore $\log \text{area} = 12{\cdot}9154672 - 10 = 2{\cdot}9154672$;

hence area = 823·127.

(δ) When the diagonal c and α its inclination to either of the sides are given.—We have

$$a = c\cos\alpha, \text{ and } b = c\sin\alpha,$$

therefore area of ABCD $= ab = c^2\sin\alpha\cos\alpha = \frac{1}{2}c^2\sin 2\alpha$;

or $2\,\text{area} = c^2\sin 2\alpha$,

and hence $\log 2\,\text{area} = 2\log c + \text{L}\sin 2\alpha - 10$.

§ 5. A square being a rectangle whose sides are equal, we can at once determine its area. When one datum, which must be a length, is given the square is completely determined, and hence we have only two cases to consider.

(α) When the side is given.—From § 4, α, we have at once

$$\text{area of square} = ab = a \times a = a^2.$$

(β) When the diagonal c is given.—From § 4, β, we have

$$a^2 + a^2 = c^2, \text{ or } a^2 = \tfrac{1}{2}c^2;$$

hence area of square $= a^2 = \frac{1}{2}c^2$, or $2\,\text{area} = c^2$;

and therefore $\log 2\,\text{area} = 2\log c$.

B. *Right-angled Triangles.*

§ 6. The diagonal of every rectangle divides it into two equivalent right angled triangles (Euel. i. 34), and hence the area of the right-angled triangle ABC (fig. 2) is equal to half the area of the corresponding rectangle ABCD.

C. *Triangles Generally.*

§ 7. In every triangle there are six elements to be considered, namely, the three sides and the three angles. If any three of these six be given, provided one is a length, the triangle is completely determined, and hence its area can be found.

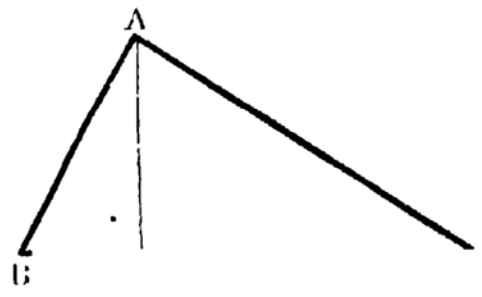


Fig. 3

§ 8. *Length of Perpendiculars of a Triangle.*—In the triangle ABC (fig. 3) let BC = a, CA = b, AB = c, AD the perpendicular from A on BC = h, BD = x, and CD = y.

Since BDA and CDA are right angles, we have

$$c^2 = x^2 + h^2, \text{ and } b^2 = y^2 + h^2,$$

and therefore

$$b^2 - c^2 = y^2 - x^2 = (y + x)(y - x) = a(y - x);$$

whence $$y - x = \frac{b^2 - c^2}{a}.$$

But $y + x = a$, and, by solving these equations, we obtain

$$y = \frac{b^2 + a^2 - c^2}{2a}.$$

Again

$$h^2 = b^2 - y^2 = b^2 - \left(\frac{b^2 + a^2 - c^2}{2a}\right)^2 = \frac{(2ab)^2 - (b^2 + a^2 - c^2)^2}{4a^2}$$

$$= \frac{(a + b + c)(b + c - a)(c + a - b)(a + b - c)}{4a^2};$$

hence $$h = \frac{1}{2a}\sqrt{(a+b+c)(b+c-a)(c+a-b)(a+b-c)}.$$

Now let $a + b + c = 2s$, then $b + c - a = 2(s - a)$, $c + a - b = 2(s - b)$, and $a + b - c = 2(s - c)$.

Therefore, on substituting and reducing, we obtain

$$h = \frac{2}{a}\sqrt{s(s-a)(s-b)(s-c)}.$$

Similarly the perpendiculars from B and C on the opposite sides are respectively

$$\frac{2}{b}\sqrt{s(s-a)(s-b)(s-c)}, \text{ and } \frac{2}{c}\sqrt{s(s-a)(s-b)(s-c)}.$$

§ 9. We now proceed to investigate formulæ for the area of a triangle in the following important cases.

(α) When the base a and the altitude h are given.—Since a

is equel to half a rectangle of the same base and altitude, at once

$$\text{area ABC} = \tfrac{1}{2}ah.$$

ple. Let $a = 40$ chains and $h = 14{\cdot}52$ chains, then

$$\text{area} = \tfrac{1}{2} \times 40 \times 14{\cdot}52 = 290{\cdot}4 \text{ square chains.}$$

Then two sides a *and* c *and the included angle* B *are given.*—

g. 3 $\dfrac{h}{c} = \sin B$, and therefore $h = c\sin B$;

$$\text{area} = \tfrac{1}{2}ah = \tfrac{1}{2}ac\sin B;$$

$$\log 2\text{area} = \log a + \log c + L\sin B - 10.$$

ple.—Let $a = 40$, $c = 30$, and $B = 30°$, then

$$\text{area} = \tfrac{1}{2}ac\sin B = \tfrac{1}{2} \times 40 \times 30 \times \tfrac{1}{2} = 300.$$

Then the three sides a, b, c *are given.*—From § 8

$$h = \frac{2}{a}\sqrt{s(s-a)(s-b)(s-c)},$$

efore

$$\tfrac{1}{2}ah = \tfrac{1}{2}a \times \frac{2}{a}\sqrt{s(s-a)(s-b)(s-c)} = \sqrt{s(s-a)(s-b)(s-c)};$$

ogarea $= \tfrac{1}{2}\{\log s + \log(s-a) + \log(s-b) + \log(s-c)\}$.

$a + b + c$, we have

rea of triangle $= \tfrac{1}{4}\sqrt{2(a^2b^2 + b^2c^2 + c^2a^2) - (a^4 + b^4 + c^4)}$.

ple 1.—Let $a = 13$, $b = 14$, and $c = 15$, then

$s = \tfrac{1}{2}(13 + 14 + 15) = 21$, $s - a = 21 - 13 = 8$,
$s - b = 21 - 14 = 7$, and $s - c = 21 - 15 = 6$;

$$\text{area} = \sqrt{21 \cdot 8 \cdot 7 \cdot 6} = 84.$$

ple 2.—Let $a = 255$, $b = 238$, and $c = 221$, then

log s	log 357	= 2·5526682
log $(s-a)$	log 102	= 2·0086002
log $(s-b)$	log 119	= 2·0755470
log $(s-c)$	log 136	= 2·1335389

$$\log\text{area} = \tfrac{1}{2}(8{\cdot}7703543) = 4{\cdot}3851771;$$

$$\text{area} = 24276.$$

Then any two angles B *and* C *and the adjacent side* a *are* Since

$$\frac{c}{a} = \frac{\sin C}{\sin A}, \qquad c = \frac{a\sin C}{\sin A},$$

efore (by β)

ea $= \tfrac{1}{2}ac\sin B = \dfrac{a^2\sin B\sin C}{2\sin A}$, where $A = 180° - (B + C)$,

$$\log 2\text{area} = 2\log a + L\sin B + L\sin C + L\operatorname{cosec} A - 30.$$

l the angles of a triangle are given when any two are e can find the area of a triangle when any two angles and side are given. Thus, when A, B, and c are given, we know nd the problem reduces to a case of the preceding.

Then the three medians α, β, γ *are given.*—If a, b, c be the les of a triangle, and α, β, γ the three medians, *i.e.*, the awn from the angles to the middle points of the opposite en by well-known geometrical propositions we have

$$4(\alpha^2 + \beta^2 + \gamma^2) = 3(a^2 + b^2 + c^2),$$
$$16(\alpha^2\beta^2 + \beta^2\gamma^2 + \gamma^2\alpha^2) = 9(a^2b^2 + b^2c^2 + c^2a^2),$$
$$16(\alpha^4 + \beta^4 + \gamma^4) = 9(a^4 + b^4 + c^4).$$

9, γ)

riangle $= \tfrac{1}{4}\sqrt{2(a^2b^2 + b^2c^2 + c^2a^2) - (a^4 + b^4 + c^4)}$,

$= \tfrac{3}{4}\sqrt{2(\alpha^2\beta^2 + \beta^2\gamma^2 + \gamma^2\alpha^2) - (\alpha^4 + \beta^4 + \gamma^4)}$.

D. *Parallelograms*

The opposite sides and angles of a parallelogram being three independent e of which at least th, are necessary and t to determine it ly.

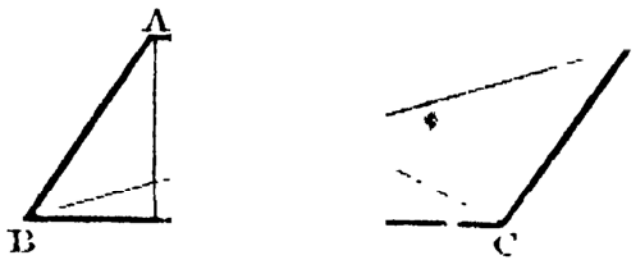


Fig. 4.

parallelogram ABCD let BC = DA = a,) = b, AC = c, AE = h, ngle ABC = α and 3.

the diagonal AC divides the parallelogram into two equi- riangles, we obtain

$$\text{area of ABCD} = 2 \text{ area of triangle ABC} = 2 \times \tfrac{1}{2}a \times h \ (\S\ 9,\ \alpha) = ah;$$

$$\text{rea of ABCD} = 2 \text{ area ABC} = 2 \times \tfrac{1}{2}ab\sin\alpha \ (\S\ 9,\ \beta) = ab\sin\alpha;$$

$$\log\text{area} = \log a + \log b + L\sin\alpha - 10;$$

$$\text{area of ABCD} = 2 \text{ area ABC} = 2(\text{ABO} + \text{CBO})$$
$$= 2\{\tfrac{1}{2}\text{BO.AO}\sin\text{AOB} + \tfrac{1}{2}\text{BO.CO}\sin\text{COB}\} = 2\{\tfrac{1}{2}\text{BO.AC}\sin\beta\}$$
$$= \tfrac{1}{2}\text{BD.AC}\sin\beta = \tfrac{1}{2}cd\sin\beta,$$

$$\log 2\text{area} = \log c + \log d + L\sin\beta - 10.$$

§ 11. If the parallelogram be *equiangular* (a rectangle and area = $\tfrac{1}{2}c^2\sin\beta$. If it be *equilateral* (a rhombus), β area = $\tfrac{1}{2}cd$. If it be both *equiangular* and *equilateral* (a $c = d$ and $\beta = 90°$, and area = $\tfrac{1}{2}c^2$ as before (§ 5, β).

E. *Trapeziums*

§ 12. To determine a trapezium completely four data a sary and sufficient.

In the trapezium ABCD (fig. 5) let BC = a, CD = b, DA = c,

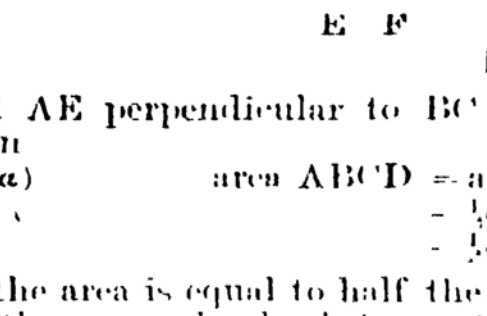


Fig. 5.

and AE perpendicular to BC = h, and draw AF parallel then

$$(\alpha)\qquad \text{area ABCD} = \text{area ABC} + \text{area ADC} = \tfrac{1}{2}ah + \tfrac{1}{2}ch = \tfrac{1}{2}(a + c)h;$$

or the area is equal to half the sum of the parallel sides m by the perpendicular between them.

Again, area of ABF = $\tfrac{1}{2}$BF · AE (§ 9, α) = $\tfrac{1}{2}(a - c)h$,

also $\text{area of ABF} = \sqrt{s(s - \text{AB})(s - \text{BF})(s - \text{FA})}$,

where $2s = \text{AB} + \text{BF} + \text{FA}$:

$$h = \frac{2}{a - c}\sqrt{s(s - \text{AB})(s - \text{BF})(s - \text{FA})}, \text{ therefore}$$

$$(\beta)\qquad \text{area of ABCD} = \tfrac{1}{2}(a + c)h = \frac{a + c}{a - c}\sqrt{s(s - \text{AB})(s - \text{BF})(}$$

$$= \frac{1}{4}\frac{a + c}{a}\sqrt{(a + b + c + d)(a + b - c - d)(a + b - c + d)(a - b -}$$

since $\text{AB} = d$, $\text{BF} = a - c$, and $\text{FA} = \text{CD} = b$.

Thus we can find the area of a trapezium in terms of its si

§ 13. If $c = 0$, ABCD becomes a triangle, and its area

$$= \tfrac{1}{4}\sqrt{(-a + b + d)(a + b - d)(a + b + d)(a - b + d)}.$$

Again, if $c = a$, then also $b = d$, and ABCD becomes a p gram, and its area takes the indeterminate form $\frac{0}{0}$, as it sh since four sides do not completely determine a parallelogra

F. *Quadrilaterals Generally.*

§ 14. A quadrilateral is completely determined when fi pendent data are given. We consider the following cases.

(α) *When any diagonal and the perpendiculars on it opposite vertices are given.*

The quadrilateral ABCD (fig. 6) = ABD + BCD
$= \tfrac{1}{2}$BD.AE + $\tfrac{1}{2}$BD.CF
$= \tfrac{1}{2}$BD(AE + CF);

or the area is equal to half the product of the diagonal sum of the perpendiculars.

If the diagonal BD fall without the figure, as in the concave quadrilateral ABCD (fig. 7), then it is clear that

area ABCD = $\tfrac{1}{2}$BD(AE − CF).

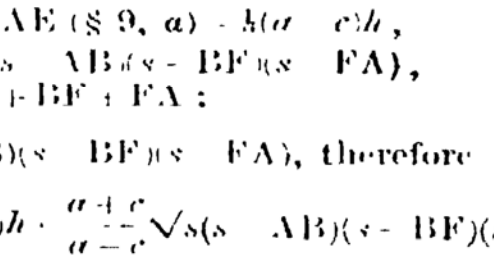


Fig. 6.

(β) *When the diagonals and their included angle are given.*—In the quadrilateral ABCD (fig 8, p. 10) let BD = h, AC = k, and angle DEA =

ABCD = ABD + BCD
= $\tfrac{1}{2}$BD.AE sin α + $\tfrac{1}{2}$BD.CE sin α (§ 10, γ)
= $\tfrac{1}{2}h$(AE + CE) sin α
= $\tfrac{1}{2}hk\sin\alpha$;

or the area is equal to the product of the diagonals and th their contained angle.

The same result holds when one of the diagonals falls without the quadrilateral, as in fig. 7, as the reader can easily verify.

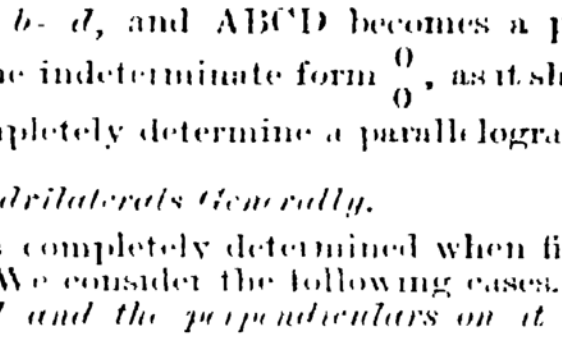


Fig. 7.

(γ) *When the four sides and the angle between the diagonals are given.*—If a, b, c, d be the sides and α the angle between the diagonals it can easily be shown that

$$\text{area of quadrilateral} = \tfrac{1}{4}(a^2 - b^2 + c^2 - d^2)\tan\alpha.$$

When the four sides are given and the opposite angles are supplementary.—In fig. 8 let AB = a, BC = b, CD = c, DA = d, angle ABC = α, angle β, and let $\alpha + \beta = 180°$.

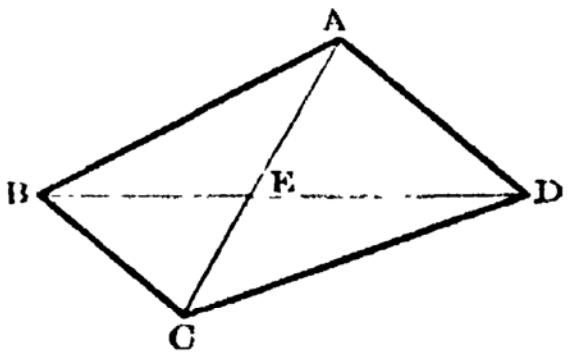


Fig. 8.

$$\text{ABCD} = \text{ABC} + \text{ADC}$$
$$= \tfrac{1}{2}ab\sin\alpha + \tfrac{1}{2}cd\sin\beta$$

$$\sin\beta = \sin(180° - \alpha) = \sin\alpha,$$

hence

$$\text{area of ABCD} = \tfrac{1}{2}(ab + cd)\sin\alpha.$$

This gives us the area of the quadrilateral in terms of the four sides and one angle.

Also we have

$$AC^2 = a^2 + b^2 - 2ab\cos\alpha = c^2 + d^2 + 2cd\cos\beta = c^2 + d^2 + 2cd\cos\alpha,$$

whence

$$\cos\alpha = \frac{a^2 + b^2 - c^2 - d^2}{2(ab + cd)}, \text{ and hence}$$

$$1 + \cos\alpha = \frac{(a + b + c - d)(a + b - c + d)}{2(ab + cd)}, \text{ and}$$

$$1 - \cos\alpha = \frac{(c + d + a - b)(c + d - a + b)}{2(ab + cd)}.$$

From this we obtain

$$\sin^2\alpha = (1 + \cos\alpha)(1 - \cos\alpha)$$
$$= \frac{(b + c + d - a)(c + d + a - b)(d + a + b - c)(a + b + c - d)}{4(ab + cd)^2}.$$

Let

$$a + b + c + d = 2s,$$

then

$$\tfrac{1}{2}(ab + cd)\sin\alpha = \sqrt{(s - a)(s - b)(s - c)(s - d)};$$

hence

$$\text{area of ABCD} = \sqrt{(s - a)(s - b)(s - c)(s - d)},$$

and

$$\log(\text{area}) = \tfrac{1}{2}\{\log(s - a) + \log(s - b) + \log(s - c) + \log(s - d)\}.$$

If $\alpha = 0$, the quadrilateral becomes a triangle, and its area is $\sqrt{s(s - a)(s - b)(s - c)}$ as before. In extracting the square root of $\sin^2\alpha$ we take the positive sign, since the angle α is less than two right angles.

G. *Regular Polygons*

Since a regular polygon is both equilateral and equiangular, a circle can be inscribed within it and also described about it, and if we join the n straight lines drawn from the common centre of the circles to the n vertices of the polygon they divide it into n triangles equal in every respect. Therefore the area of the polygon is equal to n times the area of any one of these triangles.

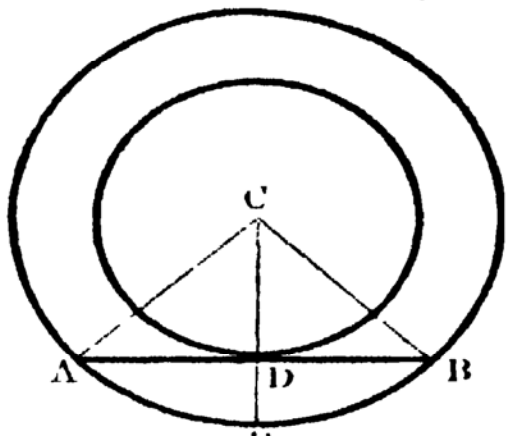


Fig. 9.

Radius of Inscribed and Circumscribed Circles. Let AB (fig. 9) be a side of a regular polygon of n sides, let C be the centre of the inscribed and circumscribed circles, CD r the radius of the inscribed circle, and CE R the radius of the circumscribed circle.

The angle ACB is evidently equal to the nth part of four right angles, that is

$$\text{ACB} = \frac{360°}{n}, \text{ and ACD} = \tfrac{1}{2}\text{ACB} = \frac{180°}{n}.$$

Also

$$\text{AD} = \frac{a}{2} = \text{CD}\tan\text{ACD} = r\tan\frac{180°}{n},$$

and

$$\text{AD} = \frac{a}{2} = \text{AC}\sin\text{ACD} = R\sin\frac{180°}{n};$$

hence

$$r = \frac{a}{2}\cot\frac{180°}{n},$$

and

$$R = \frac{a}{2}\operatorname{cosec}\frac{180°}{n}.$$

Perimeter of Polygon.—The perimeter of the polygon of n sides is na, *i.e.*, $2nr\tan\frac{180°}{n}$, or $2nR\sin\frac{180°}{n}$.

Hence it follows that the perimeters of the inscribed and circumscribed regular polygons of n sides of a circle of radius r are

$$2nr\sin\frac{180°}{n} \text{ and } 2nr\tan\frac{180°}{n} \text{ respectively.}$$

Area of Polygon.

(α) *In terms of* r.—The area of polygon

$$= n\text{ACB} - n\text{AD}.\text{CD} = n \times r^2\tan\frac{180°}{n}$$

(β) *In terms of* R.—The triangle ACB

$$= \tfrac{1}{2}\text{AC}.\text{CB}\sin\text{ACB} = \tfrac{1}{2}R^2\sin\frac{360°}{n},$$

and therefore area of polygon $= \frac{1}{2}nR^2\sin\frac{360°}{n}$.

(γ) *In terms of* a.—The triangle ACB

$$= \tfrac{1}{2}\text{AB}.\text{CD} = \frac{a}{2} \times r = \frac{a}{2} \times \tfrac{1}{2}a\cot\frac{180°}{n} = \frac{a^2}{4}\cot\frac{180°}{n},$$

and therefore area of polygon $= a^2 \times \frac{n}{4}\cot\frac{180°}{n}$,

or

$$\log 4\,\text{area} = \log n + \text{L}\cot\frac{180°}{n} + 2\log a - 10.$$

From α and β it follows that the areas of the inscribed and circumscribed regular polygons of n sides of a circle of radius r are

$$\tfrac{1}{2}nr^2\sin\frac{360°}{n} \text{ and } nr^2\tan\frac{180°}{n} \text{ respectively.}$$

§ 19. In the formula (§ 18, γ) for the area of a polygon the factor $\frac{n}{4}\cot\frac{180°}{n}$ has a definite value for every value of n, and if we find its value once for all for a large number of values and tabulate the results, we can find the area of a regular polygon of n sides by multiplying the square of its side by the appropriate tabular value.

Again, if $a = 1$ we have

$$r = \tfrac{1}{2}\cot\frac{180°}{n} \text{ and } R = \tfrac{1}{2}\operatorname{cosec}\frac{180°}{n};$$

and thus we obtain in a similar manner the radius of the inscribed and circumscribed circles by multiplying the side by the appropriate tabular value of $\frac{1}{2}\cot\frac{180°}{n}$ and $\frac{1}{2}\operatorname{cosec}\frac{180°}{n}$ respectively.

§ 20. The following table contains the values of $\frac{n}{4}\cot\frac{180°}{n}$, their logarithms, and the values of $\frac{1}{2}\cot\frac{180°}{n}$ and $\frac{1}{2}\operatorname{cosec}\frac{180°}{n}$ for values of n from 3 to 12.

n	$\frac{n}{4}\cot\frac{180°}{n}$	Logarithms.	$\frac{1}{2}\cot\frac{180°}{n}$	$\frac{1}{2}\operatorname{cosec}\frac{180°}{n}$
	0·1330127	1·6365006	0·2886751	·577
	1·0000000	0·0000000	0·5000000	·707
	1·7201774	0·2356490	0·6881909	·850
	2·5980762	0·4146519	0·8660254	1·000
	3·6339124	0·5603745	1·0383461	1·152
	4·8284271	0·6838568	1·2071068	1·306
	6·1818242	0·7911166	1·3737387	1·461
	7·6942088	0·8861640	1·5388418	1·618
11	9·3656407	0·9715375	1·7028437	1·775
12	11·1961524	1·0490688	1·8660254	1·931

Let A denote the area of a polygon of n sides and A′ the corresponding tabular value of $\frac{n}{4}\cot\frac{180°}{n}$, then

$$\text{A} = a^2\text{A}',$$

or

$$\log\text{A} = 2\log a + \log\text{A}'.$$

H.—*Length of the Radius of the Inscribed, Escribed, and Circumscribed Circles of a Triangle.*

§ 21. (α) *Radius of Inscribed Circle.* Let O (fig. 10) be the centre of the circle inscribed in the triangle ABC and touching the sides in D, E, and F. Join OA, OB, and OC. The angles at D, E, F are right angles (Euel. iii. 18). Let BC = a, CA = b, AB = c, and OD = OE = OF = r.

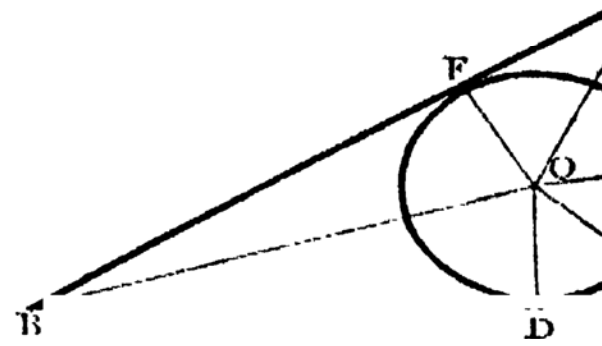


Fig. 10.

Now ABC = BOC + COA + AOB

$$= \tfrac{1}{2}ar + \tfrac{1}{2}br + \tfrac{1}{2}cr = \tfrac{1}{2}(a + b + c)r = rs;$$

whence

$$r = \frac{\text{area of ABC}}{s} = \frac{\sqrt{s(s - a)(s - b)(s - c)}}{s}$$

(β) *Radius of Escribed Circles.*—Let OD = OE = OF = r_a,

$$\text{ABC} = \text{ACO} + \text{ABO} - \text{BOC}$$
$$= \tfrac{1}{2}br_a + \tfrac{1}{2}cr_a - \tfrac{1}{2}ar_a = \tfrac{1}{2}(b + c - a)r_a = r_a(s - a),$$

and

$$r_a = \frac{\text{area of ABC}}{s - a} = \frac{\sqrt{s(s - a)(s - b)(s - c)}}{s - a} = \sqrt{\frac{s(s - b)(s}{s - a}}$$

Similarly

$$r_b = \sqrt{\frac{s(s - a)(s - c)}{s - b}} \text{ and } r_c = \sqrt{\frac{s(s - a)(s - b)}{s \quad c}}.$$

Radius of Circumscribed Circle.—Let AD (fig. 12) = p the dicular from A on the side BC, and AE = 2R the diameter

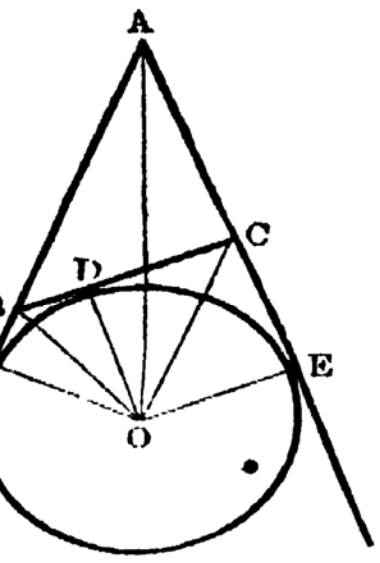


Fig. 11.

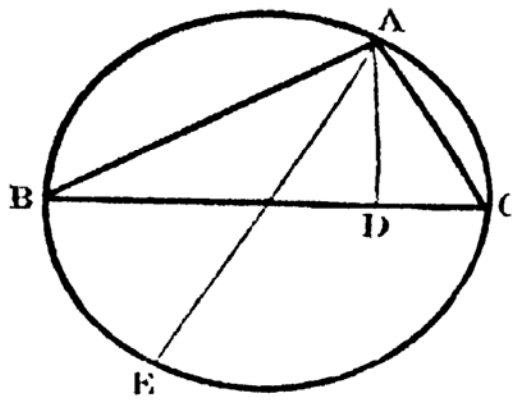


Fig. 12

ircle, then (Euel. vi. C) we have

$$2R \times p = b \times c,$$

e

$$2R \times ap = abc.$$

$= 2\Delta$, where Δ denotes the area of ABC;

$$R = \frac{abc}{4\Delta} = \frac{abc}{4\sqrt{s(s-a)(s-b)(s-c)}}.$$

ple.—Let $a = 13$, $b = 14$, and $c = 15$; then r will be found r_a $10\frac{1}{2}$, r_b 12, r_c 14, and R $8\frac{1}{8}$.

ION II.—PLANE FIGURES CONTAINED BY CURVED LINES.

A. *The Circle.*

Circumference of a Circle.—If we inscribe in any circle a polygon of n sides, and also circumscribe a regular polygon ame number of sides, it is clear that the perimeter of the intermediate between the perimeters of the inscribed and cribed polygons, and that the difference between the peri- f the inscribed and circumscribed polygons can be made as s we please by sufficiently increasing n. A similar state- olds with reference to the areas of the circle and the in- and circumscribed polygons. With the above assumptions ly proved that the circumference of a circle bears a constant its diameter. Hence we have

Circumference = C = constant × radius = constant × r.

ual to denote this constant by 2π, and therefore

$C = 2\pi r = \pi d$, where d is the diameter of the circle.

Numerical Value of π.—The constant π being, as can be roved, an interminable decimal, we can only approximate lue, but this we can do to any degree of accuracy we please. nd σ denote respectively a side of the inscribed and circum- polygons of n sides, and s' and σ' a side of the inscribed umscribed polygons of $2n$ sides, it can easily be shown that

$$(\alpha)\ \sigma = \sqrt{r^2 - (\tfrac{1}{2}s)^2}, \qquad (\beta)\ s'^2 = 2r\left\{r - \sqrt{r^2 - (\tfrac{1}{2}s)^2}\right\}$$

$$(\gamma)\ \sigma' = \frac{rs}{\sqrt{r^2 - (\frac{1}{2}s')^2}}$$

is the radius of the circle.

take $r = \frac{1}{2}$ we find, by means of these formulæ, and by g the value of s when $n = 6$, that the perimeter of inscribed of 96 sides = 3·140 . . . . , and the perimeter of circum- polygon of 96 sides = 3·142. . . .

this we learn that the circumference of the circle, in this is greater than 3·140 . . . . and less than 3·142 . . . . , refore as far as the second place of decimals

$$\pi = 3{\cdot}14.$$

ng greater and greater values of n we obtain closer and proximations to π.

receding method for approximating to the value of π is the afforded by elementary geometry, and is also the oldest; ter and more rapid methods are furnished by the higher atics. The calculation of π has been carried to 707 places nals, the following being the first 20 figures in the result:—

3·14159265358979323846.

practical purposes it is sufficient to take

$$\pi = 3{\cdot}14159 \text{ or } = \frac{355}{133}.$$

The following table contains the functions of π that are of quent occurrence in mensuration:—

	Number.	Logarithm.
π	3·1415927	0·4971499
2π	6·2831853	0·7981799
4π	12·5663706	1·0992099
$\frac{1}{2}\pi$	1·5707963	0·1961199
$\frac{1}{3}\pi$	1·0471976	0·0200286
$\frac{1}{4}\pi$	0·7853982	1·8950899
$\frac{2}{3}\pi$	0·5235988	1·7189986
$\frac{1}{8}\pi$	0·3926991	1·5940599
$\frac{1}{12}\pi$	0·2617994	1·4179686
$\frac{1}{16}\pi$	4·1887902	0·6220886
$\frac{\pi}{180}$	0·0174533	2·2418774
$\frac{1}{\pi}$	0·3183099	1·5028501
$\frac{4}{\pi}$	1·2732395	0·1049101
$\frac{1}{4\pi}$	0·0795775	2·9007901
$\frac{180}{\pi}$	57·2957795	1·7581226

	Number	Logar
π^2	9·8696044	0·994
$\frac{1}{6\pi^2}$	0·0168869	2·227
$\sqrt{\pi}$	1·7724539	0·24
$\sqrt[3]{\pi}$	1·4645919	0·16
$\sqrt{\frac{1}{\pi}}$	0·5641896	1·75
	1·1283792	0·05
$\frac{1}{2\sqrt{\pi}}$	0·2820948	1·45
	1·2107010	0·09
	0·6203505	1·79
r	1·1447299	0·05

§ 25. *Units of Angular Measurement.* In measuring select some line of constant length as the standard or uni larly in measuring angles we require to take some angle of magnitude as unit angle. The right angle is by its nature the simplest unit angle, but, for convenience, we take the $\frac{1}{90}$th part of a right angle for unit, and call it a degree, which is subdivided into sixty equal parts called minutes, and these again into sixty equal parts called seconds. For theoretical purposes we define the unit angle to be *the angle subtended at the centre of a circle by an arc equal to the radius.* This angle we call a "radian." In many treatises the radian measure of an angle is called the circular measure.

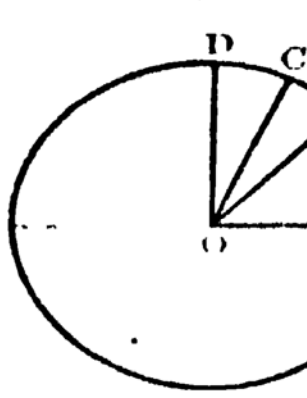


Fig. 13.

§ 26. *The radian is a constant angle.* Let OA (fig. 13) = r, then AOB = 1 radian, and let AOD = 90°, then

$$\text{arc AD} = \tfrac{1}{4} \times 2\pi r = \tfrac{1}{2}\pi r,$$

and, since angles at the centre of a circle are proportiona arcs on which they stand (Euel. vi. 33),

$$\frac{\text{number of degrees in radian AOB}}{\text{number of degrees in AOD}} = \frac{\text{AB}}{\text{AD}} = \frac{r}{\frac{1}{2}\pi r} = \frac{2}{\pi};$$

therefore number of degrees in radian

$$= 90° \times \frac{2}{\pi} = 57°{\cdot}2957795 = \text{constant}.$$

§ 27. *Number of Radians in any Angle.* Let AOC (fig any angle, AOB the radian, and AC = s; then

$$\frac{\text{number of radians in AOC}}{\text{one radian}} = \frac{\text{AC}}{\text{AB}} = \frac{s}{r},$$

therefore number of radians in AOC = $\frac{s}{r}$.

If AOC = 90°, then $s = \frac{1}{2}\pi r$, and number of radians = $\frac{1}{2}\pi$; thus π radians in two and 2π in four right angles.

When $r = 1$ we have number of radians = s, and hence treatises for the number of radians in an angle we find th of the are given

§ 28. *To transfer from degrees to radians and conversely* denote the number of degrees in an angle, and θ the nu radians in the same, then, since $\frac{x}{180} = \frac{\theta}{180}$,

$$(\alpha)\ \theta = \frac{\pi x}{180}, \qquad (\beta)\ x = \frac{180}{\pi}\theta.$$

§ 29. The following table contains the values of θ for x up to 180, and also for minutes and seconds.

Degrees.	Radian.	Degrees.	Radian.	Degrees.	Radian.			
1	·0174533	61	1·0646508	121	2·1118484	1	·002909	1
2	·0349066	62	1·0821041	122	2·1293017	2	·005818	2
3	·0523599	63	1·0995574	123	2·1467550	3	·008727	3
4	·0698132	64	1·1170107	124	2·1642083	4	·011636	4
5	·0872665	65	1·1344640	125	2·1816616	5	·014544	5
6	·1047198	66	1·1519173	126	2·1991149	6	·017453	6
7	·1221730	67	1·1693706	127	2·2165682	7	·020362	7
8	·1396263	68	1·1868239	128	2·2340214	8	·023271	8
9	·1570796	69	1·2042772	129	2·2514747	9	·026180	9
10	·1745329	70	1·2217305	130	2·2689280	10	·029089	10
20	·3490659	80	1·3962634	140	2·4434610	20	·058178	20
30	·5235988	90	1·5707963	150	2·6179939	30	·087266	30
40	·6981317	100	1·7453293	160	2·7925268	40	·116355	40
50	·8726646	110	1·9198622	170	2·9670597	50	·145444	50
60	1·0471976	120	2·0943951	180	3·1415927	60	·174533	60

example of the use of this table we proceed to find the θ when $x = 68° 45' 17''·8$.

When $x = 68°$ $\theta = 1\cdot1868239$,
$x = 40'$ $\theta = \cdot0116355$,
$x = 5'$ $\theta = \cdot0014544$,
$x = 10''$ $\theta = \cdot0000485$,
$x = 7''$ $\theta = \cdot0000339$,
and when $x = 0''·8$ $\theta = \cdot0000039$,
re when $x = 68° 45' 17''·8$ $\theta = 1\cdot2060001$

Combining the results of §§ 27 and 28 we obtain

$$(\alpha)\quad \theta = \frac{s}{r}, \text{ and } s = \frac{180}{\pi}\cdot\frac{s}{r},$$

$$(\beta)\quad r = \frac{180}{\pi}\cdot\frac{s}{\theta}$$

$$(\gamma)\quad s = r\theta$$

Length of Arcs of Circles. The following are the more im- cases

When terms of the chord of the arc and the radius of the circle are given.— (fig 14) c chord AB, r radius OC or OA, and AEB s, then

$\frac{1}{2}AB = c = r\sin\frac{1}{2}C$, whence C is known, and therefore the arc s is found (§ 30, γ).

When terms of the height of the arc and the radius of the circle are given.— h height of arc, then

$$CD = CE - DE = r - h,$$

$$\cos\tfrac{1}{2}C = \frac{CD}{AC} = \frac{r-h}{r},$$

C is found, and therefore s

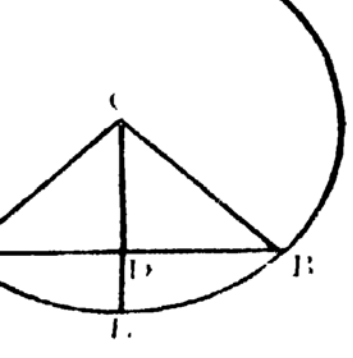


Fig. 14.

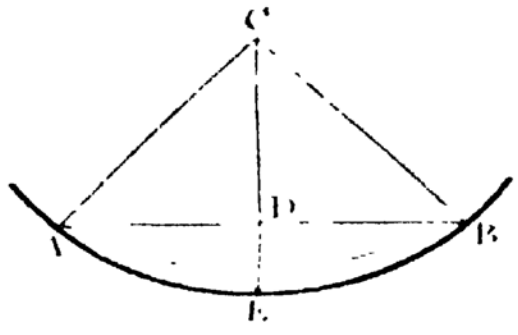


Fig. 15.

Huygens's Approximation to the Length of a Circular Arc. (fig 15) p be the chord of the arc AEB, and $AE = EB = q$ all the arc, then the arc AEB $= \frac{1}{3}(8q - p)$ approximately. r denote the radius, s the arc AEB, and 2θ the angle

hen θ Again, $AB = p = 2AD = 2r\sin\theta = 2r\sin\frac{s}{2r}$

ilarly $q = 2r\sin\frac{s}{4r}$.

$$\sin\theta = \theta - \frac{\theta^3}{3} + \frac{\theta^5}{5} - \&c.,$$

$$p = 2r\left\{\frac{s}{2r} - \frac{1}{3}\left(\frac{s}{2r}\right)^3 + \frac{1}{5}\left(\frac{s}{2r}\right)^5 - \&c.\right\}$$

$$2\cdot3\cdot4\cdot r^3 \quad 2\cdot3\cdot4\cdot5\cdot16\cdot \quad \&c.$$

arly $8q = 16r\left\{\frac{s}{4r} - \frac{1}{3}\left(\frac{s}{4r}\right)^3 + \frac{1}{5}\left(\frac{s}{4r}\right)^5 - \&c.\right\}$

$$4s = \frac{s^3}{2\cdot3\cdot4\cdot r^2} - \frac{s^5}{2\cdot3\cdot4\cdot5\cdot64\cdot r^4} - \&c.$$

, neglecting powers of $\frac{s}{r}$ be- fourth, we obtain

$$p = s\left(1 - \frac{s^4}{7680r^4}\right)$$

mately.

actice it is sometimes more ent to use the equivalent

$$s = 2q + \tfrac{1}{3}(2q - p).$$

Area of Sector of a Circle.— sector be OAB (fig 16). he arc AB into n equal parts, w the chords of these Let P denote the perimeter of the line AB, A the area of the polygon AOB, and ρ the alti-

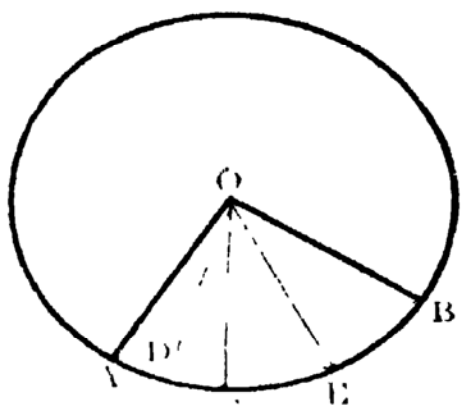


Fig. 16.

tude of any one of the n equal triangles of which this p made up.

Now in the limit, when n is indefinitely increased, P the arc AB $= s$, a result which we symbolize thus—

$$\mathbf{L}_{n=\infty} P = \text{arc AB} = s.$$

Similarly $\mathbf{L}_{n=\infty} \rho = \text{radius} = r$.

Again, the area of the sector is equal to the area of the when the broken line AB becomes the arc AB, that is,

$$\text{sector} = \mathbf{L}_{n=\infty} A = \mathbf{L}_{n=\infty} \tfrac{1}{2}\rho \times P = \tfrac{1}{2}\mathbf{L}_{n=\infty}\rho \times \mathbf{L}_{n=\infty} P = \tfrac{1}{2}rs.$$

§ 34. Let S denote the area of a sector of a circle, then, b of the above result and § 27, we have

$$(\alpha)\quad S = \tfrac{1}{2}sr,$$
$$(\beta)\quad S = \tfrac{1}{2}r\theta \cdot r = \tfrac{1}{2}r^2\theta.$$

§ 35. We proceed to find the area of a sector of a circle in lowing additional cases

(α) *When the chord of the sector and the radius of the ci given.*— In fig 14 let AB $= 2c$, and let AC $= r$, then we have

$$\sin\frac{ACB}{2} = \frac{AD}{AC} = \frac{c}{r},$$

whence ACB and therefore θ is known, and S can be found

ACB has two values, the smaller one giving the area of th and the larger that of the major conjugate sector.

(β) *When the chord and height of the chord are give* DE (fig 14) $= h$ and AB $= 2c$, then

$AC^2 = r^2 = AD^2 + DC^2 = c^2 + (r - h)^2$, whence

$r = \frac{c^2 + h^2}{2h}$, and therefore by previous case the area can be

(γ) *When the chord and angle subtended at the centre a* Let AB (fig 14) $= 2c$ and ACB $= \theta$, then

$$\frac{c}{r} = \sin\frac{ACB}{2}, \text{ or } r = \frac{c}{\sin\frac{1}{2}\theta},$$

therefore area of sector $= \frac{1}{2}r^2\theta = \frac{1}{2}\left(\frac{c}{\sin\frac{1}{2}\theta}\right)^2\theta$.

§ 36. *Area of a Circle.* The circle being a sector whose whole circumference we obtain at once

$$\text{area of circle} = \tfrac{1}{2}r \times s = \tfrac{1}{2}r \times 2\pi r = \pi r^2.$$

An independent proof of this proposition might be means of the inscribed and circumscribed polygons, and area of a circle the area of a sector can be deduced. Th tesimal calculus affords a simple and elegant proof (see § 4

§ 37. If A denote the area, r the radius, $d = 2r$ the diam C the circumference of a circle, we have

$$(\alpha)\quad A = \pi r^2,$$
$$(\beta)\quad A = \tfrac{1}{2}\times 2\pi r \times r = \tfrac{1}{2}Cr,$$
$$(\gamma)\quad A = \frac{4\pi^2r^2}{4\pi} = \frac{C^2}{4\pi},$$
$$(\delta)\quad A = \frac{\pi 4r^2}{4} = \frac{\pi d^2}{4}$$

Whence we see that the area of a circle is obtained by mul

(α) the square of its radius by $\pi = 3\cdot14159$,
(β) the radius by half the circumference,
(γ) the square of the circumference by $\frac{1}{4\pi} = \cdot07957$,
(δ) the square of the diameter by $\frac{1}{4}\pi = \cdot78539$.

§ 38. Again, from the above formulæ we deduce

$$(\alpha)\quad r = \frac{1}{\sqrt{\pi}}\sqrt{A} = \cdot5641896 \times \sqrt{A},$$
$$(\beta)\quad d = \frac{2}{\sqrt{\pi}}\sqrt{A} = 1\cdot1283792 \cdot \sqrt{A},$$
$$(\gamma)\quad c = 2\sqrt{\pi A} = 3\cdot5449077 \times \sqrt{A},$$

thus obtaining radius, diameter, and circumference from ar

§ 39. *Area of a Circular Ring.*—Let r and r_1 denote the the outer and inner circles respectively (fig 17), then the area of the space between them

$$= \pi r^2 - \pi r_1^2 = \pi(r + r_1)(r - r_1).$$

The circles need not be concentric, and the reader should note that the area of the ring is equal to the area of an ellipse whose major and minor axes are $r + r_1$ and $r - r_1$ (see § 51).

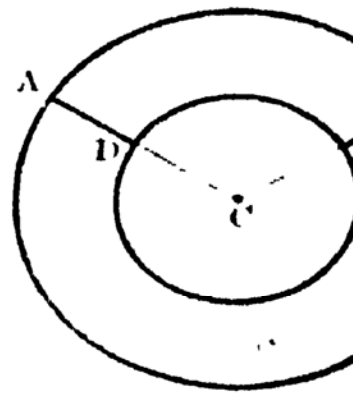


Fig. 17.

§ 40. *Area of the Sector of an Annulus.*—Let angle ACB $= \theta$ in fig. 17, then the area of ABED

$$= \text{sector ACB} - \text{sector DCE}$$
$$= \tfrac{1}{2}r^2\theta - \tfrac{1}{2}r_1^2\theta,$$
$$= \tfrac{1}{2}\theta(r + r_1)(r - r_1).$$

et $AB = l$, $DE = l_1$, and $CA - CD = r - r_1 = h$, then

$$r = \frac{l}{\theta} \text{ and } r_1 = \frac{l_1}{\theta} \text{ : therefore}$$

$$r + r_1 = \frac{1}{\theta}(l + l_1), \text{ and}$$

$$\text{sector} = \tfrac{1}{2}\theta(r + r_1)(r - r_1) = \tfrac{1}{2}\theta\left(\frac{l + l_1}{\theta}\right)h = \tfrac{1}{2}h(l + l_1).$$

Area of a Segment of a Circle. (α) *When the radius and the bended at the centre are given.*—In fig. 14, let AEB be of a circle, then its area

$$= \text{sector ACB} - \text{triangle ACB}$$
$$= \tfrac{1}{2}r^2\theta - \tfrac{1}{2}r^2\sin\theta \text{ (§§ 9, 31)}$$
$$= \tfrac{1}{2}r^2(\theta - \sin\theta).$$

egment be greater than a semicircle $\sin\theta$ is negative and ula becomes

$$\tfrac{1}{2}r^2(\theta + \sin\theta),$$

o geometrically evident.

ht in a similar manner find the area of a segment of a circle

hen the chord and radius are given,
hen the chord and its height are given,
hen the radius and height of the chord are given,
hen the chord and angle subtended by the chord are given

these cases the method of proceeding is obvious, a segment e difference between a sector and a triangle.

Area of a Lune. Let ADB and ACB (fig. 18) be two segf circles, then the area of
- ADBC

ment ADB − segment ACB.

f we so choose our data that determine the areas of the gments we have only to take fference to find the area of e.

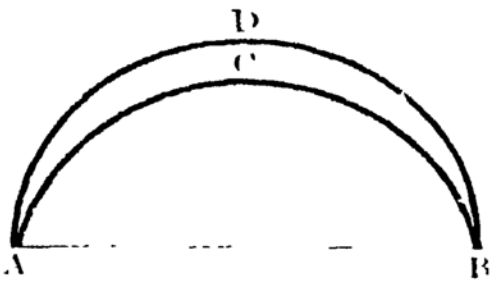


Fig. 18.

Area of a Circular Zone.—
3 and CD (fig. 19) be two chords, then the area of the zone ABCD

= circle − segment AHB − segment DFC;
= segment AED + trapezium ABCD + segment BGC
= 2 segment AED + trapezium ABCD.

The INFINITESIMAL CALCULUS (*q. v.*) furnishes a simple and proof of the formula for the areas of a circle and a sector. (x) be the equation to a plane curve referred to rectangular

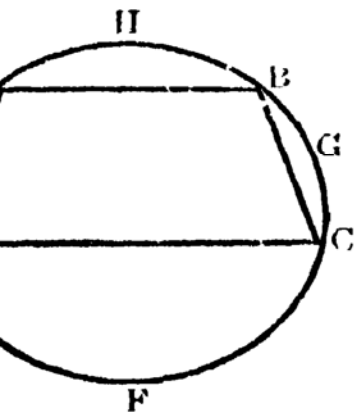


Fig. 19.

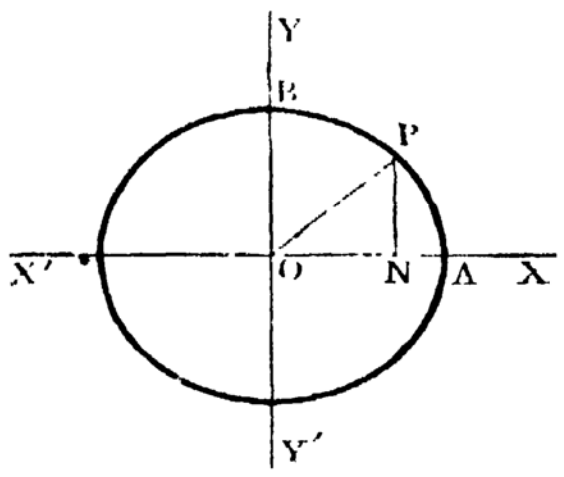


Fig. 20.

hen the area between the curve, the axis of x, and two es corresponding to the abscisse a and b is represented by egral

$$\int_a^b \phi(x)dx.$$

x and y be the coordinates of P (fig. 20), then if $OP = r$ the n to the circle is $y^2 = r^2 - x^2$, and therefore

$$\text{area of quadrant AOB} = \int_0^r \sqrt{r^2 - x^2}\,dx$$

$$= \left[\frac{r^2}{2}\sin^{-1}\frac{x}{r} + \frac{x}{2}\sqrt{r^2 - x^2}\right]_0^r = \frac{r^2}{2} \times \frac{\pi}{2} = \frac{\pi r^2}{4},$$

erefore area of whole circle $= \pi r^2$.

If the equation to a plane curve be given in polar coordi the area bounded by two radii and the curve is equal to

$$\tfrac{1}{2}\int_{\theta_1}^{\theta_2} r^2 d\theta,$$

θ_1 and θ_2 are the values of θ corresponding to the limiting

For example, let AOP (fig. 20) be θ, then area of circle

$$= \tfrac{1}{2}\int_0^{2\pi} d\theta \quad \frac{2\pi r^2}{2} = \pi r^2 \text{ as before.}$$

The area of a sector can be found in a similar manner.

B. *The Parabola*

§ 16. *Length of an Arc of any Plane Curve.*—If a plane c referred to rectangular axes, then the length of any arc curve

$$s = \int \left\{1 + \left(\frac{dy}{dx}\right)^2\right\}^{\frac{1}{2}} dx = \int \left\{1 + \left(\frac{dx}{dy}\right)^2\right\}^{\frac{1}{2}} dy$$

taken between proper limits, *i.e.*, the extremities of the ar INFINITESIMAL CALCULUS.

§ 17. *Arc of a Parabola.*—Let the axes of coordinates be

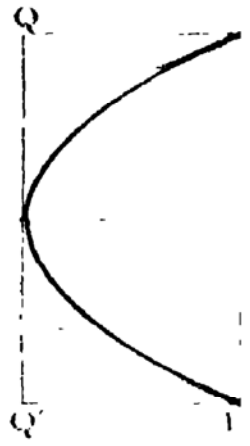


Fig. 21.

of x and the tangent at the vertex A (fig. 21), then, the to the parabola being $y^2 = 2mx$, where $m = 2a$ = latus rec have

$$\frac{dx}{dy} = \frac{y}{m}, \text{ and hence}$$

$$s = \text{arc AP} = \int_0^{y_1} \left\{1 + \frac{y^2}{m^2}\right\}^{\frac{1}{2}} dy$$
$$= \frac{y_1}{m}\sqrt{y_1^2 + m^2} + m\log\frac{y_1 + \sqrt{y_1^2 + m^2}}{m}$$

therefore whole arc PAP′ $= \frac{y_1}{m}\sqrt{y_1^2 + m^2} + m\log\left(\frac{y_1 + \sqrt{y_1^2}}{m}\right.$

Since $y_1^2 = 2mx_1$, the formula may be written

$$\text{PAP}' = \sqrt{4x_1^2 + y_1^2} + \frac{y_1}{2x_1}\log\frac{2x_1 + \sqrt{4x_1^2 + y_1^2}}{y_1}$$

§ 18. *Area of a Parabola.*—Taking the equation to the in the form $y^2 = 4px$, we get

$$\text{area of segment PAP′ (fig. 21)} = 2\int_0^{x_1} 2\sqrt{px}\,dx$$

$$= \tfrac{8}{3}p^{\frac{1}{2}}x_1^{\frac{3}{2}} = \tfrac{2}{3}x_1 y_1$$

From these formulæ we see that the area of a parabolic varies directly as the cube of the square root of the abscissa, and directly as the cube of the ordinate, and that it is equal to $\frac{2}{3}$ rectangle PQQ′P′, or $\frac{4}{3}$ triangle PTP′.

A similar relation holds for the segment cut off by any chord, and thus the area of any parabolic segment can be determined in terms of any data that are sufficient to de termine the segment

§ 49. *Area of a Parabolic Zone.*—Let PM (fig. 22) = y_1, QN = y_2, AM = x_1, AN = x_2, and let the ordinates be inclined to the axis at an angle α.

Area of zone PQQ′P′ = segment PAP′ − segment QAQ′

$$= \frac{y_1^3}{3p} - \frac{y_2^3}{3p} \times \sin\alpha.$$

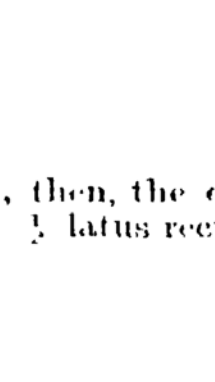


Fig. 2

Now $y_1^2 = 4px_1$ and $y_2^2 = 4px_2$, therefore $\frac{y_1^2 - y_2^2}{4(x_1 - x_2)} = p$, and substituting for p we have area of zone

$$= \tfrac{1}{3}(x_1 - x_2)\left(\frac{y_1^3 - y_2^3}{y_1^2 - y_2^2}\right)\sin\alpha = \tfrac{1}{3}\frac{x_1 - x_2}{y_1 + y_2}(y_1^2 + y_1y_2 + y_2^2)\sin$$

C. *The Ellipse.*

§ 50. *Circumference of an Ellipse.* The equation to th being $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$, where a and b are the semiaxes, we have

$\frac{dy}{dx} = -\frac{b^2x}{a^2y}$, and therefore (fig. 23)

of quadrant AB $= \int_0^a \left(\frac{a^2-e^2x^2}{a^2-x^2}\right)^{\frac{1}{2}} dx$, where $e^2 = \frac{a^2-b^2}{a^2}$.

integral may be shown to be equal to the series

$$\frac{\pi a}{2}\left(1 - \frac{e^2}{2^2} - \frac{1\cdot 3e^4}{2^2\cdot 4^2} - \frac{1\cdot 3^2\cdot 5e^6}{2^2\cdot 4^2\cdot 6^2} - \&c.\right),$$

dly converging series when e is a small fraction.

taking more and more of the above series we can ximate as nearly as we to the circumference of an . For example, we have rant AB

$$\left(1 - \frac{e^2}{4}\right) \quad \frac{\pi a}{2}\left(1 - \frac{e^2}{2}\right)^{\frac{1}{2}}$$

a first approximation, whole circumference

$$\left\{\frac{(2a)^2 + (2b)^2}{2}\right\}^{\frac{1}{2}} \text{ nearly.}$$

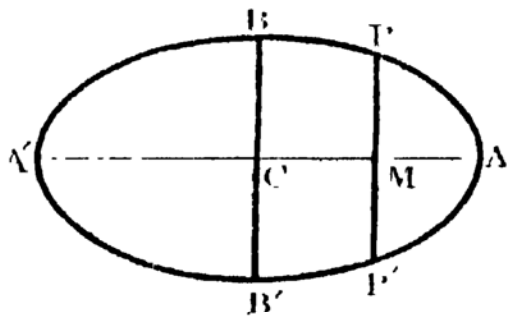


Fig. 23

1. *Area of an Ellipse.*— We have at once

$$\text{area} = 4\int_0^a y\,dx = 4\frac{b}{a}\int_0^a \sqrt{a^2 - x^2}\,dx.$$

$\int_0^a \sqrt{a^2 - x^2}\,dx$ is the area of the quadrant of a circle of radius thus

$$\text{area of ellipse} = 4\frac{b}{a}\frac{\pi a^2}{4} \quad (\S\ 44)$$
$$= \pi ab.$$

following proof is worth the reader's attention. By a well- theorem in conic sections the orthogonal projection of a on a given plane is an ellipse. Now, if A denote the area of ane figure, A′ the area of the projected figure, and θ the angle en the planes it can easily be shown, by dividing the two by planes indefinitely near to each other and perpendicular common section of the planes, that

$$A\cos\theta = A'.$$

case of the circle and ellipse $A = \pi a^2$ and $\cos\theta = \frac{b}{a}$;

$$\text{area of ellipse} = \pi a^2 \frac{b}{a} = \pi ab.$$

2. *Area of an Ellipse in terms of a Pair of Conjugate Diame-* Let a' and b' denote the semiconjugate diameters, and α the between them, then by an elementary property of the ellipse

$$ab = a'b'\sin\alpha;$$

$$\text{area of ellipse} = \pi a'b'\sin\alpha.$$

D. *The Hyperbola.*

3. *Area of a Segment of an Hyperbola.*—The equation of an bola being $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$, we have

$$y = \frac{b}{a}\sqrt{x^2 - a^2};$$ hence (fig. 24)

of the segment PAP′ $= 2\frac{b}{a}\int_a^{x_1}\sqrt{x^2 - a^2}\,dx$

$$= \frac{b}{a}x_1\sqrt{x_1^2 - a^2} - ab\log_e\left(\frac{x_1 + \sqrt{x_1^2 - a^2}}{a}\right)$$

$$= x_1y_1 - ab\log_e\left(\frac{x_1}{a} + \frac{y_1}{b}\right).$$

4. *Area of a Sector of an Hyperbola.* The sector PAP′C is to triangle PCP′ − segment PAP′

$$= x_1y_1 - \left\{x_1y_1 - ab\log_e\left(\frac{x_1}{a} + \frac{y_1}{b}\right)\right\}$$

$$= ab\log_e\left(\frac{x_1}{a} + \frac{y_1}{b}\right).$$

5. *Area of a Zone of an Hyperbola.* In fig. 24 the zone PQ

= segment QAQ′ − segment PAP′

$$= x_2y_2 - ab\log_e\left(\frac{x_2}{a} + \frac{y_2}{b}\right) - x_1y_1 + ab\log_e\left(\frac{x_1}{a} + \frac{y_1}{b}\right)$$

$$= x_2y_2 - x_1y_1 - ab\log_e\left(\frac{ay_2 + bx_2}{ay_1 + bx_1}\right), \text{ where}$$

and x_2, y_2 are the coordinates of P and Q respectively.

If the axes of coordinates be inclined at an angle α, we the above results by $\sin\alpha$ to obtain the correct areas.

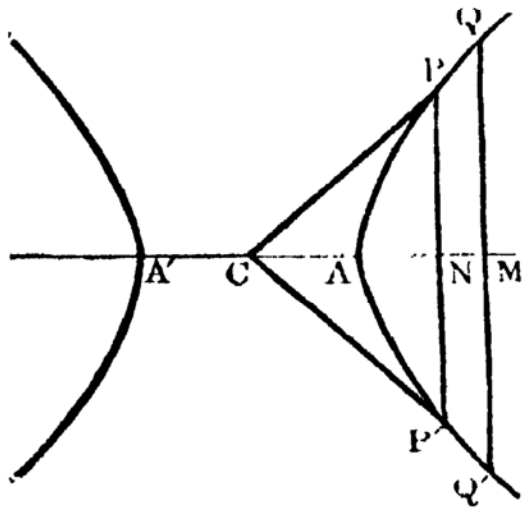


Fig. 24.

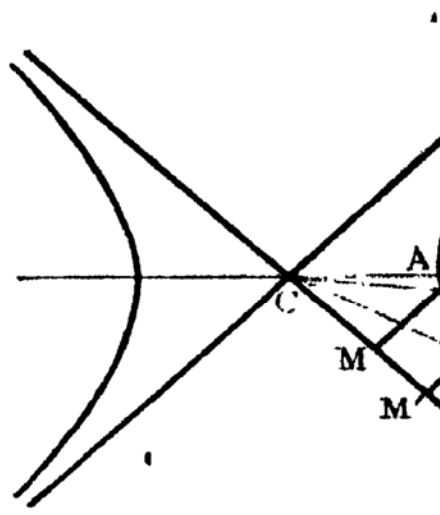


Fig. 25.

§ 56. *Area bounded by an Hyperbola and its Asymptot* equation of an hyperbola referred to its asymptotes is of th

$$xy = c^2.$$

Let CM′ (fig. 25) $= x_1$, CM $= x_2$, Q′M′ $= y_1$, Q M $= y_2$, then the angle between the asymptotes,

$$\text{area of } QMM'Q' = \int_{x_2}^{x_1} y\sin\alpha\,dx$$

$$= c^2\sin\alpha\int_{x_2}^{x_1}\frac{dx}{x} = c^2\sin\alpha\log_e\left(\frac{x_1}{x_2}\right) = c^2\sin\alpha\log_e\left(\frac{y_2}{y_1}\right)$$

since $x_1 = \frac{c^2}{y_1}$ and $x_2 = \frac{c^2}{y_2}$.

Now $c^2 = \frac{a^2 + b^2}{4}$ and $\sin\alpha = \frac{2ab}{a^2 + b^2}$, and therefore

$$(\alpha) \qquad \text{area} = \tfrac{1}{2}ab\log_e\left(\frac{x_1}{x_2}\right) = \tfrac{1}{2}ab\log_e\left(\frac{y_2}{y_1}\right).$$

Again, let MM′ $= x_1 - x_2 = p$, then

$$c^2 = x_1y_1 = x_2y_2 = \frac{py_1y_2}{y_2 - y_1}, \text{ therefore}$$

$$(\beta) \qquad QMM'Q' = \frac{py_1y_2}{y_2 - y_1}\log_e\left(\frac{x_1}{x_2}\right)\sin\alpha = \frac{py_1y_2}{y_2 \quad y_1}\log_e\left(\frac{y_2}{y_1}\right)\sin$$

Again, since

$$\tfrac{1}{2}x_1y_1\sin\alpha = \tfrac{1}{2}c^2\sin\alpha = \tfrac{1}{2}x_2y_2\sin\alpha,$$

we have triangle QCM = Q′CM′, and hence the sector QCQ′ = QMM′Q′.

The corresponding results for a rectangular hyperbola tained by substituting in the above formulæ $\frac{1}{2}a^2$ for c^2 a

Section III.—Plane Irregular, Rectilineal, and C lineal Figures.

A. *Irregular Rectilineal Figures.*

§ 57. The area of any irregular polygon can be found by it into triangles, trapeziums, &c., in the most convenient and adding together all the areas. For example,

ABCDEF (fig. 26) = CKB + BKHA + AHF + FGE + EGH

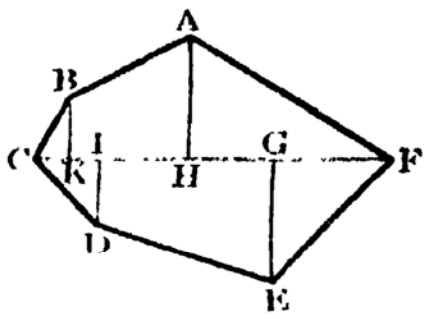


Fig. 26.

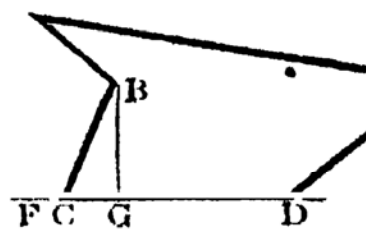


Fig. 27.

It may sometimes happen that some of the componen have to be subtracted instead of added; for example,

ABCDE (fig. 27) = AFHE + BCG − AFGB − EDH

§ 58. Again, the irregular rectilineal figure P_1P_2 . . . 28) can be broken up into a series of triangles and trape shown in the figure, and hence its area can be found.

§ 59. A figure made up of straight lines may be mea cutting it up into triangles by lines drawn from some one the others. For example (fig. 29),

ABCDEF = ABC + ACD + ADE + AEF.

polygon be concave some of the triangles will have to be ted.

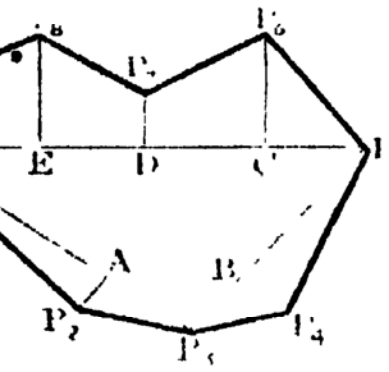


Fig. 28.

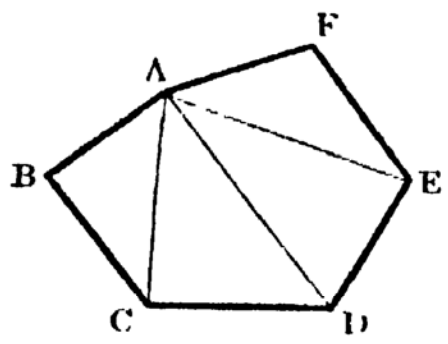


Fig. 29.

Area of a Polygon in terms of the Coordinates of its Angular — Let the coordi- P, Q, R (fig. 30) be (x_2, y_2), and (x_3, y_3) vely, and let the inclined at an angle w PL, QM, and RN to OY, then

OM $OL = x_2 - x_1$,

$ON - OM = x_3 - x_2$,

$ON - OL = x_3 - x_1$.

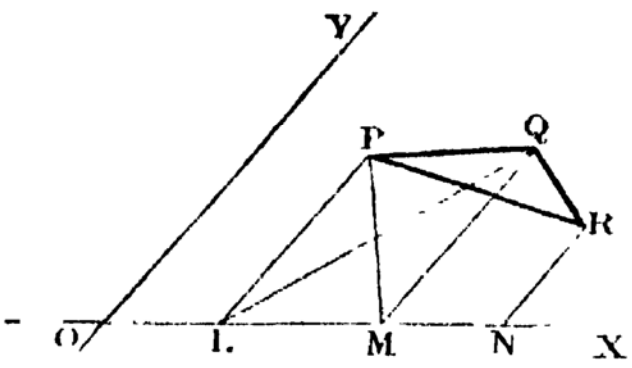


Fig. 30.

PQR PLMQ + QMNR PLNR.

PLMQ = PLM + QMP = PLM + QLM

$= \frac{1}{2}PL \cdot LM \sin\alpha + \frac{1}{2}QM \cdot LM \sin(180° - \alpha)$ (§ 9, *β*)

$= \frac{1}{2}(x_2 - x_1)(y_1 + y_2)\sin\alpha$.

y QMNR $= \frac{1}{2}(x_3 - x_2)(y_2 + y_3)\sin\alpha$,

PLNR $= \frac{1}{2}(x_3 - x_1)(y_3 + y_1)\sin\alpha$; hence

of PQR $= \frac{1}{2}\sin\alpha\{y_1(x_2 - x_3) + y_2(x_3 - x_1) + y_3(x_1 - x_2)\}$;

notation of determinants

$$= \frac{1}{2}\sin\alpha \begin{vmatrix} 1 & 1 & 1 \\ x_1 & x_2 & x_3 \\ y_1 & y_2 & y_3 \end{vmatrix}$$

he axes are rectangular $\sin\alpha = \sin 90° = 1$, and the formula rea becomes

$$\frac{1}{2}\{y_1(x_2 - x_3) + y_2(x_3 - x_1) + y_3(x_1 - x_2)\}$$

$$= \frac{1}{2}\begin{vmatrix} 1 & 1 & 1 \\ x_1 & x_2 & x_3 \\ y_1 & y_2 & y_3 \end{vmatrix}.$$

The area of any rectilineal figure of n sides can be found by ny point within the figure and joining it to the n vertices gure, thus dividing it into n triangles the area of each of an be obtained as in the preceding case.

ay, however, find the area of the figure directly.

xample, in fig. 31

QRST = PP'T'T + TT'S'S + SS'R'R − RR'Q'Q − QQ'P'P,

g. 32

U = PP'U'U + RR'Q'Q + TT'S'S − PP'Q'Q − RR'S'S − TT'U'U.

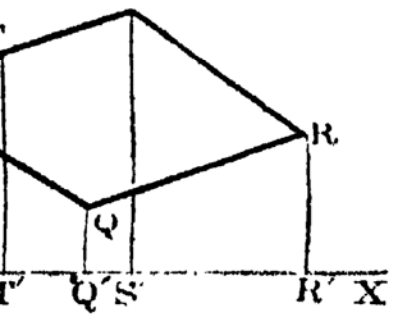


Fig. 31.

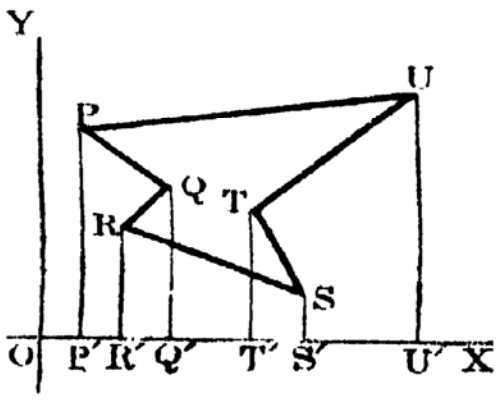


Fig. 32.

B. *Irregular Curvilineal Figures.*

Length of any Curve.—If we divide the given arc into an umber of intervals and re- ese as approximately circu- can find an approximation ength of the arc by means gens's formula, § 32. For , if we divide ABC (fig. 33) r parts in D, B, and E, and e chords AD, AB, DB, BE, EC, then

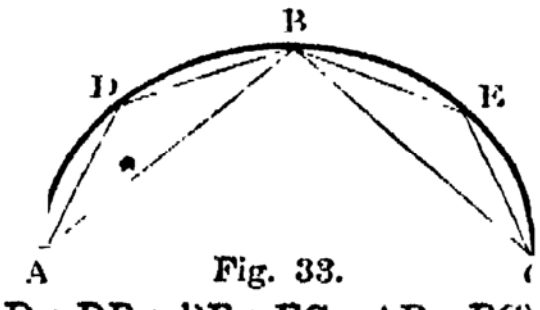


Fig. 33.

= AD + DB + BE + EC + ½(AD + DB + BE + EC − AB − BC)

nately.

For other methods of approximation, see Rankine's *R Tables.*

§ 63. *Area of an Irregular Curvilineal Figure.*—For ro proximations the following, called the trapezoidal method, used:

Divide A_1A_n (fig. 34) into n equal parts, and through th

P_{n-2} P_n,

A_1 A_2 A_{n-2} A_n

Fig. 34.

of division draw the ordinates, called by surveyors offset A_2P_2, &c.

Let $A_1P_1 = s_1$, $A_2P_2 = s_2$, &c., $A_nP_n = s_n$, and $A_1A_2 = A_2A_3 = \ldots = A_{n-1}A_n = a$.

Join P_1P_2, P_2P_3, &c., then the area of the polygon A_1A_nP

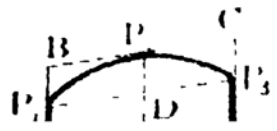
$= A_1A_2P_2P_1 + A_2A_3P_3P_2 + \ldots + A_{n-1}A_nP_nP_{n-1}$

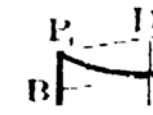
$= \frac{1}{2}a(s_1 + s_2) + \frac{1}{2}a(s_2 + s_3) + \ldots + \frac{1}{2}a(s_{n-1} + s_n)$ (§ 13, a

$= a\{\frac{1}{2}(s_1 + s_n) + s_2 + s_3 + \ldots + s_{n-1}\}$.

If we take n sufficiently great the difference between the the polygon and the curvilineal figure can be made as sma please, in other words, the smaller we make a the more ne will the above formula represent the area of the curvilineal

The curve may either be wholly convex or wholly concave to the line A_1A_n, or partly convex and partly concave.





§ 64. *Simpson's Rule.*—Let A_1A_n (fig. 34) be divided into an *even* number of equal parts, and as before through the points of division draw the ordinates A_1P_1, A_2P_2, &c.

Let $A_1A_3P_3P_1$ (figs. 35, 36) be a part of the figure thus divided, join P_1P_3, and through P_2 draw BC parallel to P_1P_3 to meet A_1P_1 in B and A_3P_3 in C.

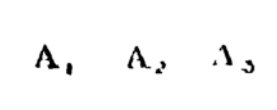


Fig. 35.

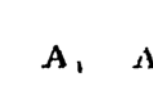


Fig.

Conceive a parabola to b through $P_1P_2P_3$ having its axis parallel to the ordinates, t

$A_1P_1P_2P_3A_3$ = trapezium $A_1P_1DP_3A_3$ + parabolic segment

$= a(s_1 + s_3) + \frac{1}{3}a\{s_2 - \frac{1}{2}(s_1 + s_3)\} = \frac{1}{3}a(s_1 + 4s_2 + s_3)$.

Now when the points P_1, P_2, P_3 are near each other the curve will coincide very nearly with the given curve; hence

$A_1P_1P_2P_3A_3 = \frac{1}{3}a(s_1 + 4s_2 + s_3)$ very nearly.

Similarly $A_3P_3P_5A_5 = \frac{1}{3}a(s_3 + 4s_4 + s_5)$, &c.;

hence whole area of figure

$= \frac{1}{3}a\{s_1 + s_n + 2(s_3 + s_5 + \ldots + s_{n-2}) + 4(s_2 + s_4 + \ldots +$

whence the rule: add together the two extreme ordinate the sum of the intermediate odd ordinates, and four times of the even ones, and multiply this result by one-third of the distance between the ordinates; the result is the area, *accu* the curved boundary be the arc of a parabola, in other proximately.

The curve may either be wholly convex or wholly concav line A_1A_n, or partly convex and partly concave, provide latter case the points of contrary flexure occur only at ordinates, for otherwise the intermediate arcs could not approximately parabolic. When points of contrary flexu ordinates may be drawn at these points, and the interme being found separately may be added to obtain the whole a

§ 65. In the two preceding sections we investigated two for approximating to the areas of curvilinear figures. proceed to consider the subject more generally.

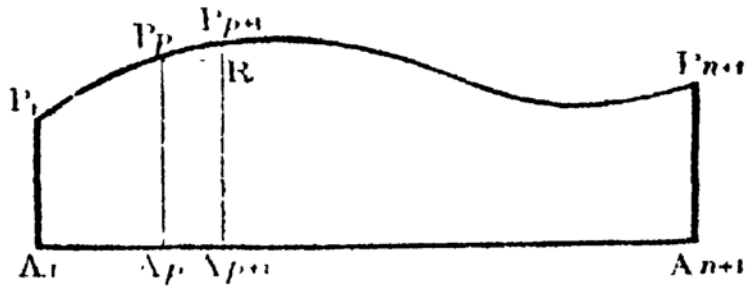


Fig. 37.

Let the equation to the curve $P_1P_pP_{n+1}$ (fig. 37) agree

$y = A + Bx + Cx^2 + \ldots + Kx^n$ for $n+1$ points between P_{n+1}, then the area of the curvilinear figure bounded by the lines A_1P_1, A_1A_{n+1}, and $A_{n+1}P_{n+1}$ and the curve P_1P_{n+1} ...ce very nearly with the curvilinear figure bounded by the ...aight lines and the curve whose equation is $y = A + Bx + \ldots + Kx^n$, and the greater the number of common points ...n will be the agreement

...A_{n+1} be divided into n equal parts, each equal to h, then ... nh. Now

$x = 0, \quad y = y_1 = A;$

$x = h, \quad y = y_2 = A + Bh + Ch^2 + \ldots + Kh^n$

$x = 2h, \quad y = y_3 = A + B\cdot 2h + C\cdot 2h^2 + \ldots + K(2h)^n;$

$\ldots\ldots\ldots\ldots\ldots\ldots$

$x = ph, \quad y = y_{p+1} = A + Bph + Cp^2h^2 + \ldots + K(ph)^n;$

$\ldots\ldots\ldots\ldots\ldots\ldots$

$x = nh, \quad y = y_{n+1} = A + Bnh + Cn^2h^2 + \ldots + K(nh)^n.$

...hese $n+1$ equations the $n+1$ quantities A, B, ... K ...letermined as functions of $y_1, y_2, \ldots y_{n+1}$, and h

...let A_1A_{n+1} be divided into m equal parts each equal to k. ... $h = mk$ and hence $k = \frac{nh}{m}$

... the area of the rectangle $A_pA_{p+1}P_pR = A_pA_{p+1} \cdot A_pP_p$.

$A_pP_p = y_p = A + B(ph) + C(ph)^2 + \ldots + K(ph)^n$

$A_pA_{p+1} = k = \frac{nh}{m}$

area of $A_pR = \left\{ A + B(ph)\frac{nh}{m} + C(ph)^2\frac{nh}{m} + \ldots + K(ph)^n\frac{nh}{m} \right\}\frac{nh}{m}$

$= \left\{ A + Bph\frac{n}{m} + Cp^2h^2\frac{n^2}{m^2} + \ldots + Kp^nh^n\frac{n^n}{m^n} \right\}\frac{nh}{m}$

of the whole figure

$= \sum_{p=0}^{p=m-1} \frac{nh}{m}\left\{ A + Bph\frac{n}{m} + Cp^2h^2\frac{n^2}{m^2} + \ldots + Kp^nh^n\frac{n^n}{m^n} \right\}$

$= \frac{nh}{m}\left\{ AS_0 + Bh\frac{n}{m}S_1 + Ch^2\frac{n^2}{m^2}S_2 + \ldots + Kh^n\frac{n^n}{m^n}S_n \right\},$

$S_n = 1^n + 2^n + 3^n + \ldots + m^n.$

...we take the limit of each of the terms

$\frac{S_0}{m}, \quad \frac{S_1}{m^2}, \quad \frac{S_2}{m^3}, \quad \ldots \quad \frac{S_n}{m^{n+1}}$

...curvilinear figure

$= nh\left\{ A + \frac{B}{2}nh + \frac{C}{3}n^2h^2 + \ldots + \frac{1}{n+1}n^nh^n \right\}.$

... this general result we can deduce "Simpson's Rule" and ...ther rule called "Weddle's Rule."

...let $n = 2$, that is, assume that the curve under consideration ...points in common with the curve whose equation is ...$Bx + Cx^2$, . . . , with a parabola, then

$y_1 = A,$
$y_2 = A + Bh + Ch^2,$
$y_3 = A + 2Bh + 4Ch^2.$

... area is approximately

$2h\left\{ A + B2h + \frac{4}{3}C2^2h^2 \right\}$

$\frac{1}{3}h\left\{ 6A + 6Bh + 8Ch^2 \right\}$

$= \frac{1}{3}h\left\{ y_1 + 4y_2 + y_3 \right\}$. Simpson's Rule.

...w put $n = 6$, we have area of curvilinear figure

$= h\left\{ A + \frac{1}{2}B6h + \frac{1}{3}C6^2h^2 + \frac{1}{4}D6^3h^3 + \frac{1}{5}E6^4h^4 + \frac{1}{6}F6^5h^5 + \frac{1}{7}G6^6h^6 \right\}.$

$y_1 = A,$

$y_2 = A + Bh + Ch^2 + \ldots + Gh^6,$

$\ldots\ldots\ldots\ldots\ldots$

$y_7 = A + B(6h) + C(6h)^2 + \ldots + G(6h)^6.$

...is system of equations we can determine A, B, C, . . . G, ...stituting the values so obtained in the above expression we ...he following remarkable formula for the approximate area:

area $= \frac{3}{10}h\left\{ (y_1 + y_3 + y_5 + y_7) + y_1 + 5y_2 + y_4 + y_6 \right\}$.

This formula, called Weddle's Rule, gives the closest approximation to the curvilinear area that can be obtained by any simple rule.

We are now in a position to find the approximate area of any irregular plane figure. For the given figure be divided into plane rectilinear and curvilinear figures, the areas of which can be separately determined by the rules already given. For example, APQRS (fig. 38)

$= ABC + APD + BRC - DQB - ASC.$

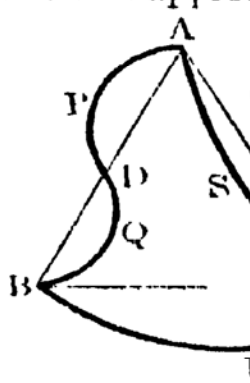


Fig. 38.

PART II. SOLIDS.

SECTION I. SOLIDS CONTAINED BY PLANES.

A. *Prisms, Parallelepipeds, and Prismatoids.*

§ 66. *Volume of a Right Prism.* First let the prism be a rectangular parallelepiped (fig. 39), and let the sole AB contain a units of length, BC b units of length, and CD c units of length. If we divide AB into a equal parts, BC into b equal parts, and CD into c equal parts, and if, through the points of division we draw planes parallel to the sides of the parallelepiped, these planes will divide it into a series of parallelepipeds whose edges are each equal to the unit of length. Each horizontal layer contains ab of these cubes, and since there are c layers the whole number of cubes will be abc. But each of these is the unit of volume, and

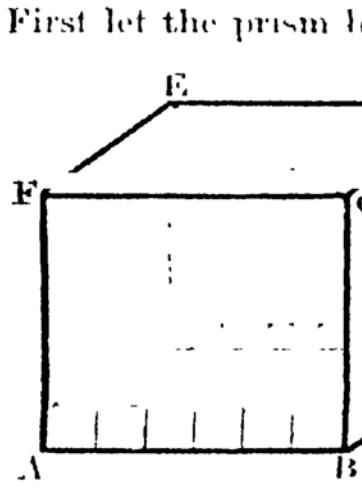


Fig. 39.

volume of ABCD $= abc = ab \times c =$ area of base ABC $\times$ altitude.

In the above demonstration we have assumed the edges commensurable, but from § 2 it follows that the proof will also when the edges are incommensurable. If the parallelepiped be cut by a plane BGE it will be divided into two equal triangular right prisms, and hence

volume of right triangular prism $= \frac{1}{2}ab \times c =$ area of its base $\times$ altitude.

Since every prism can be divided into triangular prisms as in fig. 40, we have at once

volume of right prism A'ABCDE = A'ABC + A'ACD + A'ADE
$= ABC \times BB' + ACD \times CC' + ADE \times DD'$
$= (ABC + ACD + ADE) \times$ altitude
(since $BB' = CC' = DD' =$ altitude)
= area of base ABCDE $\times$ altitude.

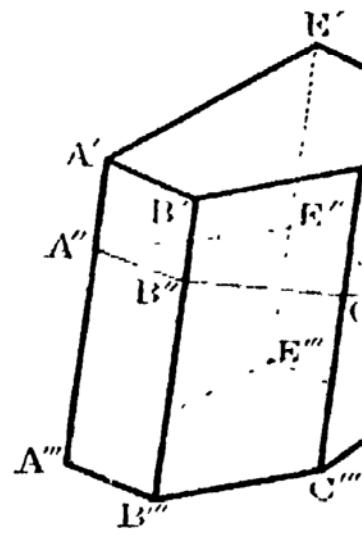


Fig. 41.

Fig. 40.

§ 67. *Volume of an Oblique Prism.*—Draw the right section A"B"C"D"E" (fig. 41), and let A' denote its area and A the area of the base A'B'C'D'E'. Let l denote the length of the prism or altitude, and α the angle between the planes A'B'C'D'E' and A"B"C"D"E".

Conceive the part above the right section placed at the other extremity of the prism. Then we have a right prism whose volume $= A' \times l$ (§ 66); but $A' = A\cos\alpha$, since A' is the projection of A (§ 51),

and $l = \frac{h}{\cos\alpha}$; hence

$$\text{volume} = A' \times l = A\cos\alpha \times \frac{h}{\cos\alpha} = A \times h;$$

or the volume of any prism is equal to the area of its base multiplied by its altitude.

Surface of a Prism.—Since the lines A″B‴, B″C‴, &c. (fig. ich make up the perimeter of the right section are all n ne perpendicular to the parallel edges AA‴, BB‴, &c., they pendicular to these edges and are therefore the altitudes of rallelograms A′B′B‴A‴, B′C′C‴B‴, &c., respectively. The surface of the prism is equal to the sum of these parallelo- and therefore

$$= A'A''' \cdot A''B'' + B'B'' \cdot B''C''' + \dots\dots$$
$$= A'A'''(A''B'' + B''C'' + \dots\dots),$$
$$A'A''' = B'B''' \text{ &c.};$$

lateral surface of any prism is equal to the perimeter of its ection multiplied by the length of the prism.

e prism be *right*, that is, if the faces be perpendicular to the hen its lateral surface is equal to the perimeter of its base lied by its length.

whole surface of any prism is obtained by adding to the surface the areas of its bases.

. If the prism be *regular*, that is, if the bases be regular ns, then

$$\text{base} = a^2 \times \frac{n}{4} \cot\frac{180^\circ}{n} \text{ (§ 18, } \gamma\text{)}, \text{ where } n \text{ is the number}$$

s each of length a, and therefore

$$\text{volume} = a^2 \times \frac{n}{4} \cot\frac{180^\circ}{n} \times h,$$

h is the altitude of the prism.

in, if the prism be right and regular, then

$$\text{its lateral surface} = nah + 2a^2 \times \frac{n}{4} \cot\frac{180^\circ}{n}$$

. *Volume of a Pyramid.* Let VABC (fig. 42) be for sim- a triangular pyramid. Divide VA into n equal portions, and h the points of section draw parallel to the base ABC, and h BC and through the inter- s of these planes with VBC draw parallel to VA. Let h denote itude of the pyramid, then the o of the base of the r^{th} prism he vertex V

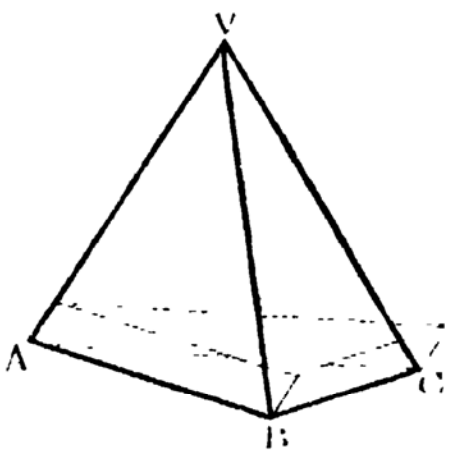


Fig. 42.

$$= r^2 \times \frac{h}{n^3},$$

A denote the area of ABC, we

$$\frac{\text{base of } r^{th} \text{ prism}}{A} = \frac{r^2h^2}{n^3} \times \frac{1}{h^2} = \frac{r^2}{n^3},$$

by a well-known theorem in solid ry, the areas of sections of a pyramid made by planes parallel base are proportional to the squares of their altitudes. s we have

$$\text{base of } r^{th} \text{ prism} = \frac{r^2}{n^2} A, \text{ and therefore}$$

$$\text{its volume} = \frac{r^2}{n^2} A \times \frac{h}{n} \text{ (§ 67)}$$

$$= \frac{hA}{n^3} \times r^2.$$

ore volume of whole pyramid

$$= hA \prod_{n=\infty} \frac{1^2 + 2^2 + \dots + r^2 + \dots + n^2}{n^3}$$

$$= hA \prod_{n=\infty} \frac{n(n+1)(2n+1)}{6n^3} = \frac{hA}{3}$$

volume of any pyramid is equal to one-third of the area of its ultiplied by its height.

n this we see that pyramids on equal bases are to one another r altitudes.

e pyramid be *regular*, that is, if its base be a regular polygon rpendicular through whose centre passes through the vertex,

$$\text{its volume} = \frac{1}{3} \cot\frac{180^\circ}{n} \cdot h^3.$$

Surface of a Regular Pyramid.—The lateral surface of the pyramid VABCDEF (fig. 43) is equal to the sum of the areas n congruent triangles which make up the lateral surface of ramid.

area of triangle VAB = $\frac{1}{2}$AB × VG; hence whole lateral sur- $\frac{1}{2}n$AB·VG = $\frac{1}{2}nal$, where l is the slant height and a the length side of the base.

n, if VO = h = altitude of pyramid, we have

$$l = VG = \sqrt{VO^2 + OG^2} = \sqrt{h^2 + \frac{a^2}{4} \cot^2\frac{180^\circ}{n}},$$

therefore whole surface = base + lateral surface

$$= a^2 \times \frac{n}{4} \cot\frac{180^\circ}{n} + \frac{1}{2}na\sqrt{h^2 + \frac{a^2}{4} \cot^2\frac{180^\circ}{n}}$$

$$= \frac{1}{2}na\left(\frac{a}{2} \cot\frac{180^\circ}{n} + \sqrt{h^2 + \frac{a^2}{4} \cot^2\frac{180^\circ}{n}}\right).$$

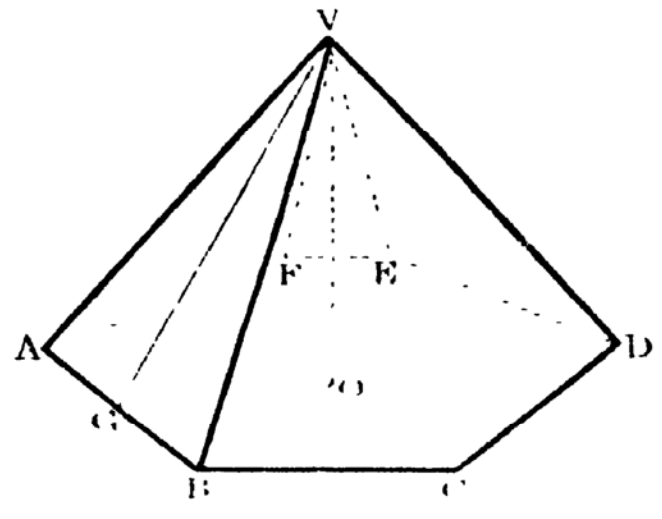


Fig. 43.

§ 72 *The Prismatoid.* If we have a polyhedron whose two polygons in parallel planes, the number of sides in ea the same or different, and if we so join the vertices of the that each line in order forms a triangle with the preceding line and one side of either base, the figure so formed is called a "prismatoid," and holds in stereometry a position similar to that of the trapezium in planimetry. To make the investigation of the volume of the prismatoid as simple as possible, we take the case where the lower base is a polygon of four and the upper one of three sides.

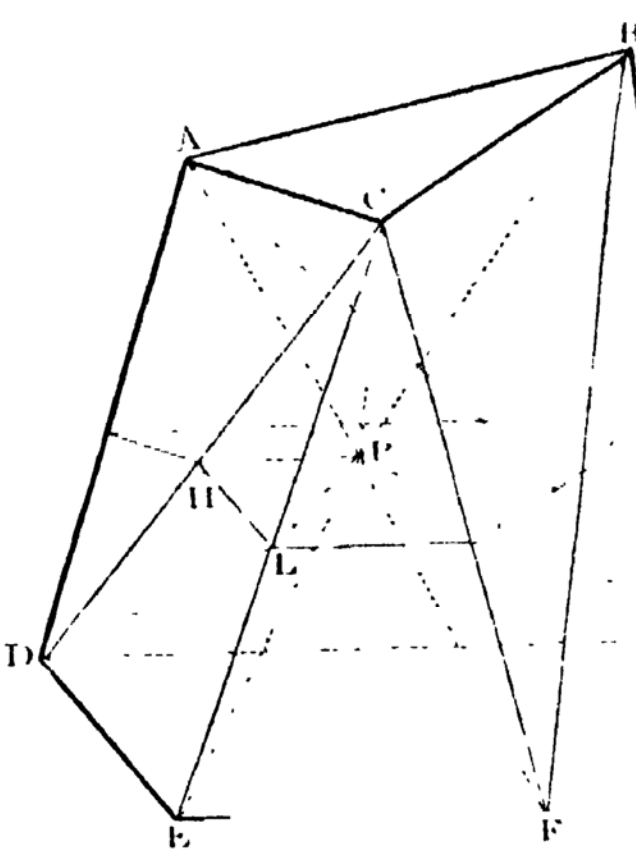


Fig. 44.

Let ABCDEFG (fig. 44) be the prismatoid, of which ABC or A_1 is the upper and DEFG or A_3 the lower base, and let HLM be the section equidistant from the bases. Take any point P section and join it to the corners of the prismatoid. divide the polyhedron into two pyramids PABC and and a series of polyhedra of which CPDE may be tak specimen.

Let h be the altitude of the prismatoid, then $\frac{1}{2}h$ is the al each of the pyramids PABC, PDEFG, and hence

$$\text{volume of PABC} = \tfrac{1}{6}hA_1, \text{ and}$$
$$\text{volume of PDEFG} = \tfrac{1}{6}hA_3.$$

Again join PH, PL, and LD, then

$$\text{volume of CPDE} = 2 \text{ volume of CPDL},$$
$$\text{since DE} = 2\text{HL},$$
$$\text{and volume of CPDL} = 2 \text{ volume of CPHL},$$
$$\text{hence volume of CPDE} = 4 \text{ volume of CPHL}.$$

Now volume of CPHL = $\frac{1}{6}h \times$ area of HLP, and therefo of CPDE = $\frac{2}{3}h \times$ area of HLP.

Similarly the volume of every such polyhedron is $\frac{2}{3}h \times$ of its own portion of the middle section. Hence if A_2 de area of the middle section we have

$$\text{volume of prismatoid} = \tfrac{1}{6}hA_1 + \tfrac{1}{6}hA_3 + \tfrac{2}{3}hA_2$$
$$= \tfrac{1}{6}h(A_1 + 4A_2 + A_3).$$

§ 73. *Volume of the Frustum of a Pyramid.* Let A′A″B (fig. 45) be a frustum of the pyramid VA′B′C′, and let A denote the areas of the ends A′B′C′, A″B″C″ respective VP = x = altitude of pyramid VA″B″C″, and let PQ = h = al frustum.

Now $\frac{A_2}{A_1} = \frac{x+h}{x}$, whence $x = \frac{h\sqrt{A_1}}{\sqrt{A_2} - \sqrt{A_1}}$.

frustum = VA′B′C′ − VA‴B‴C‴

$$= \tfrac{1}{3}\{A_1(c+h) \quad A_3 c\}$$

$$\left\{ A_1\left(\begin{matrix} h\sqrt{A_1} \\ \sqrt{A_1}-\sqrt{A_3}\end{matrix}\right) \quad A_3\left(\begin{matrix} h\sqrt{A_3} \\ \sqrt{A_1}-\sqrt{A_3}\end{matrix}\right)\right\}$$

$$= \tfrac{1}{3}h(A_1 + \sqrt{A_1 A_3} + A_3);$$

a which applies to the frusta of all pyramids regular and

bove result may be otherwise expressed. For, let $A'B' = a_1$ $A'''B''' = a_3$, then, if $A''B''C''$ be a section equidistant from the the frustum, $A''B'' = a_2 = \tfrac{1}{2}(a_1 + a_3)$.

$A_1 = pa_1^2$ and $A_3 = pa_3^2$ (see § 70);

A_2 = area of $A''B''C''$ $= pa_2^2 = p\left(\frac{a_1+a_3}{2}\right)^2$, which gives

$$4A_2 = pa_1^2 + 2pa_1a_3 + pa_3^2 \quad A_1 + 2\sqrt{A_1A_3} + A_3;$$

e volume of frustum

$$= \tfrac{1}{6}h(2A_1 + 2\sqrt{A_1A_3} + 2A_3) = \tfrac{1}{6}h(A_1 + 4A_2 + A_3);$$

olume of the frustum of a pyramid is obtained by adding as of the ends to four he area of the middle and multiplying the one-sixth of the alti-

above result can be ob- at once from § 72, since ‴B‴C‴ is a prismatoid nilar bases.

Surface of the Frustum ular Pyramid. In fig. the perimeter of A_1 p_1, A_2 p_2, and that of and let $VD' = l_1$, l_3, and therefore $D'D'''$ $VD''' = l_1 \quad l_3 \quad l$. The surface of the frustum is the difference between the lateral surfaces of the pyramids ′ and VA‴B‴C‴,

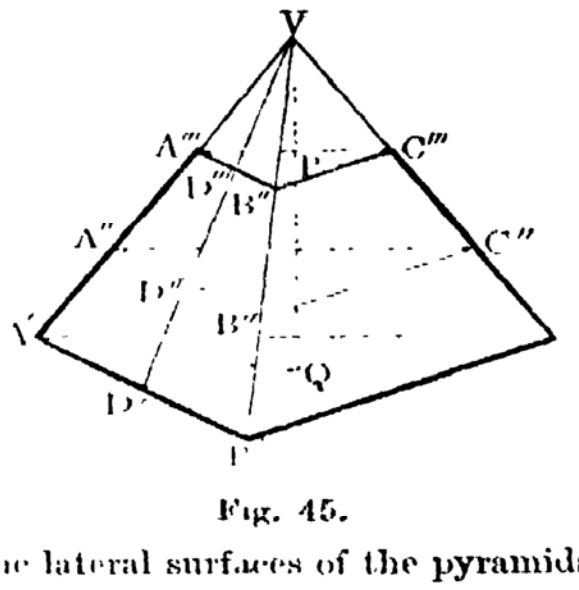


Fig. 45.

$$\tfrac{1}{2}p_1 l_1 \quad \tfrac{1}{2}p_3 l_3.$$

nce $\frac{l}{l_3} = \frac{a_1}{a_3} = \frac{ma_1}{ma_3} = \frac{p_1}{p_3}$, we have $l_1 = \frac{p_1 l}{p_1 - p_3}$ and $l_3 = \frac{p_3 l}{p_1 - p_3}$,

re lateral surface of frustum

$$= \tfrac{1}{2}l\left(\frac{p_1^2 - p^2}{p_1 - p_3}\right) \qquad p_1 + p \qquad lp_2;$$

lateral surface of the frustum of a regular pyramid is equal product of the slant height and the perimeter of the section tant from the ends.

wise. The top and base being regular polygons, the inclined are congruent trapeziums. Let l be the height of each um, and let there be n of them, then

$$\text{area of each face} = \frac{l}{2}(p_1 + p_3),$$

herefore the area of lateral surface $= \frac{l}{2}(p_1 + p_3) = lp_2$.

If h the altitude of the frustum be given, we deduce the height and then proceed as before. Thus let $VP = h_3$, , and using the same notation as in §§ 72, 73, and 74 we

$$\frac{h_1}{h_1 - h_3} = \frac{a_1}{a_1 - a_3}, \text{ which gives } h_1 = \frac{a_1(h_1 - h_3)}{a_1 - a_3}, \quad \frac{a_1 h}{a_1 - a_3}.$$

$$l, \qquad \text{of } 180°, \text{ and } l = \left(\qquad\right) l,$$

l is known since l_1 is known in terms of h

n the pyramid is irregu- lateral planes are non- ent trapeziums, the areas of can be found separately by nd hence the whole surface.

Volume of the Frustum of angular Prism.—Let A denote ea of ABC (fig. 46), and let , h_3 be the altitudes of A′, respectively with reference to ne ABC. Divide the frustum ree pyramids B′A′AC, B′ABC, A′ACC′ by the planes B′AC′ A′AC. These three pyramids spectively equal to BA′AC, , and ABCC′;

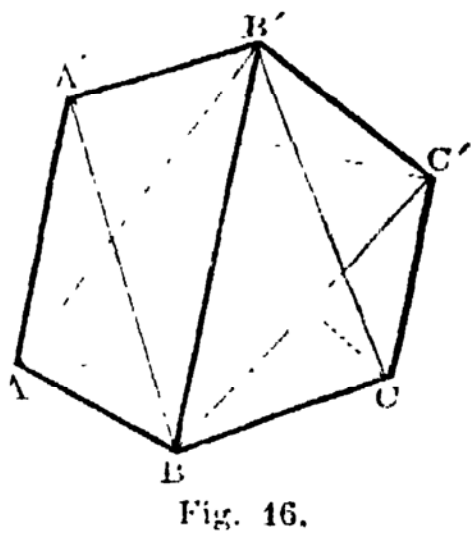


Fig. 46.

volume of frustum $= \tfrac{1}{3}h_1 A + \tfrac{1}{3}h_2 A + \tfrac{1}{3}h_3 A$

$$= \tfrac{1}{3}A(h_1 + h_2 + h_3).$$

§ 77. If the prism be right or oblique, the volume of a frus equal to one-third of the area of its right section multiplied sum of the parallel edges. For divide the frustum AA′B′ 47) into two frusta by a plane A″B″C″ of area A at right to the edges, then

AA′B′C′ = AA″B″C″ + A″A′B′C′

$= \tfrac{1}{3}A(AA'' + BB'' + CC'') + \tfrac{1}{3}A(A'A'' + B'B'' + C'C'')$

$= \tfrac{1}{3}A(AA'' + BB'' + CC'' + A'A'' + B'B'' + C'C'')$

$= \tfrac{1}{3}A(AA' + BB' + CC'')$.

Again, since every prism can be divided into triangular we can find by repeated applications of the above proposit volume of the frustum of any prism whatever. For exar

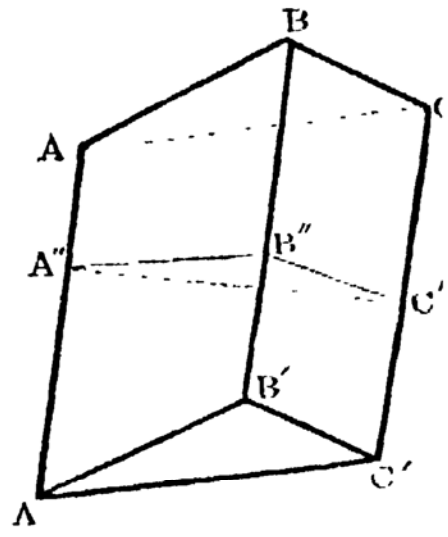


Fig. 47

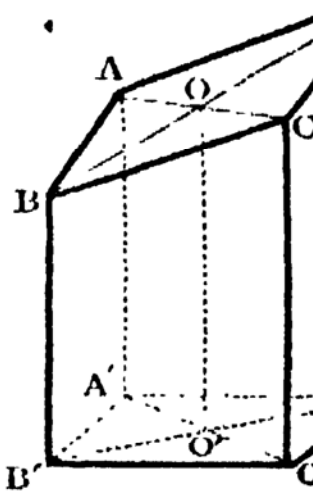


Fig. 48.

the base of the frustum of a right prism AA′B′C′D′ (be a rectangle 12 feet by 6 feet, and the parallel edges i 6, 4, 10, and 12 feet, then

A = area of base $= 12 \times 6 = 72$ square feet.

Frustum = ABCA′B′C′ + ADCA′D′C′

$= \frac{1}{3} \times \frac{1}{2}A(AA' + BB' + CC') + \frac{1}{3} \times \frac{1}{2}A(AA' + CC' + DD')$

$\frac{1}{6}A(2AA' + 2CC' + BB' + DD') = 576.$

§ 78. *Volume of a Wedge.* The wedge (fig. 49) being merely the frustum of a triangular prism, we have at once

volume $= \frac{1}{3}A(FE + AD + BC)$,

where A is the area of its right section; otherwise, the wedge may be considered a prismatoid whose upper base is a straight line, and hence its volume $= \frac{1}{6}h(4A_2 + A_3)$, since A

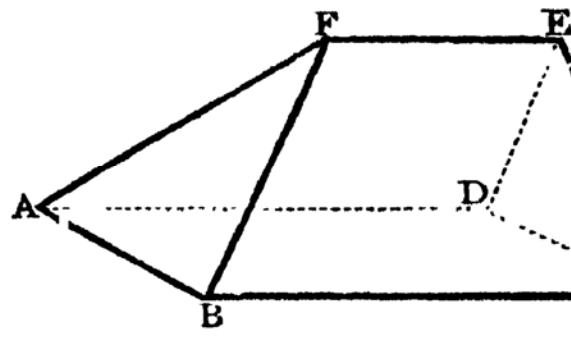


Fig. 49.

B. *Regular Polyhedra.*

§ 79. The regular polyhedra are five in number, nam *tetrahedron*, *cube*, *octahedron*, *dodecahedron*, and *icosahedro* solid angles are formed respectively by three equilateral t three squares, four equilateral triangles, three pentagons, equilateral triangles.

Since a regular polyhedron admits of having a sphere i within it and described about it, it can easily be shown volume of the polyhedron

$$= a^3 \times \frac{nl}{24} \times \frac{\cos\frac{\pi}{m}\cot^2\frac{\pi}{n}}{\left\{1 - \cos\left(\frac{\pi}{m}+\frac{\pi}{n}\right)\cos\left(\frac{\pi}{m}-\frac{\pi}{n}\right)\right\}^{\frac{1}{2}}};$$

and from § 18, γ, it follows that the surface of the polyhed

$$= a^2 \times \frac{ln}{4}\cot\frac{\pi}{n},$$

where l = the number of faces,
m = the number of faces in each solid angle,
n = the number of edges in each face,
and a = the length of each side.

The following table contains the surfaces and volumes five regular polyhedra whose edge is 1.

Polyhedron.	Surface.	Volume.
Tetrahedron	1·7320508	0·117851
Cube	6·0000000	1·000000
Octahedron	3·4641016	0·471404
Dodecahedron	20·6457788	7·663118
Icosahedron	8·6602540	2·181695

face and volume of a regular polyhedron whose edge is
ined by multiplying the surface and volume of a similar
on whose edge is 1 by a^2 and a^3 respectively

s II. Solids contained by Surfaces which are not all Planes

A. *The Cylinder*

Volume of a Cylinder (fig. 50). Inscribe in the cylinder a
l prism of which the number of sides may be increased
ely. Then in the limit the base of the prism becomes the
he cylinder, and the volume of the prism the volume of
der. Now by § 67 we have

volume of prism = area of base × altitude;
volume of cylinder = area of base × altitude.

Surface of a Right Cylinder.—As above, in the limit the
he prism becomes the base of the cylinder, and the surface
rism the surface of the cylinder. Now the lateral surface

meter of right section × length
meter of base × length, in the case of a right prism (§ 68)
ateral surface of right cylinder = circumference of base
.

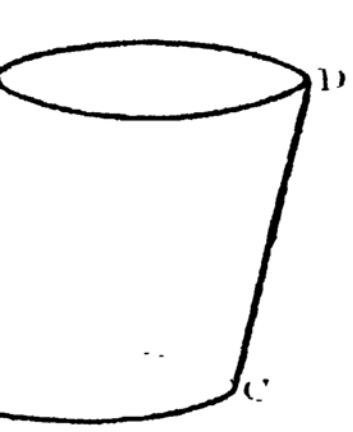


Fig. 50.

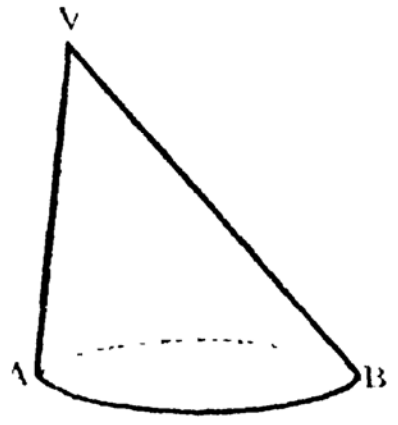


Fig. 51.

B. *The Cone.*

Volume of a Cone (fig. 51). Inscribe within the cone a
l of which the number of sides may be indefinitely
then in the limit the base of the pyramid becomes the base
one and the volume of the pyramid the volume of the cone.

volume of pyramid = ⅓ base × altitude,
ce volume of cone = ⅓ base × altitude.

Volume of the Frustum of a Cone.—From § 73 we find that
me of the frustum of a pyramid

$$\tfrac{1}{3}h(A_1 + \sqrt{A_1A_3} + A_3),$$

nce in the limit the frustum of the pyramid becomes the
of the cone, we have

volume of conical frustum $= \tfrac{1}{3}h(A_1 + \sqrt{A_1A_3} + A_3)$,

A_1 and A_3 are the areas of the terminating planes of the

he terminating planes be circles of radii r_1 and r_3, then
of frustum

$$= \tfrac{1}{3}h(\pi r_1^2 + \pi r_1 r_3 + \pi r_3^2) = \tfrac{1}{3}\pi h(r_1^2 + r_1 r_3 + r_3^2).$$

, by the same section we have

volume of frustum of pyramid $= \tfrac{1}{6}h(A_1 + 4A_2 + A_3)$,
e volume of conical frustum $= \tfrac{1}{6}\pi h(r_1^2 + 4r_2^2 + r_3^2)$,

r_2 is the radius of the circular section parallel to the ter-
g planes and equidistant from them.

Surface of a Right Cone.—The lateral surface of a regular
l is by § 71

½ perimeter of base × slant height;

nce in the limit the surface of the pyramid becomes the sur-
the cone, the lateral surface of a right cone is equal to half
umference of its base multiplied by the slant height.

the lateral surface of a right cone of slant height l and the
f whose base is r is equal to

$$\tfrac{1}{2} \times 2\pi r \times l = \pi r l,$$

whole surface = lateral surface + area of base
$= \pi r l + \pi r^2$
$= \pi r(l + r)$.

, if h, the altitude of the cone, be given, we have

$$l = \sqrt{h^2 + r^2},$$

refore whole surface $= \pi r(\sqrt{h^2 + r^2} + r)$.

Surface of the Frustum of a Right Cone.—The lateral surface
frustum of a regular pyramid is equal to the product of th
eight and the perimeter of its middle section (§ 74); hence
in the limit we find that the lateral surface of the frustum
right cone is equal to the product of its slant height and t
umference of the section equidistant from its parallel fac

Let r_1 and r_3 denote the radii of the ends of the frustum
the length of the slant height, then

$r_2 = \tfrac{1}{2}(r_1 + r_3)$ = radius of middle section,

and therefore

lateral surface $= 2\pi r_2 l = 2\pi \cdot \tfrac{1}{2}(r_1 + r_3) \cdot l = \pi l(r_1 + r_3)$,

and whole surface $= \pi r_3 + \pi l(r_1 + r_3) + \pi r_1^2$.

If h, the altitude of the frustum, be given, we have

$$l = \sqrt{h^2 + (r_1 - r_3)^2}.$$

C. *The Sphere.*

§ 86. *Surface of a Spherical Zone.* Let AB (fig. 52) be a small arc of the sphere, and let AA′, BB′ be perpendicular to the axis AA′ to find the surface of the zone generated by the arc AB. Join AB, and draw OP perpendicular to AB, BD parallel to AA′, and PP′ parallel to AA′ or BB′. The chord AB generates the frustum of a cone, whose lateral surface $= 2\pi PP' \cdot AB$.

But, since the triangles ABD and OPP′ are similar,

AB : OP = BD : PP′.

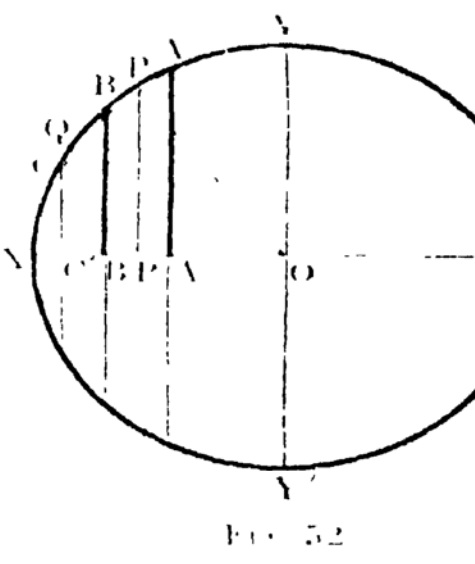


Fig. 52.

therefore area of conical frustum $= 2\pi \cdot OP \cdot BD = 2\pi \cdot OP \cdot AA'$.
Similarly the area of the frustum generated by BC $= 2\pi \cdot OQ \cdot$

But in the limit when the chords AB, BC, &c., are indefinitely diminished, the perpendiculars OP, OQ, &c., become each
hence by summing all the areas we get in the limit

area of zone $= 2\pi r \times$ projection of arc on axis of revolution.

Hence the convex surface of a segment of a sphere is equal
circumference of a great circle multiplied by the height of t
ment or zone.

§ 87. *Surface of a Sphere.* The whole sphere is one
whose height is $2r$, we obtain at once

surface of sphere $= 2\pi r \cdot 2r = 4\pi r^2$,

or the surface of a sphere is equal to four great circles.

The total surface of the cylinder circumscribing the sp
radius r is $6\pi r^2$, hence the surface of the sphere = ⅔ surface
circumscribing cylinder.

§ 88. *Surface of a Lune, a Spherical Triangle, and a Sp
Polygon.* It is shown in spherical trigonometry that

(α) the area of a lune included between two great cir
sphere of radius r, and whose inclination is θ radians

$= 2\theta r^2$;

β) the area of a spherical triangle whose angles are A, B
$= (A + B + C - \pi)r^2$,

) spherical polygon of n sides is
$= \{P - (n-2)\pi\}r^2$, where P = the sum of its angles

§ 89. *Measurement of Solid Angles.* A convenient unit
measurement of plane angles is the "radian." If we a su
h unit of surface of a sphere subtends the same solid ang
centre, we can deduce a very convenient unit for the meas
of solid angles. The unit, which has received the name
dian," we define to be the solid angle subtended at the cen
sphere by a portion of the surface whose area is r^2.

§ 90. *Value of Steradians in any Angle.* Let A be the
the centre of a sphere, and let S be the portion of the surfa
sphere which it intercepts, then

number of steradians in A $= \dfrac{S}{r^2}$.

For example, if A be a plane solid angle, S a hem
$2\pi r$; hence the number of steradians
in a plane solid angle $= \dfrac{S}{r^2} = \dfrac{2\pi r}{r} = 2\pi$,

and therefore the number of steradians in
the solid angle at a point $= 4\pi$. This solid
angle is sometimes called a "sphere."

Hence, if we can find the surface in
tended by any solid angle, we can alw
find its magnitude in terms of the u
solid angle.

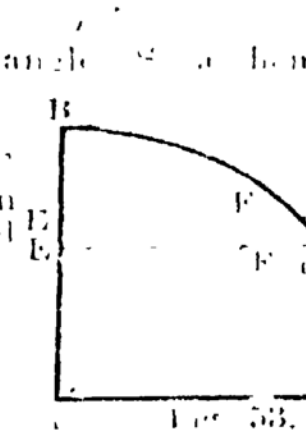


Fig. 53.

Volume

(fig. 53) be the quadrant of a circle, draw DB and DC tang
it, then, if AD be joined and the whole figure be conce

round AB, ABD, ABC, and ABDC will generate a cone, sphere, and a cylinder respectively.

draw two parallel planes EFGH and E′F′G′H′ very near each d perpendicular to AB, and draw EE′ and GG′ parallel to n, by § 80,

olume generated by LHH′L′ πEH² − EE′,
EGG′E′ πEG² − LE′,
EFF′E′ πEF² − LF².

lume generated by EFF′E′ + volume generated by EGG′E′
π(EF² + EG² − LE′ = πEA′ · EG² − EE′
π(AG² − EE′ = πLH² − LL′
volume generated by LHH′L′

n the limit, when the number of frustums indefinitely increased and their thickness indefinitely diminished, we have volume generated by AF = volume of spherical zone generated by CG = volume of cylinder generated by CH.

radius of sphere, h = AL = height of zone ACGE, then

volume of cone = $\frac{1}{3}\pi h^3$ · h = $\frac{1}{3}\pi h^3$, and
volume of cylinder = $\pi r^2 \cdot h$,
volume of spherical zone = $\pi r^2 h - \frac{1}{3}\pi h^3$
= $\frac{1}{3}\pi h(3r^2 - h^2)$.

eight of a hemisphere is r,

volume of hemisphere = $\frac{1}{3}\pi r \cdot 3r^2 - r^3$ = $\frac{2}{3}\pi r^3$,
volume of whole sphere = $\frac{4}{3}\pi r^3$,

readily obtainable by the infinitesimal calculus, or by ng within the sphere a series of triangular pyramids whose all meet at the centre of the sphere, and the angles of whose l rest on the surface. In the limit the altitude of each becomes the radius of the sphere, and the sum of the bases yramids the surface of the sphere; hence

volume = $\frac{1}{3}S \cdot r$ = $\frac{1}{3} \cdot 4\pi r^2 \cdot r = \frac{4}{3}\pi r^3$.

ume of the circum-cribing cylinder = $\pi r^2 \cdot 2r = 2\pi r^3$,
e volume of sphere = $\frac{2}{3}$ volume of circumscribing cylinder.

Let S denote the surface of a sphere and V its volume, then 87 and 91 we have

$$(\alpha)\quad r = \frac{S}{2\sqrt{\pi}}\sqrt{\frac{S}{4\pi}} = \sqrt[3]{\frac{3}{4\pi}}\cdot\sqrt[3]{V};$$

$$(\beta)\quad S = \sqrt{\pi}\sqrt[3]{6V}\cdot\sqrt[3]{V},$$

$$= \frac{1}{6\sqrt{\pi}}\sqrt{S^3}$$

which give the radius in terms of the surface or volume, the in terms of the volume, and the volume in terms of the

Volume of a Spherical Shell.—Let r and r_1 denote the radii wo spheres, then

volume of shell V = $\frac{4}{3}\pi r_1^3 - \frac{4}{3}\pi r^3$
= $\frac{4}{3}\pi(r_1^3 - r^3)$
= $\frac{4}{3}\pi r_1 - r)(r_1^2 + r_1 r + r^2)$.

t $r_1 - r = h$, then

$$V = \frac{4}{3}\pi r_1^3 h\left(1 + \frac{r}{r_1} + \frac{r^2}{r_1^2}\right)$$

small compared with r_1, then r/r_1 is very nearly equal to 1, have approximately

$V = \frac{4}{3}\pi r_1^3 h(1 + 1 + 1) = 4\pi r_1^2 h$.

t h be nearly equal to r_1, r is very small, and r/r_1 is also very so that we have approximately

$V = \frac{4}{3}\pi r_1^2 h$.

Volume of a Spherical Segment.—Let CRC (fig. 54) be a of a spherical segment wh RQ is p, then, if OQ = h, of segment CRC = volume of here = volume of zone VVC′C

$= \frac{1}{3}\pi h\{3r^2 - h^2\}$, § 91
$= \frac{1}{3}\pi(r - p)\{3r^2 + (r - p)^2\}$
$= p^2(3r - p)$.

ut $p = 2r$, we obtain as before of sphere = $\frac{4}{3}\pi r^3$
t CQ = r_1 we have
r_1 = RQ.EQ = $p(2r - p)$

whence $r = \frac{r_1^2}{2p} + \frac{p}{2}$,

re volume of segment = $\frac{1}{3}\pi p^2(3r_1 + p^2)$.

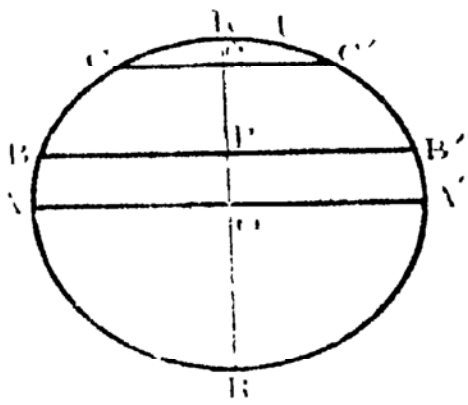


Fig. 54.

Volume of a Spherical Frustum.—When one of the terminating planes passes through the centre we have already that the volume

$= \frac{1}{3}\pi h(r^2 + h^2)$,

where h is its altitude.

Now suppose that neither of the terminating planes passes the centre; for example, to find the volume of the frustum

Let RQ = p and RP = q, then

BB′C′C = segment RBB′ − segment RCC′
$= \frac{1}{3}\pi q(3a_2^2 + q^2) - \frac{1}{3}\pi p(3a_1^2 + p^2)$,

where a_1 and a_2 are the radii of the ends CC′ and BB′.

Let $q - p = h$ = height of frustum, and, since, from the geo the figure,

$$\frac{a_1^2 + p^2}{p} = \frac{a_2^2 + q^2}{q} = 2r,$$

we have volume = $\frac{1}{6}\pi h\{3(a_1^2 + a_2^2) + h^2\}$,

a result which may also be obtained by considering BB′C′C difference of the two zones AA′C′C and AA′B′B.

D. *Spheroid.*

§ 96. *Surface of a Prolate Spheroid.*—The prolate sphero solid generated by the revolution of an ellipse about its ma If S be the surface generated by an arc of the curve, then

$S = 2\pi\int y\sqrt{1 + \left(\frac{dy}{dx}\right)^2}dx$, taken between proper lim

In the case before us

$S = 2\pi b^2 + 2\pi\frac{ab}{e}\sin^{-1}e$,

where e is the eccentricity (INFINITESIMAL CALCULUS, art.

§ 97. *Surface of an Oblate Spheroid.*—The oblate sphero solid generated by the revolution of an ellipse about its m (fig. 55).

Here surface = $2\pi a^2 + \pi\frac{b^2}{e}\log_e\frac{1+e}{1-e}$ (INFINITESIMAL CA art. 179).

§ 98. *Volume of a Spheroid.*—We have volume of prolate

$$\pi\int_{-a}^{+a} b^2\left(1 - \frac{x^2}{a^2}\right)dx = 2\pi b^2\int_0^a\left(1 - \frac{x^2}{a^2}\right)dx = \frac{4}{3}\pi ab^2$$

Similarly volume of oblate spheroid = $\frac{4}{3}\pi a^2 b$.

Thus,

$$(\alpha)\quad \frac{\text{volume of prolate spheroid}}{\text{volume of oblate spheroid}} = \frac{\frac{4}{3}\pi ab^2}{\frac{4}{3}\pi a^2 b} = \frac{b}{a};$$

$$(\beta)\quad \frac{\text{sphere described on major axis}}{\text{prolate spheroid}} = \frac{\frac{4}{3}\pi a^3}{\frac{4}{3}\pi ab^2} = \frac{a^2}{b^2};$$

$$(\gamma)\quad \frac{\text{sphere described on minor axis}}{\text{oblate spheroid}} = \frac{\frac{4}{3}\pi b^3}{\frac{4}{3}\pi a^2 b} = \frac{b^2}{a^2}.$$

§ 99. *Volume of a Segment of a Spheroid.*

(α) *The prolate spheroid.*—This segment is generated revolution of AMP (fig. 23, p. 20) about AM, and hence

its volume = $\pi\int_0^h y^2dx = \pi\frac{b^2}{a^2}\int_0^h(2ax - x^2)dx = \frac{\pi}{3} \times \frac{b^2h^2}{a^2}(3$

where A is the origin and AM = h.

(β) *The oblate spheroid.* The segment in this case is g by the revolution of BMP (fig. 55) about BC, and hence

its volume = $\pi\int_0^h y^2dx = \pi\frac{a^2}{b^2}\int_0^h(2bx - x^2)dx = \frac{\pi}{3} \times \frac{a^2h^2}{b^2}(3$

where B is the origin and BM = h.

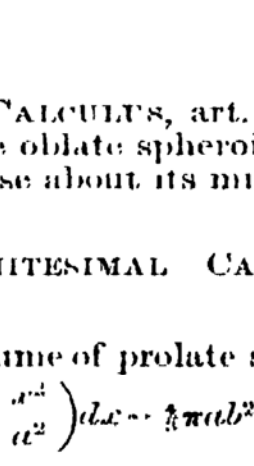


Fig. 55

§ 100. *Volume of the Frustum of a Spheroid when one of the Terminating Planes passes through the Centre.*

(α) *The prolate spheroid.* The frustum in this case is generated by the revolution of BCMP about CM (fig. 23).

Now volume generated by BCMP
= volume generated by BCA
− volume generated by PMA

$$\frac{2}{3}\pi ab^2 - \frac{b^2h^2}{a}(3a - h)$$

$$= \frac{\pi}{3}\frac{b^2k}{a^2}(3a^2 - k^2), \text{ where}$$

k = CM = height of frustum = $a - h$.

(β) *The oblate spheroid.*—We can show in a similar that the volume generated in this case

$$= \frac{\pi}{3} \times \frac{a^2k}{b^2}(3b^2 - k^2).$$

The above formulæ may be put into another form. Thu case of the prolate spheroid, since the point P lies on t $b^2x^2 + a^2y^2 = a^2b^2$, we have

$b^2k^2 + a^2b_1^2 = a^2b^2$, where b_1 = PM, which gives

$$k^2 = a^2\frac{(b^2 - b_1^2)}{b^2};$$

by substitution, the volume of prolate frustum
$$= \tfrac{1}{3}\pi k(2b^2 + b_1^2).$$
y we can show that the volume of the oblate frustum
$$= \tfrac{1}{3}\pi k^2(2a^2 + a_1^2),$$
where a_1 = PM.

rmulæ play an important part in the gauging of casks.

E. *Paraboloid.*

Surface of a Paraboloid. - Let the equation to the para $y^2 = 4ax$, and let the coordinates of P (fig. 21, p. 19) be x_1, the surface of the paraboloid generated by the revolution bout AP
$$2\pi\int_0^{x_1} y\sqrt{1+\left(\frac{dy}{dx}\right)^2}dx = 4\pi\sqrt{a}\int_0^{x_1}\sqrt{x}\sqrt{x+a}\,dx$$
$$= \tfrac{8}{3}\pi\sqrt{a}\left\{(x_1+a)^{\frac{3}{2}} - a^{\frac{3}{2}}\right\}.$$

Volume of a Paraboloid.—With the same notation we
$$\text{ume} = \pi\int_0^{x_1} y^2dx = 4\pi a\int_0^{x_1} x\,dx = \tfrac{1}{2}\pi \quad 4ax_1 = x_1 \quad \tfrac{1}{2}\pi y_1^2 \quad x_1;$$
olume of a paraboloid generated by the revolution of a part abola between the vertex and any point is equal to half the of the circumscribing cylinder.

If the coordinates of Q be x_2, y_2, then the volume of the PP'Q'Q
$$= \tfrac{1}{2}\pi\left\{y_2^2x_2 \quad y_1^2x_1\right\} - 2\pi a(x_2^2 - x_1^2) - \tfrac{1}{2}\pi(y_2^2 + y_1^2)h,$$
= MN; hence the volume of the frustum of a paraboloid to half the sum of the areas of its ends multiplied by its

F. *Ellipsoid*

Volume of an Ellipsoid. - The equation to the ellipsoid
$$\frac{x^2}{a^2} + \frac{y^2}{b^2} \quad 1,$$
ation to the elliptic section at the distance z from the
$$\frac{x^2}{a^2} + \frac{y^2}{b^2} - 1 \quad \frac{z^2}{c^2}.$$
we draw an indefinite number of parallel planes per- ar to the axis of z, each slice will be an infinitely thin cal plate, and accordingly the whole volume of the ellipsoid $= \int A\,dz$, where A is the area of the elliptic section.

$= \pi ab\left(1 - \frac{z^2}{c^2}\right)$, § 51,

$$\text{volume} = \pi ab\int_{-c}^{c}\left(1 \quad \frac{z^2}{c^2}\right)dz = \tfrac{4}{3}\pi abc.$$

ere being an ellipsoid whose axes are all equal, we obtain

$$\text{volume of sphere} \quad \tfrac{4}{3}\pi a^3 = \tfrac{4}{3}\pi r^3.$$

G. *Hyperboloid.*

Volume of an Hyperboloid. The hyperboloid is generated evolution of the hyperbolic segment ANP about AN (fig 0). If the coordinates of P be x_1, y_1, then

$$\text{olume of hyperboloid} = \pi\int_a^{x_1} y^2dx \quad \pi\frac{b^2}{a^2}\int_a^{x_1}(x^2 - a^2)dx$$
$$= \pi\frac{b^2}{a^2}\left\{\frac{x_1^3}{3} - a^2x_1 + \frac{2a^3}{3}\right\} = \frac{\pi b^2h^2}{3a^2}(3a + h),$$
where $h = \text{AN} = x_1 \quad a$.

, since x_1, y_1 is on the curve, we have

$b^2(a + h)^2 = \quad a^2b^2$, which gives $\frac{b^2}{a^2} = \frac{y_1^2}{2ah + h^2}$; whence

$$\text{volume of hyperboloid} = \frac{\pi hy_1^2}{3} \quad \frac{3a + h}{2a + h}.$$

Solids to which the "Prismoidal Formula" applies.

It was shown in § 72 that the volume of any polyhedron by two parallel planes and by plane rectilinear figures
$$\tfrac{1}{6}h(A_1 + 4A_2 + A_3),$$
A_1, A_3, and A_2 denote respectively the areas of the two ends he middle section.

ow proceed to show that the same formula determines the of all solids bounded by two parallel planes, provided the any section parallel to these planes can be expressed as a integral algebraic function of the third degree in x, where distance of the section from either plane.

Let $\phi(x) = A + Bx + Cx^2 + Dx^3 + \ldots + Kx^n$ denote t of the section in question

Now the solid between the sections $\phi(0)$ and $\phi(4)$ is equa solid between the sections $\phi(0)$ and $\phi(2)$ plus the solid betw sections $\phi(2)$ and $\phi(4)$. Hence if the prismoidal formula is in this case, we have
$$\tfrac{1}{6}h\left\{\phi(0) + 4\phi(2) + \phi(4)\right\}$$
$$= \tfrac{1}{12}h\left\{\phi(0) + 4\phi(1) + \phi(2)\right\} + \tfrac{1}{12}h\left\{\phi(2) + 4\phi(3) + \phi(4)\right\}$$
where h is the distance between the sections $\phi(0)$ and $\phi(4)$. Hence we have
$$\phi(0) - 4\phi(1) + 6\phi(2) - 4\phi(3) + \phi(4) = 0.$$

Now	$\phi(0)$	A						
	$4\phi(1)$	$-4A$	$4B$	$4C$	$4D$	$4E$	. . . .	$4K$
	$+6\phi(2)$	$6A$	$+12B$	$+24C$	$+48D$	$+96E$	. . . .	$+6\ 2^n$
	$-4\phi(3)$	$-4A$	$-12B$	$-36C$	$-108D$	$-324E$	. . . .	
	$+\phi(4)$	A	$+4B$	$+16C$	$+64D$	$+256E$	. . . .	$+4^nK$.

Therefore 0 0 0 0 0 $+24E + PF + \ldots + Tk$

Hence E F . . . . K 0, and therefore $\phi(x)$ must be tion of the third degree in order that the prismoidal formu apply.

§ 107. If we take $\phi(x) = A + Bx + Cx^2 + Dx^3$, there will be possible varieties as there are combinations of four things, o three, and four together, $= 4 + 6 + 4 + 1 = 15$ varieties. Corres to each of these there will be *at least one solid* the area of a of which at a distance x from one of the parallel pl $\phi(x) = A + Bx + Cx^2 + Dx^3$, and *at least one solid* of re generated by the curve whose equation is of the form
$$\pi y^2 = \phi(x) = A + Bx + Cx^2 + Dx^3.$$
As space prevents us discussing all the cases that may a content ourselves by giving three examples as illustrations.

(α) *Volume of an ellipsoid.* Here $\phi(x) = Bx + Cx^2$.

Let $2a$, $2b$, and $2c$ be the axes of which $2a$ is the greate $h = 2a$, $A_1 = 0$, $A_3 = 0$, and $A_2 = \pi bc$, therefore volume $= \frac{1}{6}h(A_1 + 4A_2 + A_3) = \frac{1}{3}a(4\pi bc) = \frac{4}{3}\pi abc$, which agrees with the result in § 104.

(β) *Volume of a sphere.* —Here $\pi a = \phi(x) = Bx + Cx^2$.

Let r be the radius of the sphere, then $h = 2r$, $A_1 = 0$, A_3 $A_2 = \pi r^2$, hence, as before (§ 91),
$$\text{volume of sphere} = \tfrac{1}{6}h(A_1 + 4A_2 + A_3) = \tfrac{2r}{6}(4\pi r^2) = \tfrac{4}{3}\pi r$$

(γ) *Volume of a right circular cone.* —Here $\pi a^2 = \phi(x) = C$.

Let r = radius of base and h the altitude, then $A_1 = 0$, and $A_2 = \pi(\frac{1}{2}r)^2$, hence
$$\text{volume of cone} = \tfrac{1}{6}h\left\{A_1 + 4A_2 + A_3\right\} = \tfrac{1}{6}h\left\{\pi r^2 + \pi r^2\right\} = \tfrac{1}{3}h$$

In a similar manner we can determine the volumes of a a prolate spheroid, an oblate spheroid, &c.

§ 108. In general, if in any solid we have
$$\phi(x) = A + Bx + Cx^2 + Dx^3,$$
where A, B, C, and D are known constants, then, if h be th of the solid,
$$A_1 = \phi(0) = A,$$
$$A_2 = \phi(\tfrac{1}{2}h) = A + B\tfrac{1}{2}h + C(\tfrac{1}{2}h)^2 + D(\tfrac{1}{2}h)^3,$$
$$A_3 = \phi(h) = A + Bh + Ch^2 + Dh^3,$$
and therefore
$$\text{volume of solid} = \tfrac{1}{6}h(A_1 + 4A_2 + A_3)$$
$$= Ah + \tfrac{1}{2}Bh^2 + \tfrac{1}{3}Ch^3 + \tfrac{1}{4}Dh^4.$$

I. *Solid of Revolution in General*

§ 109. *Volume of any Solid of Revolution.* Let P_1P_2 (fig. 34) be the generating curve and A_1 . . A_n the revolution. Divide the curve into portions in the points &c., and draw the chords and tangents of the small ar P_2P_3, &c., then it is evident that the solid generated by t is greater than the sum of the conical frusta traced out chords and less than the sum of the conical frusta traced ou tangents. Hence, by increasing the number of chords, an increasing the points of division of the curve, we can m difference between these sums as small as we please, and t by this method we can approximate as closely as we plea volume of the solid generated.

Assuming that the points P_1, P_2, P_3 are so near each ot the solid generated differs little from the frustum of a co using the same notation as in § 63, we have volume generat
$$P_1P_2P_3 = \tfrac{1}{3}\pi A_1A_2(s_1 + s_2) + \tfrac{1}{3}\pi A_1A_2(s_2 + s_3)$$
$$+ \tfrac{1}{6}\pi a(s_1^2 + 4s_2^2 + s_3^2);$$
similarly the volume generated by
$$P_3P_4P_5 = \tfrac{1}{6}\pi a(s_3^2 + 4s_4^2 + s_5^2),$$
whence the volume generated by the whole curve P_1P_2 . . .
$$= \tfrac{1}{6}\pi a\left\{s_1^2 + s_n^2 + 2s_2^2 + s_4^2 + \ldots + s_{n-2}^2 + 4s_3^2 + 4s_5^2 + \ldots + 4s_{n-1}^2\right\}$$

$\pi s_1^2 \frac{c_1}{4\pi}$, $\pi s^2 \frac{c^2}{4\pi}$, &c.

$c_1 : c_2 : 2c^2 : \ldots : c_3 : c_4 : \ldots : c_5 : c_6$

…n more convenient in practice, and it is sometimes more easy …ate equidistant circumferences than equidistant radii.

4. *Theorems of Pappus.*

The following two general propositions concerning surfaces and …revolution usually called Guldin's theorems, are worth the …attention

…plane curve revolve about any external line situated in its …then

…e surface of the solid which is thereby generated is equal …product of the perimeter of the revolving curve and the …f the path described by the centre of gravity of that peri-

…e volume of the solid is equal to the product of the area of …olving curve and of the length of the path described by the …gravity of the curve.

…ntent ourselves with one example or two of the application …theorem, reference to the article INFINITESIMAL CALCULUS …mod-

Ex. 1. To find the surface and volume of a circular ring …the distance of the centre of the generating circle, in the …nch, from the axis of rotation and r the radius of the …on

perimeter of generating curve $= 2\pi r$,
area of generating circle $= \pi r^2$, and

…cribed by the centre of gravity either of the perimeter or …a, be

surface of ring $= 4\pi^2 cr$, and
volume of ring $= \pi r^2 \cdot 2\pi c$.

Ex. 2. To find the volume swept out by an ellipse whose …r and r', revolving about an axis in its own plane whose …from the centre of the ellipse is c.

…rea of generating curve $= \pi ab$,
…described by centre of gravity of area $= 2\pi c$, hence
volume generated $= \pi ab \cdot 2\pi c = 2\pi \cdot abc$.

Ex. 3. A circle of r inches radius, with an inscribed regular …revolves about an axis x inches distant from its centre, and …one side of the hexagon, to find the difference in area of …ated surfaces and volumes.

Here perimeter of circle $= 2\pi r$,
and perimeter of hexagon $= 12 r \sin 30° = 6r$ (§ 17).

and area of hexagon $= 3r^2 \sin 60°$ (§ 18, β)
$= \frac{3}{2}\sqrt{3}r^2$;

…ference of surfaces generated
$= 4\pi \cdot x \cdot 6r - 12\pi r^2 = 24\pi xr - 12\pi r^2 = 12\pi r(2x - r)$,

…rence of volumes generated
$= 2\pi r^2 \cdot 3x - \frac{3}{2}\sqrt{3}r^2 \cdot 3x = 3\pi r^2(2x - \frac{3}{2}\sqrt{3}r)$.

PART III. GAUGING.

By *Gauging* is meant the art of measuring the volume of a …any portion of it. The subject is one of great interest and …importance, but space will only permit us to discuss it very …If the cask whose capacity we wish to determine be a solid …ation, then its volume can at once be computed, either …or approximately, by the methods already described.

It is usual to divide casks into the following four classes, a… to the nature of the revolving curve:

(α) the middle frustum of a spheroid;
(β) the middle frustum of a parabolic spindle;
(γ) two equal frusta of a paraboloid, united at their base…
(δ) two equal frusta of a cone, united at their bases.

Casks of the second, third, and fourth variety are rarely m… in practice, and we shall accordingly confine our attention… first kind, which is considered the true or model form of ca…

Let ABCD (fig. 56) be a section of the cask, and assume… the middle frustum of a prolate spheroid, then

its volume $= \frac{1}{12}\pi(2b^2 + bb_1 + \frac{3}{4}b_1^2)k$,

where $b = OY$, $b_1 = AX$, and $k = XX'$ (§ 99).

YY' is called the bung diameter, and AB or CD th… diameter.

An imperial gallon contains 277·274 cubic inches, and t… the number of gallons in the above cask

$$\frac{\pi}{3} \cdot \frac{2b^2 + bb_1}{277 \cdot 274} k = \frac{\pi}{831 \cdot 822}(2b^2 + bb_1)k$$
$$\left(\frac{2b^2 + d^2}{1059}\right)k, \text{ where } d = 2b,\ d_1 = 2b_1;$$

whence we have the rule … to the square of the head … add twice the square of the bung diameter, multiply the sum… length and divide the result by 1059·1, and the answer is… tent in imperial gallons.

Casks are ordinarily met with are not true spheroidal fru… it is better to consider them as such, calculate their capacity on this assumption, and then make allowance for the departure from the spheroidal form. The determination of the proper allowance to be made in each case is a matter depending on the skill and experience of the gauger, and proficiency in the art can only be attained by considerable practice.

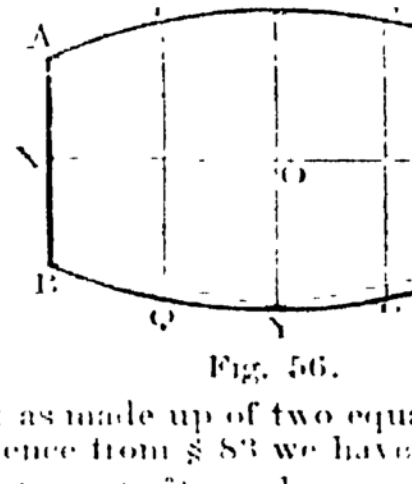


Fig. 56.

§ 112. If the cask be very little curved, we obtain an approximation to its capacity by considering it as made up of two equa… of a cone, united at their bases. Hence from § 83 we have

volume of cask $= \frac{1}{3}\pi h(r_1^2 + r_1r_3 + r_3^2)$ nearly.

Here we neglect the small volumes generated by APY… BQY', and YRC', and therefore the volume is too small.

If we put $r_1r_3 = r_1^2$, we obtain

volume $= \frac{1}{3}\pi h(2r_1^2 + r^2)$,

which is a little too large, and therefore the true volume lies… these two limits, and a very close approximation to it is s… given by the formula

§ 113. *Ullage of a Cask.* The quantity of liquor contai… cask, partially filled and the capacity of the portion which i… are termed respectively the wet and dry ullage.

(α) *Ullage of a standing cask.*—By means of the method… in § 105, the following rule is deduced:—

Add the square of the diameter at the surface, the square… diameter at the nearest end, and the square of double the… half way between, multiply the sum by the length betw… surface and the nearest end, and by ·00172.

The product will be the wet or dry ullage according as th… portion of the cask is filled or empty.

(β) *Ullage of a lying cask.* The ullage in this case i… approximately on the assumption that it is proportional to… ment of the bung circle cut off by the surface of the liqu… rule adopted in practice is:

ullage = ⅔ content × segmental area. (

…TAL DISEASES. See INSANITY.

…TON (Ital. *Mentone*), a cantonal capital in the …ment of Alpes Maritimes, France, situated 15 miles …st of Nice, on the border of the Mediterranean. …n, which has a population of about 8000, rises … amphitheatre on a promontory by which its semi… bay (5 miles wide at its entrance, and bounded on … by Cape Martin and on the E. by the cliffs of La …) is divided. It is composed of two very distinct …, below, along the sea-shore, is the town of hotels … and of foreigners, which alone is accessible to v… vehicles; above is that of the native Mentonese… steep, narrow, and dark streets, spread over and c… to the mountain, around the strong castle which w… its protection against the attacks of pirates. Faci… south-east, and sheltered on the north and west b… mountains, the Bay of Menton enjoys a delicious c… and is on this account much frequented by inva… quiring a mild and equable temperature. The me… the year is 61° Fahr., exceeding that of Rome…

and equalling that of Naples. Frost occurs on verage only once in ten years; in one particular he thermometer did not fall below 16° Fahr. In r the heat is never very great, the temperature exceeding 86° Fahr. Winter and summer are the greeable seasons; in autumn the rain storms are panied by sudden changes of temperature, and in the sea breezes are apt to be violent. Besides the s of its climate, Menton offers those of an almost al vegetation. Lemon trees, olive trees, and pines, above each other in successive stages, adorn the ing slopes. The district produces forty millions of s yearly, and this is the principal source of its natural . The olive-trees are remarkable for the great size ave attained in the course of the centuries during they have continued to bear. Of their wood a ude of fancy objects are made for sale to strangers.

origin of Menton is unknown. During the Middle Ages it ccessively occupied by the Saracens, the Genoese, and the of Anjou. In the middle of the 14th century it was pur as a single domain by the Grimaldis, lords of Monaco the times of the republic and the first empire it belonged nce, but in 1815 it again became the property of the of Monaco, who subjected it to such exactions that in 1848 abitants, weary of finding their reasonable demands put off mpty promises, proclaimed their town free and independent, the protection of Sardinia. Menton, with the neighbouring ne of Roquebrune, was united to France in 1860, at the same Nice and Savoy.

ENTZ. See MAINZ.

ENZEL, WOLFGANG (1798–1873), poet, critic, and ian, was born June 21, 1798, at Waldenburg in , studied at Breslau, Jena, and Bonn, and after for some time in Aarau and Heidelberg finally d in Stuttgart, where, from 1830 to 1838, he had a in the Wurtemberg "landtag." His first work, a and original volume of poems, entitled *Streckverse* elberg, 1823), was followed in 1824–25 by a popular *chte der Deutschen* in three volumes, and in 1829 830 by *Rübezahl* and *Narcissus*, the ballads upon his reputation as a poet chiefly rests. In 1851 he hed the romance of *Furore*, a lively picture of the d of the Thirty Years' War; his other very numerous gs include *Geschichte Europa's*, 1789–1815 (1853), istories of the German war of 1866 and of the o-German war of 1870–71. From 1825 to 1848 el edited a "Literaturblatt" in connexion with the *nblatt*; in the latter year he transferred his allegiance the Liberal to the Conservative party, and in 1852 "Literaturblatt" was again revived in that interest. 66 his political sympathies again changed, and all his es were employed to oppose the "particularism" of Prussian "junkers" and the antiunionism of South any. He died on April 23, 1873. His large private y of 18,000 volumes was afterwards acquired for the rsity of Strasburg.

EPHISTOPHELES, the name of one of the personi ns of the principle of evil. In old popular book puppet-plays the word appears in various forms, ephistopheles, Mephistophiles, Mephistophilis, and ostophilis. In the *Tragical History of Doctor us*, Marlowe writes "Mephistophilis"; in the *Merry of Windsor* we find "Mephistophilus." The etymo of the word is uncertain. According to one theory, y be taken to represent *μηφιστοφίλης*; in which case eaning would be "one who loves not light." Another y is that the word is a combination of the Latin hitis" and the Greek *φίλος*, signifying "one who noxious exhalations." Probably it is of Hebrew —from מפר, a destroyer, and טפל, taken to mean a This view is supported by the fact that almost all the names of devils in the magic-books of the 16th spring from the Hebrew. In the old Faust leger character of Mephistopheles is simply that of a pe and wicked being who fulfils Faust's commands in o obtain possession of his soul. Marlowe attributes a certain dignity and sadness, and there can be little that the Mephistophilis of the *Tragical History* sug some important traits of Milton's Satan. The na been made famous chiefly by Goethe, whose concep the character varied at different periods of his care the fragment of *Faust* published in 1790, but many years before, Mephistopheles has a clearly individuality; he is cynical and materialistic, but man's delight in activity and adventure, and his feats alone remind us that he is preternatural. In and extending this fragment, which forms the chief of the first part of *Faust*, Goethe treated Mephist as the representative of the evil tendencies of especially of the tendency to denial for its own sake than as a living person. This character Mephist maintains in the second part, where, indeed, the nam stands for a pure abstraction.

See Julius Mosen, *Faust*; Duntzer, *Charakteranlage zu Goethes Faust*; Vrchlicky, *Goethe's Faust*.

MEQUINEZ (the Spanish form of the Arabic *Me* a town of Morocco, the ordinary residence of the e is situated in a fine hilly country about 70 miles fr west coast and 35 west south-west of Fez on the Sallee, in 34° N. lat. and 5° 35′ W. long. The tow with its four-cornered towers, is kept in good co and a lower wall of wider circuit protects the lu gardens with which the outskirts are embellished. general regularity of its streets, and in the fairly sub character of its houses, Mequinez ranks higher th other town in Morocco; but it possesses few build any note, except the palace, and the mosque of Mulei which serves as the royal burying-place. At one t palace (founded in 1631) was an imposing structu the finest part has been allowed to go to ruin. I Windhus described it as "about 4 miles in circum the whole building exceeding massy, and the walls part very thick; the outward one about a mile long feet thick." The best part consisted of oblongs c large open courts or gardens. Mortar or concrete principal material used for the walls, but the pilla in many cases marble blocks of great beauty and c (*A Journey to Mequinez*, London, 1725). Most inhabitants of Mequinez are connected more or less with the court. Their number has been very va estimated by different travellers. Graberg de Hem 56,000 in 1831, Rohlfs in 1861 from 40,000 to and Conring in 1880 about 30,000. The tow formerly called Takarart. Edrisi refers the presen to a Berber chief Meknas.

MERAN a favourite health resort, and the capi district in South Tyrol, Austria, is picturesquely at the foot of the vine-clad Kuchelberg, on the rig of the Passer, about half a mile above its junction w Adige, and 45 miles to the south of Innsbruck proper consists mainly of one long narrow street the Laubengasse, flanked by covered arcades. In sense, the name is often used to include the a villages of Untermais, Obermais, and Gratsch. Th noteworthy buildings are the Gothic church of St N with its lofty tower, dating from the 14th an centuries; the Spitalkirche, built in the 15th centu restored in 1880; and the quaint old Furstenh residence of the counts of Tyrol. The town co gymnasium, a nunnery and school for girls, an ins for sick priests, and several other charitable establish

owes its high reputation as a resort for consumptive vous invalids to the purity of its air and its com- immunity from wind and rain in winter. It stands 11′ N. lat., at a height of 1050 feet above the sea, s a mean annual temperature of about 51° Fahr. enjoys three seasons, being also visited in spring whey cure and in autumn for the grape cure. The ment for the comfort of the visitors are very com and the environs afford opportunity for numerous t walks and excursions. The favourite promenade of abitants is on a massive dyke, built to protect the gainst the encroachments of the Passer. Nearly old castles and chateaux are visible from the bridge e Passer, the most interesting being Schloss Tyrol, ent edifice which has given its name to the entire . Meran is now frequented by about 6500 patients 00 to 9000 passing travellers annually. In 1880 its ion, including Obermais and Untermais, amounted 4 souls.

is probably the representative of the Roman Urbs Majensis, ls known as Maiania. It became a town in 1290, and 1490 was the capital of the counts and dukes of Tyrol. n suffered somewhat during the Peasants' War in the 16th and subsequently from destructive floods. As a health- has been known for about forty years. The whole region t best is singularly rich in historic interest.

ties Beda Weber, *Meran* (Innsbruck, 1849); Noe, *Der ort Meran*, Stuttgart, 1864; *Chronik von Meran* (1864); and *Geschichte der Meraner Kurgesellschaft*, 1870; Plant, *Fabrik ran*, 2d ed., 1869; Knoblauch, *Meran* (3d ed., 1881).

RCATOR, GERARDUS (Latinized form of Gerhard r) (1512–1594), mathematician and geographer, was t Rupelmonde in Flanders, May 5, 1512. Hav- mpleted his studies at Louvain, he devoted him- geography, and, after being for some time attached household of Charles V., he was appointed cosmo- r to the duke of Julliers and Cleves in 1559, taking residence at Duisburg, where he died December 2, One of his earliest cartographical works was a rial globe (1541), followed in 1551 by a celestial In 1552 he published a treatise *De usu annuli mici* (Louvain), and at Cologne in 1569 his *Chrono- hoc est temporum demonstratio . . . ab initio mundi ad Annum Domini* 1568, *ex eclipsibus et observa- s astronomicis, sacris quoque Bibliis*, &c. In the same is published the first map on Mercator's well-known ion, with the parallel and meridians at right angles, in navigation. At Cologne, in 1578, appeared his *geographica ad mentem Ptolemæi restituta et emend-* The work by which he is chiefly known is his atlas, ed in 1594 at Duisburg, in folio, under the title of *sive Cosmographicæ meditationes de fabrica mundi*. tains, besides the maps, cosmographical and other ations, some of the theological views in which were ned as heretical; it was completed by Hondius in Several of the maps had been previously published ely, the atlas being delayed to allow Ortelius to te his. Mercator also published in 1592 a *Har Evangeliorum*.

RCURIAL AIR PUMP. This name is given to stinct instruments, one of which is founded on , the other on hydrodynamical principles.

The Statical Pump. The famous spiritualist Sweden- us the first to conceive an air-pump in which a mass reury, by being made to rise and fall alternately a vertical vessel, should do the work which in the y instrument is assigned to the piston. He pub- a description of his pump in 1722; but it is nable whether his design was ever realized. Of us subsequent inventions the only one which, in s survived is the admirably simple and yet efficient ent first described in 1858, but constructed some time before, by H. Geisler of Bonn, which at once justly, met with universal acceptance.

The general scheme of Geisler's pump is shown in A and B are pear shaped glass vessels connected by narrow india-rubber tube, which must be sufficiently strong in the body (or strengthened by a linen coating) to stand an outward pressure of 1 to 1½ atmospheres. A terminates below in a narrow vertical tube *c*, which is a few inches longer than the height of the barometer, and to the lower end of this tube the india-rubber tube is attached which connects A with B. To the upper end of A is soldered a glass two-way stop-cock, by turning which the vessel A can either be made to communicate through *s* and a hole in the hollow cock with the vessel to be exhausted (I., fig. 2), or through *g* with the atmosphere (II., fig. 2), or can be shut off from both when the cock holds an intermediate position. The apparatus, after having been carefully cleaned and dried, is charged with pure and dry mercury, which must next be worked backwards and forwards between A and B to remove all the air bells. The air is then driven out of lifting B to a sufficient level, turning the cock into po II., and letting the mercury flow into A until it g the other side of the stop-cock, which is then pla the intermediate position. Supposing the vessel to be exhausted to have already been securely connected with *b*, we now lower the reservoir B so as to reduce the pressure in A sufficiently below the tension in the gas to be sucked in, and, by turning the cock into position I., cause the gas to expand into and almost fill A. The cock is now shut against both *a* and *b*, the reservoir lifted, the gas contents of A discharged through *a*, and so on, until, when after an exhaustion mercury is let into A, the metal strikes against the top without interposition gas bell. In a well-made apparatus the pressure exhausted vessel is now reduced to $\frac{1}{100}$ or $\frac{1}{200}$ of a metre, or even less. An absolute vacuum cannot b duced on account of the unavoidable air-film betwee mercury and the walls of the apparatus.

FIG. 1. — Gei Mercurial Air-

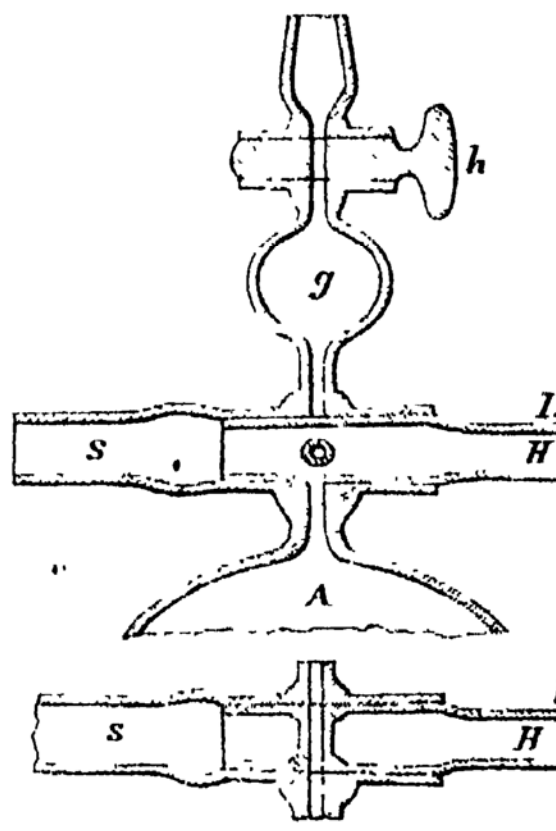


FIG. 2.— Arrangements of Stop in Air-Pump.

The great advantage of the mercurial over the ordinary ai is that it evacuates far more completely than the latter, affords direct and unmistakable evidence of the exhaustive its work, and—last not least—that it enables one to transfer sucked out to another vessel without loss or contamination, it can be measured and analysed. On account of this latter more especially, the instrument is highly valued as an auxil gasometric researches. Without it the researches of whic our present knowledge of the gases of the blood could not ha carried out. The actual instrument, as constructed for kinds of work, has of course various complexities of detail in the above description. For these the reader must refer t books of practical physiology.

takes a height of about 30 inches of mercury to balance sure of the atmosphere, a Geisler pump necessarily is a t long-legged and unwieldy instrument. It can be con- y shortened, the two vessels A and B brought more closely , and the somewhat objectionable india-rubber tube be dis- with, if we connect the air-space in B with an ordinary an- nd by means of it do the greater part of the sucking and le of the lifting work An instrument thus modified was ted by Poggendorff (see his *Annalen*, vol cxxv. p 151, nd another, on somewhat different principles, by Prof. (see the "*Challenger*" *Reports*).

a Geisler's stop-cock requires to be lubricated to be abso- as-tight, and this occasionally proves a nuisance Hence a of attempts have been made to do without stop-cocks alto- In Topler's pump[1] this is attained by using both for the d the outlet vertical capillary glass tubes, soldered, the o somewhere near the bottom, the latter to the top of the These tubes, being more than 30 inches high, obviously fficient mercury traps; but the already considerable height mp is thus multiplied by two. This consideration has led er Mitscherlich (*Pogg. Ann.*, cl 420, 1873), and quite . Neesen (*Z. f. Instrumentenkunde*, 1882, p 285) to intro ss valves in lieu of stop cocks. As glass floats on mercury, ves do not necessarily detract from the exhaustive power mp.

The Dynamic Pump.—This was invented in 1865 by renge1. The instrument, in its original (simplest) ig. 3), consists of a vertical y glass tube *a* of about . bore, provided with a branch *b* near its upper hich latter, by an india- joint governable by a screw- communicates with a funnel. wer end is bent into the of a hook, and dips into a atic trough. The vessel to austed is attached to *b*, and, r to extract its gas contents, rly regulated stream of mer- allowed to fall through the tube. Every drop of mer s it enters from the funnel, closes the narrow tube like n, and in going past the here the side tube enters a portion of air and carries to the trough, where it can ected. If the vertical tube, ing from the point where nch comes in, is a few inches than the height of the ter, and the glass and mer e perfectly clean, the apparatus slowly but surely es an almost absolute vacuum.

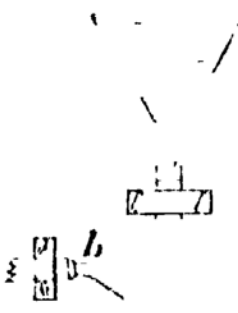


Fig. 3. - Sprengel Air-Pump

reat advantages of Sprengel's pump lie in the simplicity of truction and in the readiness with which it adapts itself to cting of the gas. It did excellent service in the hands of for the extraction of gases occluded in metals, and since s become very popular in gas-laboratories, especially in Many improvements upon the original construction have posed One of these which deserves mention is to pass the , before it enters the "falling" tube, through a bulb in good vacuum is maintained, by means of an ordinary air a second "Sprengel." (W. D.)

RCURY was the Roman god who presided over trade, and all commercial dealings. His nature is ly more intelligible and simple than that of any Roman deity. His very name, which is connected *ner*, *mercator*, &c., shows that he is the god of ndise and the patron of merchants. In the native states no merchants and no trade existed till the re of the Greek colonies on the coast introduced customs into the cities of the land. All the usages and terminology of trade, and all the religious cere connected with it, were borrowed by the Romans fr Greeks. It was no doubt under the rule of the Ta when the prosperity of the state and its intercours the outer world were so much increased, that me began to ply their trade in Rome. Doubtle merchants practised their religious ceremonies fr first, but their god Mercurius was not officially rec by the state till the year 495 B.C. Rome frequently s from scarcity of corn during the unsettled time followed the expulsion of the Tarquins. Various r innovations were made to propitiate the gods, in Greek worship of Demeter, Dionysus, and Pers was established in the city (see LIBER), and in Greek god HERMES (*q.v.*) was introduced into Rom the Italian name of Mercurius (Livy, ii. 21, 27). thinks that at the same time the trade in corn wa lated by law, and a regular college of merchan instituted. This *collegium* was under the protection god; their annual festival was on the Ides of M which day the temple of the god had been dedic the southern end of the *circus maximus*, near the Av and the members were called *mercuriales* as w *mercatores*. The Ides of May was chosen as the Mercury, obviously because Maia was the mot Hermes, *i.e.*, of Mercury (see MAIA); and she w shipped along with her son by the *mercuriales* day. According to Preller, this religious foundat a political object; it established on a legitimate a basis the trade between Rome and the Greek col the coast, whereas formerly this trade had been exp the capricious interference of the Government offic the year. Like all borrowed religions in Rome, have retained the rites and the terminology of its original (Festus, p. 257). Mercury became the g only of the *mercatores* and of the corn trade, but of and selling in general, and it appears that, at leas streets where shops were common, little chapels and of the god were erected. There was a spring dedic Mercury between his temple and the *Porta Capena* shopman drew water from this spring on the Ides and sprinkled it with a laurel twig over his head a his goods, at the same time entreating Mercury to from his head and his goods the guilt of all his (Ovid, *Fasti*, v. 673 *sq.*). The art of the Roman tra was evidently like that of an Oriental tradesman in times, and the word *mercuriales* was popularly equivalent to "cheat. In the Latin poets Mercury gifted with some of the manifold characters of the Hermes, but this finer conception seems to have real existence in Roman religion.

Roman statuettes of bronze, in which Mercury is represen the Greek Hermes standing holding the caduceus in the and a purse in the other, are exceedingly common. The must have been introduced as a symbol of Mercury at a v time, for it is found on Italian coins as early as the 4th before Christ, and we learn that several were kept as sacre in the *adytum* of the sanctuary at Lavinium (Dion. Hal But its foreign origin is shown by the fact that, although sign of peace, it was never borne by the *fetiales*, the old heralds. The very name is derived from the Greek Preller's view (*Rom. Myth.*) that *mercuriales* and *mercu* the same guild is a tempting one, but its truth is very Mommsen thinks that *mercuriales* were a purely local gu the *pagani* of the Circus valley

MERCURY, in chemistry, is a metal (symbol Hg is easily distinguished from all other by its being at even the lowest temperatures naturally occu moderate climates. To this exceptional property the synonyms of *quicksilver* in English (with the G *quecksilber* is the only recognized name) and of *gyrum* (from ὕδωρ, water, and ἄργυρος, silver) in Greec

[1] *Dingler's Polytechn. Journal*, 1862; an improved form by Hagen is described in *Wiedemann's Annalen*, xii. 425, 1881.

etal does not appear to have been known to the Jews, nor is it mentioned by the earlier Greek Theophrastus (about 300 B.C.) mention it a ve of cinnabar. With the alchemist it was a ce of great consequence. Being ignorant of its ibility of freezing into a compact solid, they did not ze it as a true metal, and yet, on the authority of they held that mercury (meaning the predominating in this metal) enters into the composition of all and is the very cause of their metallicity. When, he beginning of the 16th century, chemistry and ic medicine came to merge into one, this same ous element of "mercury" played a great part in ories of pathology and the metal, in the free as in combined states, came to be looked upon as a al medicinal agent, which position, on purely em ground, it continues to hold to the present day

ury occurs in nature chiefly in the form of a red e, HgS, called cinnabar, which, as a rule, is accom by more or less of the regulus metal, the latter probably derived from the former by some secondary n. The most important mercury mines in Europe se of Almaden in Spain and of Idria in Illyria, until lately furnished the bulk of the mercury of ce, but they are now almost eclipsed by the rich s of New Almaden in California. Considerable ies of mercury are said to be produced in China and n, minor deposits are being worked in the Bavarian ate, in Hungary, Transylvania, Bohemia, and Peru. aden the ore forms mighty veins traversing micaceous of the older transition period, in Illyria it is dis ted in beds of bituminous schists or compact lime l more recent date.

nically speaking, the extraction of mercury from its a simple matter. Metallic mercury is easily vola and separated from the gangue, at temperatures far redness, and cinnabar at a red heat is readily reduced metallic state by the action of iron or lime or heric oxygen, the sulphur being eliminated, in the se as sulphide of iron, in the second as sulphide phate of calcium, in the third as sulphurous acid To the chemical mind a close iron retort would itself as the proper kind of apparatus for carrying se operations, but this idea is acted upon only in mall establishments, for instance, in that of Zwei- in the Palatinate, where lime is used as a decom- agent. In a few large works the decompo cinnabar is effected by the direct exposure of the the oxidizing flame of a furnace, and the mercury , which of course gets diffused through an immense f combustion gases, is sought to be recovered in less imperfect condensers.

Almaden chiefly used for distillation are of two kinds, which, by the way, are also employed in prismatic , the lower chamber, the upper chamber, the latter serving for the re-

he upper accommodates the ore, which is introduced through ing in the dome-shaped roof. To avoid an excessive dilu the mercury vapour with combustion gases, part of these are laterally into a chimney and the rest allowed to strike up the heap of ore. The large mass of metalliferous vapour d passes out through a system of pipes inserted laterally into e and so arranged that they follow first a descending and ascending plane, to lead ultimately into a condensation which communicates in its turn with a chimney. The e formed each of a large number of cone-to-cone pear-shaped ware adapters, called *aludels*, which are telescoped into ther as in the case of the iodine-sublimation apparatus, the being luted with clay. The lowest row of aludels, which e line of intersection of the two inclined planes are pierced oles below, so that what arrives as liquid mercury there t into a gutter leading to a reservoir. What of mercury remains uncondensed in the aludels passes into the chamber, ention being to have it condensed there, in reality a large ion of the mercury passes out through the chimney (and through the numerous leaks in the aludels) into the atm to poison the surrounding vegetation and the workmen. furnaces to the Almaden ones are used in Idria and Almaden, only the condensation apparatus are a little perfect. But in all three places the loss of metal is very c able, at New Almaden it is said to amount to close upon 40 p

The mercury obtained is purified mechanically by stra through dense linen bags, and then sent out into commerce in bags, or in wrought-iron bottles provided with screw plug holding about 75 lb avoirdupois.

According to Balling's *Metallurgische Chemie* 1882), the production of mercury in the years nam as follows:

Austria, exclusive of Hungary (1880)	369
Hungary (1879)	180
Italy (1877)	
Spain (1873)	929
United States (1875)	2054

Assuming the amount to be the same from year t this gives a total of 3587 tons.

The price of the metal is subject to immense fluctua it generally ranges from 2s. to 7s. 6d. a pound avoir

Commercial mercury, as a rule, is very pure chem so that it needs only to be forced through chamois to become fit for all ordinary applications; but the having the power of dissolving most ordinary other is very liable to get contaminated with these in the tory or workshop, and requires then to be purified this purpose a great many chemical methods hav proposed, which, however, all come to this, th base admixtures are sought to be removed by tre with nitric acid, oil of vitriol, or other agents wh preferably on the impurities. The best of these m is that of Bruhl, who shakes the metal with a solu 5 grammes of bichromate of potash and a few cubic metres of sulphuric acid in one litre of water, until chromate of mercury, first produced, has disappear its place been taken by green chromic sulphates supernatant liquor and chromic scum are washed a a powerful jet of water, and the clean metal is dri filtered through a perforated paper filter. The only exhaustive method is redistillation out of a glass app Unfortunately the operation is difficult of execut mercury "bumps" badly on boiling; but this avoided by distilling the metal in a *perfect* vacuum ingenious apparatus for this purpose, in which the metal itself is made to keep up the vacuum, wa structed lately by Leonhard Weber. A U tube, th of which are longer than the height of the baro filled with pure mercury, and inverted, the on being made to dip into a vessel with pure, th into another containing the impure, mercury. This limb is inflated above so that the meniscus is ab middle of the bulb. This bulb is heated, and the quence is that the metal there distils over into t limb to add to the supply of pure metal, the rising up in the second by itself to maintain a c level. Dewar has modified the apparatus so tha is no need of a supply of pure metal to star Absolutely pure mercury does not at all adhere surface which does not consist of a metal soluble in m Hence the least quantity of it, when placed on a paper, forms a neatly rounded-off globule, which ret form on being rolled about, and, when subdivided, up into a number of equally perfect globules. The p in it of the minutest trace of lead or tin causes it to tails." A very impure metal may adhere even t and in a glass vessel, instead of the normal convex an irregular flat meniscus.

Properties. The pure metal is silver-white, and its strong lustre even on long exposure to ordin At −38·8 C., *i.e.*, −37·9 F. (Balfour Stewart), it

considerable contraction, into a compact mass of r octahedra, which can be cut with a knife and be ged under the hammer. The specific gravity of the metal is 14·39; that of the liquid metal at 0° C. is 5 (water of 4° C. = 1). Under 760 mm. pressure s at 357°·3 C. (675°·1 Fahr.) (Regnault). At very emperatures it seems to be absolutely devoid of ity (Faraday); but from - 13° C. upwards (Regnault) ibits an appreciable vapour tension.

following table gives the tensions "p," in millimetres rcury of 0° C., for a series of centigrade temperatures cording to Regnault :—

0°	10°	20°	50°	100°	150°	200°
·02	·03	·04	·11	·75	4·27	19·90

- 250°	300°	350°	400°	450°	500°
75·75	242·1	663·2	1588	3384	6520

ling to the same authority, its average coefficient ansion k per degree C. is as follows :—

0 100° C.	0 200° C.	0 300° C.
k = ·0001815	·0001841	·0001866
1/5510	1/5432	1/5359

pecific heat in the liquid state is ·03332, that of ozen metal (between - 78° and - 40° C.) is ·0319 ault). Its electric conductivity is $_{a}^{1}/_{7}$ of that of pure (Matthiesen). Its conductive power for heat is r than that of water, and is proved (by Herwig) to rfectly constant from 40° to 160° C. Its vapour y (air of the same temperature and pressure = 1) is (Dumas), or 100·93 for hydrogen 1. Hence its ular weight ($H_2 = 2$) is 201·86. The atomic weight, emical methods, was found = 200·0 (Erdmann and and); hence mercury vapour molecules consist of atoms. Mercury does not appreciably absorb any ally inert gas.

cury is in constant requisition in the laboratory. It for the collecting and measuring of gases, in the uction of thermometers, barometers, and manometers, determination of the capacity of vessels, and many urposes. In medicine it serves for the preparation curial ointment and of "hydrargyrum cum creta" nief component of "blue pills"); both are obtained gently triturating the metal with certain proportions se and chalk respectively until it is "deadened," *i.e.*, ided into invisibly small globules (see below).

ys.—Mercury readily unites directly with all metals t iron and platinum) into what are called amalgams. ne cases the union takes place with considerable ion of heat and large modification of the mean pro- of the components. Thus, for instance, sodium rubbed up with mercury unites with it with deflagra d formation of an alloy which, if it contains more per cent. of sodium, is hard and brittle, although is as soft as wax and mercury a liquid. Liquid ms of gold and silver are employed for gilding and ng objects of copper, bronze, or other base metal. malgam is spread out on the surface of the object ans of a brush, and the mercury then driven off application of heat, when a polishable, firmly ng film of the noble metal remains. Copper m containing from 25 to 33 per cent. of the solid when worked in a mortar at 100° C., becomes highly but on standing in the cold for ten or twelve hours es hard and crystalline. Hence it is used for the g of teeth. A certain amalgam of cadmium is ly employed.

s.—There are two oxides of mercury, namely, an oxide, called mercurous, and another, HgO, called mercuric oxide er can be produced directly by keeping the metal for a long air at a temperature somewhat below its boiling point, e oxide is gradually formed as a red powdery solid. This s long been known as "red precipitate," or as *mercurius praecipitatus per se*. Priestley made the important disco the "precipitate" when heated to dull redness is reduced t with evolution of what has since been known as oxygen g was reserved for Lavoisier to correctly interpret this expe and thus to establish our present views on the constit atmospheric air. The oxide is easily prepared by heat nitrate of the metal as long as nitrous fumes are seen (when it remains as a scaly mass, black when hot, red after or else by precipitating the solution of a mercuric salt wit of caustic potash or soda, when it comes down as an am yellow precipitate, which is free of combined water. Me oxide, a black solid, can be obtained only indirectly, by the position of mercurous salts with fixed caustic alkalies. Bot are insoluble in water, but dissolve in certain, and combi all, aqueous acids with formation of mercury salts and elim of water. Thus, for instance,

$$Hg_2O + 2HNO_3 = H_2O + Hg_2(NO_3)_2.$$
Mercurous nitrate

$$HgO + 2HNO_3 = H_2O + Hg(NO_3)_2.$$
Mercuric nitrate

The Nitrates. When metallic mercury is set aside with weight of nitric acid of 1·2 specific gravity, at ordinary t tures, the normal mercurous salt $Hg_2(NO_3)_2$ is gradually pr and after a day or two is found to have separated out in co crystals. These are soluble (somewhat sparingly) in water lated with nitric acid, but are decomposed by the action water, with formation of difficultly soluble basic salts this salt (or the metal itself) is treated with excess of nitric is oxidized into mercuric nitrate $Hg(NO_3)_2$, a white crystalli readily soluble in water without decomposition.

The Sulphates. Cold aqueous sulphuric acid does not a mercury, but the hot concentrated acid converts it fi mercurous and then into mercuric sulphate, with evolu sulphurous acid

$$Hg_2 + 2H_2SO_4 = 2H_2O + SO_2 + Hg_2SO_4,$$
$$Hg_2SO_4 + 2H_2SO_4 = 2H_2O + SO_2 + 2HgSO_4.$$

Both salts form white crystalline magmas. The mercur is difficultly soluble in water, and consequently produc precipitation of the nitrate with sulphuric acid. The mercu when treated with water, is decomposed with formation of a insoluble basic salt, which has long been known as *turpeth rab*. Its composition is $SO_3.3HgO$ when produced by e hot water. Mercuric sulphate is of importance chiefly as the basis for the manufacture of the two chlorides.

The Chlorides.—These are both extensively used medicinal The mercuric salt, $HgCl_2$, known in medicine as corrosi limate, is prepared by mixing the sulphate intimately with c salt, and subjecting the mixture to sublimation, a little o of manganese being added to oxidize the mercurous salt, w generally present as an impurity. The process is conduct glass flask buried in a hot sand-bath. When the decompos accomplished, the sand is removed from the upper half of t and the temperature raised so that the chloride $HgCl_2$ p sublimes up and condenses in the upper part as a "subl The salt, as thus produced, forms compact crystalline crusts, when heated, melt into a limpid liquid before volatilizing solvable in water, 100 parts of which at 10°, 20°, 100° dissolv 7·39, 54 parts of salt. Corrosive sublimate dissolves in 3 alcohol and in 4 parts of ether. This salt, on account solubility in water, is a deadly poison. Mercurous chloride, better known as "calomel" (from καλός, fair, and μέλας, because it becomes dead-black when treated with ammoni curic chloride yielding a white product), is prepared by corrosive sublimate with the proper proportion of metallic m ($HgCl_2 \cdot Hg$) or mercuric sulphate with salt and mercury proportions of $HgSO_4 + Hg + 2NaCl$, and subjecting the mix sublimation in glass flasks. The salt Hg_2Cl_2 is thus obta the form of white, opaque, crystalline crusts, which, when volatilize, without previously melting, into a mixture of and Hg vapour, which, on cooling, recombine into calome medicinal purposes the sublimate is reduced to an impa powder, washed with water to remove any corrosive sublima may be present, and dried. Being insoluble in water, it a less violently on the organism than mercuric chloride doe action, no doubt, is due to its very gradual conversion stomach into mercury and corrosive sublimate. Finely c calomel can be produced, without trouble, by the precipitati solution of mercurous nitrate with hydrochloric acid or c salt; but this preparation is liable to be contaminated mercurous nitrate, and, even when pure, has been found to more violently than ordinary calomel does. Hence its use tolerated by the pharmacopœias. According to Wöhler a mer chloride, more nearly equivalent to the sublimed article, is p ible by heating corrosive sublimate solution with sulphurous

$$2HgCl_2 + H_2SO_3 + H_2O = H_2SO_4 + 2HCl + Hg_2Cl_2.$$

vriter is unable to say whether Wohler's calomel has ever
s way anywhere into medicinal practi
Iodides The mercuric salt HgI_2 is produced in two ways,
st by mixing the two elementary components intimately
jecting the mixture to sublimation, and secondly by pre
g corrosive sublimate solution with its exact equivalent of
f potassium In the first case the salt is obtained in yellow
which, on the slightest touch with a solid body, assume
n permanently retain a rich scarlet colour The precipita-
cess at once yields the scarlet salt The salt is insoluble
, but soluble in alcohol and in iodide of potassium solution
ercurous salt Hg_2I_2 is obtained by *precipitating mercurous*
with iodide of potassium as a dirty-green powder insoluble
Both iodide are used medicinally
Sulphides Mercurous sulphide, Hg_2S does not seem to
The mercuric salt, HgS exists in two modifications, of
e is amorphous and has a black colour while the other is
ne and red The black one is obtained by precipitation of
of mercuric salt with excess of sulphuretted hydrogen,
ment synthetics The right proportions of mercury and
sulphur is rubbed together in a mortar until the whole
rted into a jet black uniform powder. This preparation
ot mercuric of the pharmacopœia is, however, apt to be
nated with uncombined sulphur and mercury Application
le heat causes explosive combination The red sulphide,
ur in nature as cinnabar, and can be produced artificially
black The artificial preparation, known as vermilion, is
alled as the most brilliant, stable, and innocuous of all
ed pigment Vermilion can be produced from the black
in two ways, viz., first by sublimation, and secondly by
t of it with fixed alkaline sulphide solution According
ner, 100 part of mercury are mixed intimately with 38 part
s of sulphur, and the sublimate is digested, with constant
, in a solution of 25 parts of potash in 150 parts of water at
e water lost by evaporation being constantly replaced, until
mation has become up to its maximum of fire and brilliancy,
ke of many hour Purely sublimed vermilion has a
tively dull colour, and must be manipulated with alkaline
at the essary fire. The action of the
ide consists probably in this that it dissolves successi-
ns of the amorphous preparation and redeposits them

Ammonia Derivatives or Ammonia (1) Recently precipitated
g is digested, cold, in carbonic acid free ammonia, and
are allowed to stand for
d off and the precipitate washed with alcohol and then
ter, and dried over sulphuric acid The product is a
ellow base ("Millon's base") of the composition

$$NH_2 \cdot HgO \cdot HO \quad N_2Hg_2O \cdot 2HO + 2H_2O$$

insoluble in alcohol and in ether and requires 13 000 parts
water for its solution readily unit all acids,
a rule, are insoluble in water, all
ydrates, when shaken with the base, are decomposed
Thus, for instance, even
ts of alkaline nitrates, chlorides, or sulphates are decom-
with formation of solutions of caustic alkali
body $NHg_2I_2 + 2HO$, *viz.*, of the composition of the iodide
ndance to the oxide in I, is produced as a brown precipitate
mmonia or an ammonia salt is added to a solution of mercuric
n iodide of potassium mixed with large excess of caustic
or soda ("Nessler's reagent"). In very dilute solutions of
a Nessler reagent produces only a brown or yellow color-
hich, however, is so intense that $\frac{1}{1000000}$th of ammonia in
cubic centimetres of liquid becomes clearly visible.
he chloride NH_2Hg_2Cl of the "ammonium" NH_4Hg is
d as an insoluble white precipitate when ammonia is added
ution sublimate This substance is known in
as infusible white precipitate, in contradistinction to (4).
he fusible white precipitate was at one time supposed to be
d with (3), and is obtained by boiling it with sal ammoniac
Its composition is $NH_2HgCl + NH_4Cl$ $N_2H_6Hg_2Cl_2$
yses Any ordinary solid mercury compound, when heated
blimation tube with carbonate of soda, yields a sublimate of
mercury, which, if necessary needs only to be scraped
with a wooden spill to unite into visible globules From any
-salt solution the metal is precipitated by digestion with a
bright copper-foil The precipitated mercury forms a coat-
the copper, which becomes silvery on being rubbed with
paper When the quicksilvered copper is heated in a sub-
tube, it reassumes its red colour with formation of a sub-
of mercury.
ions of mercurous salts with hydrochloric acid give a white
ate of calomel, which, after filtration, is easily identified by
ming jet-black on treatment with ammonia From mercuric
s hydrochloric acid precipitates nothing; but stannous
, in its twofold capacity as a chloride and a reducing agent,

yields a precipitate of calomel. On addition of an excess of
the precipitate becomes grey through conversion into finely
quicksilver Sulphuretted hydrogen, when added very g
to an acid mercuric solution, gives at first an almost white
tate, which, on addition of more and more reagent, assu
cessively a yellow, orange, and at last jet black colour. T
precipitate is HgS, which is identified by its great he
and by its being insoluble in boiling nitric and in boilin
chloric acid A mixture of the two (aqua regia) dissolv
chloride. (V

Therapeutics of Mercury.

The use of mercury as a therapeutic agent is c
paratively recent date. To the Greeks and Rom
value was unknown, and the Arabian physicians onl
it for skin affections. It was not till the middle
16th century that the special properties of mercur
fully appreciated, but since that time the metal ha
tinued to hold a high though fluctuating value
medicine. At first the metal in a finely divided s
in vapour was used, but very soon its various comp
were found to be endowed with powers even greate
those of the metal itself, and with the discovery
compounds the number of mercurial medicines has
increased.

The preparations now in use may be thus classifie
Of the preparations containing metallic mercury th
members are blue pill (pilula hydrargyri), grey p
(hydrargyrum cum creta), and blue ointment (ungu
hydrargyri). The first consists of mercury, liquoric
and confection of roses, the second of mercury and
the third of mercury, suet, and lard. The power
three preparations seems to depend on the fine s
subdivision of the mercury they contain; mercury
ordinary liquid state seems devoid of medicinal prop
It is thought by some that the fine subdivision
metal leads to the formation of a little oxide, and th
efficacy of the preparations in part depends on thi
Three oxides of mercury are employed in medicine
red, from which is made red precipitate ointment (u
tum hydrargyri oxydi rubri), the yellow, an allotropi
of the red, and the black oxide. The yellow and
oxides suspended in lime water form respectively
and black wash (lotio flava and lotio nigra). (
chlorides of mercury form a very important
calomel (hydrargyri subchloridum) is a white
powder; corrosive sublimate (hydrargyri perchlorid
a heavy crystalline substance. (4) Two iodides ar
medicinally; they are known from their colour
green and red iodides. (5) Nitrate of mercury ent
the composition of a powerful caustic known as t
nitrate of mercury. It is also the active principle of
ointment (unguentum hydrargyri nitratis). (6) In th
only ammoniated mercury and its ointment co
known as white precipitate ointment, are containe
the many compounds not included in the above cla
tion the oleate and albuminate are the most importa

Mercurial preparations are largely employed as externa
cations. Several of them are potent agents for the destru
the lower forms of animal life, and hence are employed to
parasites having their habitat in skin, hair, and clothin
white and red precipitate ointments are specially effectiv
destruction of pediculi, and blue ointment is occasionally
the same purpose. Corrosive sublimate is, however, th
energetic of the mercurial parasiticides, and recent obse
seem to show that it is superior to almost all other subst
a germ destroyer. It is sometimes used to get rid of ri
It should be remembered that corrosive sublimate is a
irritant to the skin, and also an active poison.

Acid nitrate of mercury is a caustic, and by it warts a
growths are sometimes removed; it is also one of the caust
sionally applied to prevent the spread of lupus.

In skin diseases mercurial preparations are largely used, e
in some forms of eczema. A few grains of the red oxi
ammoniated mercury in an ounce of zinc ointment are oft
of great service in this ailment; citrine ointment is also

ointment is not irritating, but rather tends to soothe It ore sometimes applied to irritable rashes; in pruritus ani pecial value. Mercurial preparations are not usually found t in scaly eruptions. In acne a weak solution of corrosive e is often most effective.

rations of mercury are often used to heal ulcers, especially syphilitic origin. Black wash is one of the commonest ons for this purpose. The red oxide ointment is at times d to stimulate indolent ulcers, and it is capable of removerant granulations (proud flesh), which sometimes retard ing of wounds

ry is largely used externally to promote the absorption of atory products, especially in the neighbourhood of joints. ointment is frequently employed for this purpose, more plaster containing mercury or a mercurial liniment. For the absorption of goitre (Derbyshire neck) the ointment d iodide is often relied on especially in India, where it is y to expose the patient's neck to the sun after rubbing it ointment. In enlargements of the liver and spleen the on of mercurial ointment sometimes seems to promote re- in size.

internally in continued doses, mercury produces a peculiar own as salivation First a metallic taste is experienced, followed by soreness of the gums, an undue flow of saliva, or of the breath Further administration of the drug may greatly the salivary flow, and also lead to swelling of the ulceration of the mouth, and even disease of the jaw-bone. ame time the blood becomes impoverished, and feverishness s of flesh occurs A single large dose—rarely too a single se may produce some of the above symptoms They may ow the inhalation of the metal or its compounds, or their n through the skin The long-continued inhalation of our of mercury acts likewise on the nervous system, causcular kind of trembling Mercurial tremor is sometimes looking-glass makers, often in those who work in quicksilvers.

ally mercury is chiefly given for two purposes (1) to nflammation and cause the absorption of the products it e to, and (2) to antagonize the syphilitic virus and remove s it causes Some years ago the belief in the power of to control inflammation was almost universal, and it was dministered in almost all inflammatory affections, but of has been much less used, both because it seems doubtful it has really the power it was once supposed to have and of the possibility of evil results from its continued use omitis and iritis it is still often employed, small doses of being given. Not unfrequently too it is administered in itis and hepatitis, but in pneumonia, pleurisy, and most nflammatory affections its use is now discarded by many ns As an antidote to the syphilitic poison it is still held esteem, though opinions vary much as to the extent of re- There can be little doubt that, given in an early stage of der, it minimizes the secondary symptoms; but it cannot l on to prevent their occurrence. It aids in removing the y symptoms, and tends to the avoidance of tertiary ations, which nevertheless sometimes occur even when has been freely given. The custom of giving mercury ause salivation is established has long been abandoned; now is so to give it as to prevent salivation occurring; for pose blue pill, calomel, and corrosive sublimate are given small doses, but if the gums become tender the dose is d or the administration stopped.

rial treatment is sometimes carried out by rubbing the blue t into the skin, sometimes by exposing the patient to the t calomel; syphilitic eruptions are often treated by such ion. More rarely mercury is introduced by injecting the ate or some other preparation under the skin or by means of ories. In children grey powder is generally used when mer eatment is required Children bear mercury well.

pill, calomel, and grey powder are often used as purgative, power of promoting the secretion of bile is attributed to Experimentally it has not been proved that they stimuliver functions, but there is good reason for believing that omote the expulsion of bile from the body. Grey powder is ly valued as a mild and efficient aperient for children and given in the early stage of diarrhoea to expel the irritating s of the bowel.

se of calomel in tropical dysentery, once very prevalent, has the last few years been abandoned. (D. J. L.)

RGANSER, a word originating with Gesner (*Hist. lium*, iii. p. 129) in 1555, and for a long while used glish as the general name for a group of fish eating possessing great diving powers, and forming the *Mergus* of Linnaeus, now regarded by ornithologists Subfamily, *Merginæ*, of the Family *Anatidæ*. The Mergansers have a long, narrow bill, with a sm evident hook at the tip, and the edges of both dibles beset by numerous horny denticulations, whe English the name of "Saw bill" is frequently appl them. Otherwise their structure does not much from the Anatine or Fuligoline type. All the speci a more or less developed crest or tuft on the head. of them, *Mergus merganser* or *cucullator*, *M. serrator*, *albellus*, are found over the northern parts of t World, and of these the first two also inhabit America, which has besides a fourth species, *M. cu* said to have occasionally visited Britain. *M. mer* commonly known as the Goosander, is the largest being nearly as big as the smaller Geese, and the male in breeding attire is a very beautiful bird, consp with his dark glossy green head, rich salmon c breast, and the upper part of the body and wings and white. This full plumage is not assumed t second year, and in the meantime, as well as in th nuptial dress, the male much resembles the female, like her, a reddish brown head, the upper parts g brown, and the lower dull white In this condition th is often known as the "Dun Diver." This species abundantly in many parts of Scandinavia, Russia, S and North America, and of late years has been found so in Scotland, usually making its nest in the stum hollow tree or under a slab of rock. *M. serrator* monly called the Red-breasted Merganser, is a sor smaller bird; and, while the fully dressed male wa delicate line of the lower parts, he has a gorget of mottled with black, below which is a patch of feathers, broadly edged with black The male a times and the female always much resemble the pre It is more numerous than the Goosander, with a sou more southern range, and is not so particular in s a sheltered site for its nest Both these species h bill and feet of a bright reddish orange, while *M.* known as the Smew, has these parts of a lead colo the breeding plumage of the adult male is white, with crescentic markings of black, and the flanks most fully vermiculated the female and male in undress a general resemblance to the other two already de

But the Smew is very much smaller in size, and as is known, it invariably makes its nest in a hollo as ascertained first by Wolley (*Ibis*, 1859, pp. 69 This last habit is shared by *M. cucullatus*, the Merganser of North America, in size intermediate *M. albellus* and *M. serrator*, the male of which i recognizable by his broad semicircular crest, bearing shaped patch of white, and his elongated subscapu white edged with black The conformation of the in the male of *M. merganser*, *M. serrator*, and *M. cu* is very like that of the Duck of the genus *Clangu* *M. albellus* has a less exaggerated developmen resembling that of the ordinary *Fuligulæ*.[1] Fr southern hemisphere two species of *Mergus* hav described, *M. octosetaceus* or *brasilianus*, Vieillot (*N d'Hist Naturelle*, ed. 2, xiv. p. 222; *Gal des*

[1] Hybrids between, as is presumed, *M. albellus* and *glaucion*, the common Golden-eye, have been described and (Embeck, *Isis*, 1831, 360, tab. iii.; Brehm, *Vollst. Naturg. d. Deutschlands*, p. 930; Naumann, *Vog. Deut. Inlands*, vii frontispiece, Kjærbolling, *Journ. für Ornithologie*, 1855, p. 29, *Naumannia*, 1853, p. 327, *Orn. Dan.*, tab. lv tab. 29) under the names of *Mergus anatarius*, *Clangula anan* and *Anas* (*Clangula*) *mergoides*, as though they were ordinar but the remarks of M. de Selys-Longchamps (*Bull. Ac. Sc. B* 1845, pt. ii. p. 354, and 1856, pt. ii. p. 21) leave little room as to their origin, which, when the cryptogamic habit and range of their putative parents, the former unknown to the au named, is considered, will seem to be still more likely.

. p. 209, pl. 283), inhabiting South America, of
ut few specimens have been obtained, having some
resemblance to *M. serrator*, but much more darkly
l, and *M. australis*, Hombron and Jacquemont
Sc. Nat. Zoologie, ser. 2, xvi. p. 320; *Voy. au Pol*
Sud, pl. 31, fig. 2), as yet known only by the unique
e in the Paris Museum procured by the French
the expedition to the Auckland Island. This last
may perhaps be found to visit New Zealand, and
certainly be looked for there.

n associated with the Merganeæ is the genus
tta, the so-called Torrent Duck of South America,
h three species are said to exist, but they possess
tails and have their wings armed with a spur.
er they should be referred to the *Merginæ* or the
turinæ —the Spiny-tailed Ducks proper—is a ques
at further investigation must decide. (A. N.)

RGUI, a district of British Burmah, between 9° 58′
′ 21′ N. lat. It forms the southernmost district of the
erim division, and is bounded on the N. by Tavoy,
S. by Siam, and W. by the Bay of Bengal, with
a of 7810 square miles. Two principal ranges cross
from north to south, running almost parallel to
her for a considerable distance, with the Tenasserim
nding between them till it turns south and flows
h a narrow rocky gorge in the westernmost range
sea. Amongst these mountain ranges and their
ary spurs are several fertile plains, densely clothed
uxuriant vegetation. Indeed, the whole district, from
ter's edge to the loftiest mountain on the eastern
ary, may be regarded as almost unbroken forest, only
are miles being under cultivation. The timber trees
towards the interior, and on the higher elevations,
great size and beauty, the most valuable being teak,
n (*Hopea odorata*), *ka-gnyeng* (*Dipterocarpus tuber-*
), &c. The coast line of the district, studded with
ipelago of two hundred and seven islands, is much
, and for several miles inland is very little raised
sea-level, and is drained by numerous muddy tidal
Southwards of Mergui town it consists chiefly of
angrove swamps alternating with small fertile rice
After passing the mangrove limits, the ground to
st gradually rises till it becomes mountainous, even
banks of the rivers, and finally culminates in the
natural barrier dividing British Burmah from Assam.
our principal rivers are the Tenasserim, Le-gnya,
un, and Palouk, the first three being navigable for a
erable distance of their course. Coal is found in the
t on the banks of the Tenasserim and its tributaries.
copper, iron, and manganese are also found in various
of the district.

the no ices of early travellers it appears that Mergui, when
Siamese rule, before it passed to the Burmese, was a rich and
peopled country. On its occupation by the British in
5 it was found to be almost depopulated, the result of
warfare and of the cruelties exercised by the Burmese con-
. At that time the entire inhabitants only numbered 10,000;
6 they had increased to 51,846 (26,767 males and 25,079
s). Classified according to religion, there were Buddhists,
; Mohammedans, 2513, Hindus, 353, Christians and others.
The district contains only one town (Mergui) with more than
habitants. Only 73 square miles of the district area were
cultivation in 1876, but this area is steadily though slowly
ing. The principal manufactures are sugar-boiling and tin-
ng. Mergui carries on a flourishing trade with Rangoon,
, and the Straits Settlements. The chief exports consist
, rattans, torches, dried fish, areca nuts, sesamum seeds,
es, sea-slugs, edible birds' nests, and tin. The staple imports
e goods, tobacco, cotton, earthenware, tea, and sugar. The
l revenue in 1876 amounted to £18,208. The climate is
ainly healthy, the heat due to its tropical situation being
ated by land and sea breezes. The rainfall in 1876 amounted
inches. The prevalent diseases are simple and remittent
, bronchitis, rheumatism, and small-pox.

MERGUI, chief town of the above district, is si
on an island at the mouth of the Tenasserim river.
population (10,731 in 1876–77) consists of many r
Talaings, Burmese, Malays, Bengalis, Madrasis, Si
and Chinese. Considerable trade is carried on with
Burmese ports and the Straits Settlements. The h
admits vessels drawing 18 feet of water.

MÉRIDA, a city of 7390 inhabitants (1877),
province of Badajoz, Spain, lies about 36 miles
eastward from Badajoz, on the Madrid and Badajo
on a small eminence on the right bank of the Gua
It is connected by a branch line of rail with Llere
the south-east. The population is mostly agricu
The city owes its interest entirely to its Roman re
which are numerous and extensive. Of these one
most important is the bridge of 81 arches of granite,
by Trajan; it is 2575 feet long, 26 feet broad, and
above the bed of the river; it was unfortunately se
injured during the siege of Badajoz in 1812.
colossal wall that formerly surrounded the town a
remains is a fine fragment, built of dressed stone,
spot formerly occupied by the castellum, and wh
provisor of the order of Santiago afterwards h
residence (El Conventual). In the town are some r
temples of Diana, Mars, Fortuna, Jupiter, and other
the Arco de Santiago, 44 feet high, also dates from T
time; it has unfortunately been stripped of its
casing. Of the aqueduct from the laguna of A
thirty-seven enormous piers are still standing, wi
arches in three tiers built of brick and granite.
east of the city is the circus, measuring some 1356
feet, the eight rows of seats still remain. Furthe
ward is the almost perfect theatre, and near it a
remains of the amphitheatre, or, as some prefer to
naumachia (Baño de los Romanos).

Augusta Emerita was built in 25 B.C. by the emeriti of
and tenth legions who had served in the Cantabrian wa
Augustus. It rose to great splendour and importance as th
of Lusitania. During the Gothic period it became an episc
and several provincial councils known to history were hel
It was taken by Músa in 711, and reconquered by Alphonso

MERIDA, the capital of the Mexican state of Y
stands in a great plain in the north of the peninsul
surface of limestone rock, about 25 miles from the
Progreso on the Gulf of Mexico, with which it is co
by a railway opened in 1880. It is a well-built cit
broad streets and squares"; and the flat roofed stone
after the style introduced by the Spaniards, give a M
colour to the general view. Besides the cathedral,
posing edifice of the 16th century, the bishop's pala
the Government house (all of which are situated in t
cipal square), the most notable building is the Fra
monastery (1547–1600), which once harboured wi
high and turreted walls no fewer than two thousand
but has been allowed to fall into complete deca
their expulsion in 1820. For a long time Merida
the reputation of being one of the principal seats of
in Mexico; and it possesses, besides the eccles
seminary schools of law, medicine, and pharmacy, a
institute, a public library, a theatre, and a consi
number of periodical publications. Commercially
shared in the prosperity which Yucatan in recent yea
to the development of the Sisal hemp trade; and its
factures embrace cotton goods, cigars, sugar, and rum
population, estimated about 1840 as 25,000, was
in 1871 to number 33,025. The Mayas still form
cally the strongest element. Previous to the
conquest the site of Merida was occupied by the
town of Tehoo, which contained so great a nu
artificial stone-mounds that the new-comers had ab
material for all their buildings. The foundation

tes from 1542, and it was made a bishopric i
Compare Stephen's *Yucatan*.

RIDEN, a city of the United States, in New Haven
Connecticut, 18 miles from New Haven by rail.
busy manufacturing town; the population has
d from 3559 in 1850 to 7426, 10,195, and 18,340
, 1870, and 1880. The Britannia Company alone
s upwards of 1000 hands, and sends out every year
$3,000,000 worth of Britannia metal and electro
goods; and tin-ware, cutlery, brass-work, flint glass,
nd woollen goods are also manufactured in the town.
tate reform school had 307 inmates in 1880. A
l tavern erected by Belcher in 1660 on the road
n Boston and New Haven was the nucleus of
n; but the place was not incorporated as a town till
and became a city in 1867.

RIMÉE, Prosper (1803 1870), novelist, archaeo
essayist, and in all these capacities one of the
t masters of French style during the century, was
Paris on September 28, 1803, and died at Cannes
23d of the same month sixty-seven years later,
lived just long enough to know that ruin was
ning France. Not many details have been published
rence to his family, but his father seems to have
man of position and competence. Merimee had
blood in his veins on the mother's side, and was
considered, at least in France, to look and behave
ike an Englishman than a Frenchman. He was
d for the bar, but entered the public service instead.
g man at the time of the romantic movement, he
s influence strongly, though his peculiar tempera
revented him from joining any of the cénacles of the
This temperament was indeed exhibited by the
rm and nature of the works in which he showed
nence of romanticism. Nothing was more prominent
the romantics than the fancy, as Merimée himself
for "local colour," the more unfamiliar the better.
é exhibited this in an unusual way. In 1825 he
ed what purported to be the dramatic works of a
lady, Clara Gazul, with a preface stating circumstan-
ow the supposed translator, one Joseph L'Estrange,
t the gifted poetess at Gibraltar. This was followed
still more audacious and still more successful
erie. In 1827 appeared a small book entitled *La*
(the anagram of Gazul), and giving itself out
nslated from the Illyrian of a certain Hyacinthe
novich. This book, which has greater formal merit
lara Gazul, is said to have taken in Sir John Bow
competent Slav scholar, the Russian poet Poushkin,
me German authorities, although not only had it no
l, but, as Mérimée declares, a few words of Illyrian
book or two of travels and topography were the
's only materials. In the next year appeared a short
ic romance, *La Jacquerie*, in which all Mérimée's
eristics are visible his extraordinary faculty of
nd historical colour, his command of language, his
ony, and a certain predilection for tragic and terrible
s which was one of his numerous points of contact
e men of the Renaissance This in its turn was
d by a still better piece, the *Chronique de Charles*
hich stands towards the 16th century much as the
rie does towards the Middle Ages. All these works
a certain extent second hand, being either directly
d or prompted by a course of reading on a particular
. But they exhibited all the future literary qualities
author save the two chiefest, his wonderfully severe
nost classical style, and his equally classical solidity
atuesqueness of construction. For the latter there
t much opportunity in their subjects, and the former
d a certain maturity and self-discipline which
Mérimée had not yet given to himself. These
however, displayed fully in the famous Corsican s
Colomba, published in the momentous year 1830,
all things considered, is perhaps Mérimée's best tale

He had already obtained a considerable posit
the civil service, and after the revolution of July
chef de cabinet to two different ministers. He wa
appointed to the more congenial post of inspec
historical monuments. Merimee was a born archae
combining linguistic faculty of a very unusual kin
the accurate scholarship which does not always acco
it, with remarkable historical appreciation, and with a
love for the arts of design and construction, in the
of which he had some practical skill. In his
capacity he published numerous reports, some of
with other similar pieces, have been republished
works. He also devoted himself to history proper
the latter years of the July monarchy, and pu
numerous essays and works of no great length, chi
Spanish, Russian, and ancient Roman history. H
not, however, neglect novel writing during this perio
numerous short tales, almost without exception
pieces, appeared, chiefly in the *Revue de Paris*. He tr
a good deal, both for his own amusement and on
errands; and in one of his journeys to Spain, abo
middle of Louis Philippe's reign he made an acquai
destined to influence his future life not a little -t
Madame de Montijo, mother of the future empress E
Mérimée, though in manner and language the
cynical of men, was a devoted friend, and shortly bef
accession of Napoleon III. he had occasion to sho
His friend Libri was accused of having stolen v
manuscripts and books from French libraries, and M
took his part so warmly that he was actually sen
to and underwent fine and imprisonment. He ha
elected of the Academy in 1844, and also of the Ac
of Inscriptions, of which he was a prominent m
Between 1840 and 1850 he wrote more tales, th
of which were *Arsène Guillot* and *Carmen*.

The empire made a considerable difference in M
life. He was not a very ardent politician, but
sympathies were against democracy, and he had th
no reason to object to the Bonapartist rule, especi
his habitual cynicism and his irreligious pr
made legitimism distasteful to him. But the m
of Napoleon III. with the daughter of Mada
Montijo at once enlisted what was always the stron
Mérimée's sympathies the sympathy of personal
ship on the emperor's side. He was made a senat
continued to exercise his archaeological functions;
most important rôle was that of a constant and
private friend of both the "master and mistress
house," as he calls the emperor and empress in his
He was occasionally charged with a kind of m
diplomacy, and once, in the matter of the em
Caesar, he had to pay the penalty frequently exacte
great men of letters by their political or social a
who are ambitious of literary reputation. But
most part he was strictly the "ami de la mai
the Tuileries, at Compiegne, at Biarritz, he wa
stant though not always a very willing guest, a
influence over the empress was very considerable a
fearlessly exerted, though he used to call himself, n
tion of Scarron, "le bouffon de sa majeste. He
tions during the last twenty years of his life were nu
and important, though rather nondescript. He
however, time for not a few more tales, of which mo
be said presently, and for two correspondences, wh
not the least of his literary achievements, while the
an extraordinary interest of matter. One of these

letters which have been published as *Lettres à une* *ne*, the other of the letters addressed to Sir Antonio , the late librarian of the British Museum. Various, idle and rather impertinent, conjectures have been as to the identity of the *inconnue* just mentioned. fficient to say that the acquaintance extended over years, that it partook at one time of the character , at another of that of simple friendship, and that ee is exhibited under the most surprisingly diverse most of them more or less amiable, and all interest- The correspondence with Panizzi has somewhat less al interest Mérimée made the acquaintance origin a suggestion that his correspondent should buy for useum some MSS. which were in the possession of al's sister, and for some year it was chiefly confined respondence. But Mérimée often visited England, he had many friends (among whom the late Mr of Glengarry was the chief), and certain similarities drew him closer to Panizzi personally, while during the empire the two served as the channel for a of unofficial diplomacy between the emperor and English statesmen. These letters are full of shrewd s on the state of Europe at different times. Both abound in gossip, in amusing anecdotes, in sharp critcism, while both contain evidences of a cynical belief-au or Swiftian humour which was very strong mée. This characteristic is said to be so prominent rrespondence with another friend, which now lies in ary at Avignon, that there is but little chance of its ing printed A fourth collection of letters, of much extent and interest, has been printed by M. Blaze y under the title of *Lettres à une autre Inconnue*. latter years of his life Mérimée suffered very much ll health. It was necessary for him to pass all his at Cannes, where his constant companions were two English ladies, friends of his mother. The terrible und him completely broken in health, and anticipating ast for France He lived long enough to see his fears d and to express his grief in some last letters, and d on September 23, 1870

mée character which has been unwarrantably slandered e to whom political differences or his sarcastic intolerance e in literature made him obnoxious was a peculiar and in spect an unfortunate one, but by no means unintelligible, hap in a minor degree not uncommon Partly by tempera- artly it is said owing to some childish experience, when he ed there he had been duped and determined never to be so not least owing to the example of Beyle, who was a friend ously, and of whom he saw much, Mérimée appears at a atively have imposed upon himself as a duty the ance of an attitude of sceptical indifference and sarcastic n He certainly succeeded Although, as has been said, a singularly warm and affectionate feelings, he obtained the of being a cold hearted cynic, and, although he was both dent and disinterested, he was abused as a hanger on and ter of the imperial court Both imputations were wholly ved, and indeed were prompted to a great extent by the ent felt by the literary equal on the other side at the cool with which he met them But he deserved in some of the well a many of the good sense of the term the phrase which e applied to him of a man of the Renaissance. He had the artisanship and amiability toward friends and the scorpion- ne for his foes, he had the ardent delight in learning and ly in matters of art and belle lettres, he had the scepticism, nptuousness, the curious delight in the contemplation of the , which marked the men of letters of the humanist period em he was a man of the world, and a man who without any s liked a king's palace better than a philosopher's hovel em he had an acute judgment in matters of business, and like singular consciousness of the nothingness of things Even his work has this Renaissance character It is tolerably ex amounting to some seventeen or eighteen volumes, but its not great for a life which was not short and which was d at least nominally in little else About a third of it con- the letters already mentioned, which will always be to ho delight in personal literature the most attractive part, ch, though in a fragmentary fashion, are really important as throwing side lights on history. Rather more than another consists of the official work which has been already allude reports, essays, short historical sketches, the chief of which a history of Pedro the Cruel, and another of the curious pr known in Russian story as the false Demetrius. Some literary essays, such as those on Beyle, on Turguenief, &c. a personal element enters, are excellent. Against others and the larger historical sketches admirable as they are - M. criticism that they want life has some force. They are, ho all marked by Mérimée's admirable style, by his sound and a scholarship his strong intellectual grasp of whatever he h his cool unprejudiced views, his marvellous faculty of design proportioning the treatment of his work It is, however, remaining third of his work, consisting entirely of tales o narrative or in dramatic form, and especially in the former, t full power is perceived. He translated a certain number of chiefly from the Russians, but his fame does not rest on th his already-mentioned youthful supercheries, or on his late dramatic works There remain about a score of tales exten point of composition over exactly forty years, and in lengt that of *Colomba*, the longest, which fills about one hundred a pages, to that of *L'Enlèvement de la Redoute*, which fills p a dozen They are unquestionably the best things of the written during the century, the only *nouvelles* that can ch comparison with them being the very best of Gautier, and two of Balzac The motives are sufficiently different In *C* and *Mateo Falcone*, the Corsican point of honour is drawn *Carmen* (written apparently after reading Borrow's Spanish the gipsy character; in *La Vénus d'Ille* and *Lokis* (two finest of all), certain grisly superstitions, in the former c known in a milder form as the ring given to Venus, in the variety of the were-wolf fancy *Abbon Gaillot* is a singula full of sarcastic pathos on popular morality and religio *Chambre Bleue*, an 18th century *conte*, worthy of Crébil grace and wit, and superior to him in delicacy, *The Captur Redoubt* just mentioned is a perfect piece of description; *Arbara* is again satirical; *La Double Méprise* (the author which was objected to Mérimée when he was elected Academy) is an exercise in analysis strongly impregnate the spirit of Stendhal, but better written than anything writers These stories, with his letters, assure Mérimée's p literature at the very head of the French prose writers of the c He had undertaken an edition of Brantôme for the Bibli Elzevir one, but it was never completed.

Mérimée's works have only been gradually published si death The latest, *The Letters to Panizzi*, which have a peared in English, bears date 1881 There is as yet no u or handsome edition, but almost everything is obtainable collections of MM. Charpentier and Calmann Lévy. (G.

MERINO. See SHEEP and WOOL.

MERIONETH (Welsh *Meirionydd*), a maritime c of North Wales, is bounded N. by Carnarvon and De S.E. by Denbigh and Montgomery, and W. by Ca Bay It is triangular in shape, its greatest length east to south-west being 15 miles, and its greatest b north west to south east about 30 miles. The area is 3 acres, or about 600 square miles. Next to Carnarvon outh is the most mountainous county in Wales. scenery is less bold and striking than that of Carn it excels it in richness, variety, and picturesque l Its lofty mountains are interpenetrated by dark dee or smiling vales. The outlines of its rugged cra softened and adorned by rich foliage. The sea vie frequently fine, and rivers, lakes, and waterfalls romantic charm to the valleys. The highest summ the county are the picturesque Cader Idris (which into three peaks, one, Pen y Gadair, having an alti 2914 feet), Aran Fawddwy (2955), Arenig-fawr (Moel wyn (2566), Rhobell-fawr (2360). The finest are those of Dyfi, Dysyni, Talyllyn, Mawddach, and nnog. The river Dyfrdwy or Dee rises 10 miles nort of Bala, and, after passing through Bala Lake, flows east by Corwen to Denbighshire. The Dyfi rises in lake near Aran Fawddwy, and expands into an of Cardigan Bay. The Mawddach or Maw, fro north of Aran Fawddwy, has a course of 12 miles west, during which it is joined by several other s The Dwyryd and other streams unite in formi estuary of Traeth Bach. The finest waterfalls a

y Glyn near Corwen, Rhaiadr Du, and Pistyll he latter 150 feet high. The lakes are very us, but small, the largest being Bala Lake, or Pim (in Welsh, Llyn Tegid, fair lake), 4 miles long by , and Llyn Mwyngil (lake in a sweet nook) in the Talyllyn. Both are much frequented by anglers. ount of frequent indentations the coast-line is about les long. Sandy beaches intervene between the shores. Frequent shoals and sandbanks render ion very dangerous. There are only two harbours rtance, Barmouth and Aberdovey.

ountain tract of the county 15 miles from north to by 10 from east to west, stretching from the coast is of the Cambrian age, composed of grits, quartzose, tes, and comprising the Merionethshire anticlinal. act is enclosed on the north, east, and south by the an, Lingula, Tremadoc, and Arenig beds, which are by numerous dykes and intrusive masses, mostly one. Rhobell fawr is one of the greatest igneous in the whole area of the Lingula beds. The Arenig e interstratified with and overlaid by accumulations anic a hes, felspathic traps, or lava flows, which e ragged heights of Cader Idris, the Arans, the , Manod, and Moelwyn, and these are in turn by the Llandeilo and Bala beds, the latter mem- Bala limestone. Extensive slate quarries are near Festiniog, mostly underground, in strata of ndeilo age, giving employment to about 1000 men. ead, copper, and manganese have been obtained in places.

te and Agriculture.—The climate varies much with the , in some places being bleak and cold, and in others re- y equable and genial. At Aberdovey it is proverbially d the myrtle grows in the open air. All attempts to intro- its have proved abortive in most parts of the county. The enerally thin and poor, with fertile tracts in the valleys. portion of the moss has been reclaimed within late years. ding to the agricultural returns for 1882, there were 154,106 considerably less than half the total area, under cultiva- Of this as much as 119,133 acres were permanent pasture, 55 under rotation grasses. Of the 17,312 acres under corn 1,232 were under oats and 1807 under barley. Potatoes 2392 acres, and turnips only 1196 acres. The area under xtended to 15,049 acres.

otal number of horses in 1882 was 6088. A breed of e peculiar to this county and Montgomeryshire. The of horned cattle and dairy-farming are largely carried on, number of cattle (37,643) is considerably under the average s generally. On the other hand the number of sheep in s 400,553, a larger number than in any other county of and much beyond the general average in the principality. e a small hardy breed, which grow heavy fleeces. Goats the loftier crags.

ding to the latest return the number of proprietors was 1695, ng 303,374 acres, with a gross annual value of £183,253. Of ers 1044, or 62 per cent., possessed less than 1 acre, the extent of the properties being 189 acres, and the average r acre a little over 12s. There were ten proprietors who d over 5000 acres, viz., Sir W. W. Wynn, 20,295; R. J. L. 7,718; T. P. Lloyd, 16,975; Mrs. Kirkby, 13,410; Hon. Wynn, 10,501, A. J. G. Corbet, 9347; Sir E. Buckley, W. E. Oakeley, 6018, W. O. Gore, 5497, and R. M. s, 5701.

ufactures.—Woollen goods are manufactured in various especially at Dolgelly. They are principally coarse druggets, ets, and flannels. The knitting of stockings was a great y at the close of last century, the value of the sales at Bala stimated at from £17,000 to £19,000 annually.

ays. The Cambrian Railway skirts the coast from Port o Aberdovey. At Barmouth Junction a branch of the same to Dolgelly, where it is joined by a branch of the Great n Railway. Another branch of the Great Western unites d Festiniog, and the latter place has railway connexion both anduduno Junction and with Portmadoc.

inistration and Population.—Merionethshire comprises five ds and thirty-three civil parishes. It has one court of quarter , and the number of petty sessional divisions is six. Eccles- it is partly in the diocese of Bangor, partly in that of St The county returns one member to parliament. There is no municipal or parliamentary borough. The towns return 1881 as urban sanitary districts are Bala (1653), Barmouth (Dolgelly (2457), Festiniog (11,272), and Towyn (3363). 1801 the population has nearly doubled. From 29,506 in tha it had increased in 1851 to 38,963, in 1871 to 46,598, and in to 54,793, of whom 27,576 were males, and 27,217 females.

History and Antiquities.—Originally Merioneth belonged territory of the Ordovices, and under the Romans it was in *Britannia Secunda*. There are many Celtic, Roman, and eval remains. Caer Drewyn on the Dee, near Corwen, was a camp. There are numerous cromlechs in various parts of the especially near the sea-coast. The *Via Occidentalis* of the R passed through Merioneth from south to north, and at T y-Mur was joined by a branch of the South Watling Stre Castell Tomen y Mur being supposed to be identical wit Roman station of Heriri Mons. The immense ruin of Ca Bere was originally one of the largest castle in Wales, but l cupied since the time of Edward I. During the War Roses the castle of Harlech, still a fine ruin, was held Lancastrians, and was the last in Wales to surrender. Of astical remains the most important is Cymmer Abbey, founded Cistercians in 1198, a very fine ruin containing architect various periods from Norman to Perpendicular. There are one interesting old churches.

MERLIN. See FALCON.

MERMAIDS AND MERMEN, in the popular myth of England and Scotland, are a class of beings more completely akin to man, who have their dwelling in th but are capable of living on land and of entering into relations with men and women.[1] They are easily iden at least in some of their most important aspects, wit Old German Merminnin or Meerfrau, the Icelandic Ha Margygr, and Marmennill (mod. Marbendill), the I Hafmand or Maremmd, the Irish Merrow or Mer the Marie Morgan of Brittany and the Morforw Wales;" and they have various points of resembla the vodyany or water-sprite and the rusalka or stream of Russian mythology. The typical mermaid (w much more frequently described than the merman) h head and body of a woman, usually of exceeding love but below the waist is fashioned like a fish with scal fins. Her hair is long and beautiful, and she is represented, like the Russian rusalka, as combing i one hand while in the other she holds a looking glass other times, like the rusalka, she is seen engaged more prosaic occupation of washing or beating clothes this, as, for example, in Hugh Miller's terrible Loch legend, is a sign of some impending calamity. For at least a mermaid may become to all appearance a nary human being, and from a very striking Irish ("The Overflowing of Lough Neagh and Liban the maid," in Joyce's *Old Celtic Romances*) it is evident human being may also for a time be transformed mermaid.

The mermaid legends, both English and other, grouped as follow:—A. *A mermaid or mermaids voluntarily or under compulsion reveal things that are to happen*. Thus the two mermaids (merewip) Hae and Sigelint, in the *Nibelungenlied*, disclose his course to the hero Hagen, who, having got poss their garments, which they had left on the shore, c them to pay ransom in this way. According to Re a mermaid appeared to a peasant of Samsoe, foreto birth of a prince and moralized on the evils of

[1] The name *mermaid* is compounded of the A.S. *mere*, a l *maegd*, a maid; but though *mere-wif* occurs in Beowulf, *mer* not appear till the Middle English period (Chaucer, *Rom. R Rose*, &c.). In Cornwall the fishermen say *merry maids* and *men*. The connexion with the sea rather than with inland appears to be of later origin. "The Mermaid of Martin Roby's *Traditions of Lancashire*, vol. ii., is an example of th force of the word; and such "mere-women" are known country folk in various parts of England (*e.g.*, at Newport in shire, where the town is some day to be drowned by the agency).

[2] See Rhys, "Welsh Fairy Tales," in *Cornhill Magazine*, 1881

, &c. (*Kong Frederichs den andens Kronike*, agen, 1680, p. 302). B *A Mermaid imparts tural powers to a human being.* Thus in the l story of "The Old Man of Cury" (in Hunt's *Romances of the West of England*, 1871) the old stead of silver and gold, obtains the power of doing his neighbours by breaking the spells of witchcraft, away diseases, and discovering thieves. John he Cromarty shipmaster, was more selfish, his s three' being that neither he nor any of his should perish by the sea, that he should be unin dly successful in everything he undertook, and that ly who scorned his love should scorn it no more. *ermaid has some one under her protection, and for lone to her ward exacts a terrible penalty.* One of t and most detailed examples of this class is the f the "Mermaid's Vengeance" in Mr Hunt's book quoted D *A mermaid falls in love with a human lives with him as his lawful wife for a time, and then, nuptial being unwittingly or intentionally broken by him, to her true home in the sea.* Here, it its mermaid accepted, the typical legend is undoubtedly that *sent*, which, being made the subject of a full-fledged by Jean d'Arras, became one of the most popular oks of Europe, appearing in Spanish, German, and Bohemian versions. Melusina, whose name e a far off echo of the Mylitta (Venus) of the ians, was married to Raymond of Lusignan, and g afterwards proudly recognized as one of their s by the Luxembourg, Rohan, and Sassenaye s, and even by the emperor Henry VII. Her story found in Baring Gould's *Myths of the Middle Ages*. *ermaid falls in love with a man, and entices him to live with her below the sea; or a merman wins the or captures the person of an earthborn maiden* m of legend is very common, and has naturally favourite with poets Macphail of Colonsay fully rejects the allurements of ermaid of rekin, and comes back after long years of trial to d of Colonsay.[1] The Danish ballads are especially the theme; as "Agnete and the Merman," an ante- of Matthew Arnold's "Forsaken Merman"; the ittul Merman, or Marstig's Daughter"; and the detailed story of Rosmer Hafmand (No. 49 in)

elation to man the mermaid is usually of evil issue of evil intent. She has generally to be bribed or led to utter her prophecy or bestow her gifts, and r as wi a paramour she brings disaster in her In it elt her sea life is often represented as one of delight, but at other times a mournful mystery dines brood over it. The fish tail, which in popular orm the characteristic feature of the mermaid, is of nitary importance; for the true Teutonic id probably a remnant of the great cult of the had no fish tail' and this symbolic appendage in such remote mythological regions as to give no historical connexion The Tritons, and, in the epresentations, the Sirens of classical antiquity, the rian Dagon, and the Chaldean Oannes are all well- examples; the Ottawas and other American Indians heir man fish and woman fish (Jones, *Traditions of rth American Indians*, 1830), and the Chinese tell not unlike our own about the sea women of their rn seas (Dennis, *Folklore of China*, 1875)

st historical instances of the appearance or capture of mermaids are common enough,[3] and serve, with the fre use of the figure on signboards and coats of arms, to how thoroughly the myth had taken hold of the p imagination.[4] A mermaid captured at Bangor, o shore of Belfast Lough, in the 6th century, was ne baptized, but admitted into some of the old calendar saint under the name of Murgen (*Notes and Q* Oct. 21, 1882); and Stowe (*Annales*, under date relates how a man fish was kept for six months and in the castle of Orforde in Suffolk. As showing legendary material may gather round a simple the oft told story of the sea-woman of Edam is p larly interesting. The oldest authority, Joh. Gerbr a Leydis, a Carmelite monk (*ob.* 1504), tells (*A* &c., Franktort, 1620) how in 1403 a wild w came through a breach in the dike into Purmerlake being found by some Edam milkmaids, was ultim taken to Haarlem and lived there many years. N could understand her, but she learned to spin, an wont to adore the cross. Oeka Scharlensis (*Chron Frysland*, Leeuw., 1597) reasons that she was not because she could spin, and she was not a woman b she could live in the sea; and thus in due cour got fairly established as a genuine mermaid. Vo who has carefully investigated the matter, enumerate writers who have repeated the story, and shows th older ones speak only of a woman (see "Beschr. v zoogen. Meermin der stad Haarlem," in *Verh. van d Maatsch. van K. en Wet.*, part 23, No. 1786). As stuffed mermaids which have figured from the days tholomew Fair downwards, it is enough to mentio exhibited in the Turf Coffee-house, London, in and carefully drawn by Cruikshank (compare Cha *Book of Days*).

The best account of the mermaid-myth is in Baring *Myths of the Middle Ages*. See also, besides works alread tioned, Pontoppidan, who in his logically credulous way much matter to prove the existence of mermaids; Maillet *ued*, Hague, 1755; Grimm, *Deutsche Mythologie*, i. 4 *Altdan Heldenlieder*, 1811; Waldron's *Description* and *Hist and Stat Acc of the Isle of Man*, Folklore Society's vol. ii.; Napier, *Hist and Trad. Tales connected with the Scotland*; Sebillot, *Traditions de la Haute Bretagne*, 18 *Contes des Marins*, 1882 (H. A

MEROE, in classical geography (Strabo, xvii. 2, 2; ii. 73, v. 10; Ptol., p. 201), was the metropolis of Æt situated on an island of the same name between th and the Astaboras (Atbara). The "island" is o inaccurate name for the fertile plain between t rivers. This Meroe, first mentioned by Herodotus *sq.*), succeeded an older Ethiopian kingdom of Napat down the Nile, originally subject to and civilize Egypt, but which afterwards became independent an sent forth an Ethiopian dynasty to reign in Egypt, to the So and Tirhaka of the Bible belonged (see Ethi The name of Meroe in the form Merawi is now g Napata. The later Meroe retained its independence Egypt fell under foreign sovereigns. Diodorus describes it as entirely controlled by the priesthoo native prince Ergamenes destroyed the sacerdotal c the time of Ptolemy II. Queen Candace (Acts v was probably sovereign of Meroe; see Lepsius's Eng. tr., pp. 196, 206; and comp. Strabo, xvii. 1,

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Leyden: "The Mermaid," in Sir Walter Scott's *Border*

l Blind, "New Finds in Shetlandic and Welsh Folk Lore," in *'s Magazine*, 1882.

[3] Compare the strange account of the quasi-human creatu in the Nile given by Theophylactus, *Historiæ*, viii. 16, pp. of Bekker's ed.

[4] See the paper in *Journ. Brit. Arch. Ass.*, xxxviii., 1882, Cumming, who points out that mermaids or mermen occur in of Earls Cadogan, Howth, and Sandwich, Viscounts Boyne an Lord Lyttleton, and Scott of Abbotsford, as well as in thos Ellis, Byron, Phené, Skellington, and other families. The heralds represent the creatures with a single tail, the Fr German heralds frequently with a double one.

n Candace in Augustus's time when the Romans Petronius advanced to Napata. Meroe was visited ek merchants; and the astronomical expedition of henes determined its latitude with great accuracy. loring party in the reign of Nero found that the below Meroe, formerly the site of many towns, come almost wholly waste (Pliny, vi. 29). From to the 14th century of our era the Christian te) realm of Dongola occupied the place of the older n. The ruins of Meroe and Napata were fully d by Lepsius in 1841, and the monuments are l in his *Denkmäler*.

RSEBURG, the chief town of a district of the same the Prussian province of Saxony, is situated on r Saale, 10 miles to the south of Halle and 17 to t of Leipsic. It consists of a quaint and irregularly ld town, with two extensive suburbs, and contains rches and several schools and charitable institutions. thedral is an interesting old pile, with a Romanesque the 11th, a transept of the 13th, and a Late Gothic the 16th century. Among its numerous monuments of Rudolph of Swabia, who fell in 1080 in an ter with his rival Henry IV. It contains two gs by Lucas Cranach. Contiguous to the cathedral Gothic chateau, formerly the residence of the Saxon and the bishops of Merseburg. The town house, the ice, and the "standehaus" for the meetings of the ial estates are also noteworthy buildings. The ies of Merseburg consist of the manufacture of card- and coloured paper, dyeing, glue-boiling, machine-, calico-printing, tanning, and brewing. Its popu- n 1880 was 15,205.

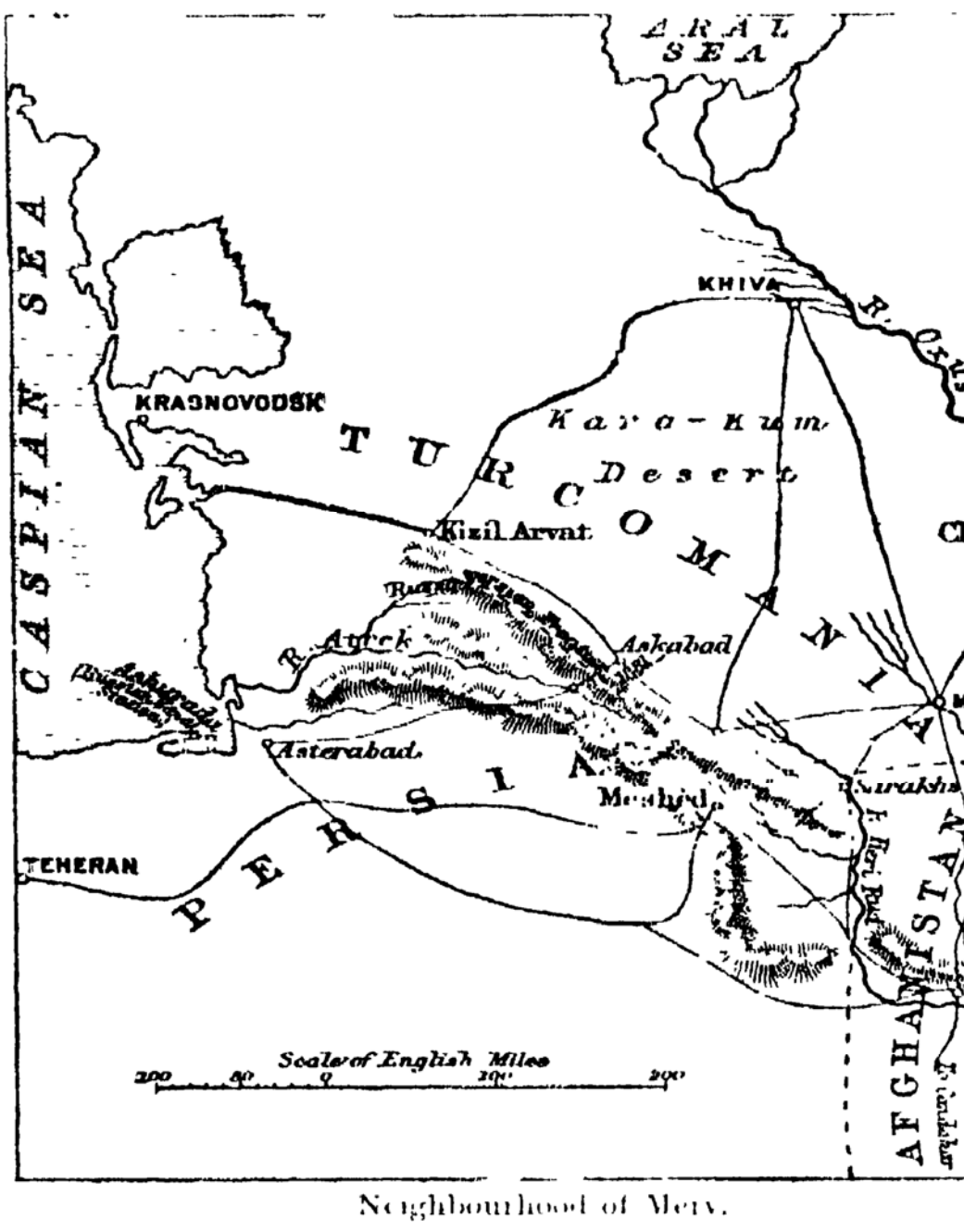
burg (*i.e.*, "march-town") is one of the oldest towns in y. From the 9th century down to 1007 it was the capital ntship of its own name, and from 968 to 1543 it was the seat op. In the 10th, 11th, and 12th centuries it was a favourite e of the German emperors, and at this time its fairs enjoyed ortance afterwards inherited by those of Leipsic. The town eatedly visited by destructive conflagrations in the 14th to turies, and also suffered severely during the Thirty Years' From 1656 to 1738 it was the residence of the dukes of Saxe- rg. The great victory gained by the emperor Henry I. Huns in 933 is believed to have been fought on the Keusch- r Merseburg.

RTHYR TYDFIL, or MERTHYR TYDVIL, a parlia- y borough and market-town of Glamorganshire, Wales, is situated in a bleak and hilly region on the Taff, and on several railway lines, 25 miles north- vest of Cardiff and 30 east-north-east of Swansea. wn, which consists principally of the houses of work s for the most part meanly and irregularly built, and time, on account of its defective sanitary arrange was frequently subject to epidemics of great severity. recent years great improvements have taken place, e town now possesses both a plentiful supply of ater and an excellent system of sewage. There are ne good streets with handsome shops, while in the s there are a number of private residences and villas ed by the wealthier classes. Apart from its extensive d steel works, the town possesses no feature of t. It is situated in the centre of the South Wales sin, and the rich coal-mines in the vicinity supp acilities for the iron industries. At Merthyr Tydfil, is said to have received its name from the martyr a British saint Tydfil, there were smelting-works ry early period, but none of any importance until From about forty years ago until 1875 the manufac- bar iron developed with great rapidity, but since he production of steel has largely taken its place. orough returns two members to parliament. The tion of the urban sanitary district in 1871 was , and in 1881 it was 48,857; the population of the parliamentary borough, which includes the parish of dare and parts of the parishes of Llanwonno and M Tydfil and of Vainor (Brecon), and has an area of acres, was in the same years 97,020 and 91,347.

MERV, MERU, or MAOUR,[1] a district of Central situated on the border-land of Iran and Turan.

The oasis of Merv lies in the midst of a desert, in 37° 30′ N. lat. and 62° E. long. It is about 250 from Herat, 170 from Charjui on the Oxus, 360 Khiva, and 175 from Gawars, the nearest point i newly acquired (1881) Russian territory of Akhal.

The great chain of mountains which, under the n Paropamisus and Hindu-Kush, extends across the continent from the Caspian to China, and forms t of ethnic demarcation between the Turanian and Germanic races, is interrupted at a single point; that is on the same longitude with Merv. Through or n



Neighbourhood of Merv.

trouée or gap which nature has created flow northw parallel courses the rivers Heri-rud (Tejend) and Mu until they lose themselves in the desert of Kara-kum large expanse of waste, known also as Turcomania, spreads at the northern foot of the mountains, and st from the lower Oxus to the Caspian.

Whether as a satrapy of Darius and subsequen a province of Alexander, whether as the home Parthian race, whether as a bulwark against the dest waves of Mongol invasion, or later as the glacis of Khorasan, the valleys of those rivers the district o

[1] Merv is the modern Persian name. The river *Margus*, Murghab, on which was built the ancient city, is derived from the name of the province as recorded in the Behistan inscrip Darius. Spiegel connects the name *Merga* with old Bactrian *m* bird, in allusion to the numerous swarms of bird that gathe So, too, the er name Murghab means bird-water. The dist pears to have been known in the 5th century as Marv-i-rud, the river was then the Marv. The name *Meruna* for the occurs in the Armenian geography ascribed to Moses of K written probably in the 7th century (ed. Patkanoff). Maou Uzbek name, and of comparatively recent date.

ever been important outposts on the borders of
In bye gone epochs their banks have, under powerful
been studded with populous and flourishing cities,
bore the name of "Sovereign of the Univers (*Mere
fehan*), and vied for fame with "Balkh, the Mother
", of late times, with weakness or absence of govern
hose same banks have become choked with fallen
ents and ruins, the home of the snake and the jackal.
has soared to prosperity or fallen to decay accord-
her political status at the moment, and history,
spects itself, may yet have to sing her praises in
ure as it has done in the past. All that human
the desert requires i there, water in abundance,
soil unsurpassed for fertility. Good government is
wanting to turn these natural gifts to full account
present inhabitants of the district are Turcomans
Tekke tribe, who, like the other tribes inhabiting
mania, enjoyed until the approach of the Rus ians
independence, and acknowledged allegiance to no
; paying tribute when shocked out a miserable existen
trade of pre datory raids, and in bad times pillaged
neighbouring and equally barbarous states, to whose
, they were in turn subjected.

In the year 1869, the date of the establishment of
an military settlement at Krasnovodsk on the ea t
of the Caspian, the wave of Russian conquest has
ily swept eastwards along the northern frontier
s until it has for the moment stopped at the outer-
border of the Akhal Turcoman country, which was
nated in 1881 by Russia as the result of the defeat
tribe at Geok Tepe. Among the districts still
east, to which the Russians give the name of
n Turcomania, is that of the Merv Tekke Turcomans,
n of the Akhal Te e, the most recent of Russia's
s. The district of the Merv Tekkes may be taken
that included between the lower Murghab below
n, where the river enters the plain, and the Persian
r from Sarakhs to Chawars.

ference to the map will show the strategical import-
of this district, situated at the point of meeting of
nes, of which one is the strategic line of Russian
e on Herat from Krasnovodsk to Sarakhs, and the
the strategic line of advance on the same place from
end through Bokhara. The capital of the district
reover, the cross-ing point of the Herat-Khiva and
d Bokhara trade routes.

sequently this district, a solitary oasis in a vast
, guarantees to its possessor the command of an
tant avenue between north and south, and, in the
of its falling into Russian hands, will give that power
ition a valuable link in the chain of connexion
ee her recent acquisitions on the Persian frontier
here in Turkestan, the forging of which has been
tently advocated by Russian writers for years past.
f these, Colonel Vonnikoff, frankly admits that it is
litical results "the consolidation of friendly relations
the Turcomans" and not commercial interests
s, that are primarily looked to, and openly states
he forward movement in Central Asia "cannot end
wise than by the annexation to Russia of the whole
tan."

ether by design or by the force of circumstances, the
mendations of those writers have been translated into
and Russia with her advanced post at Askabad is
ithin 100 miles of Herat, which Sir Henry Rawlinson
ates as the key of India. The occupation of the
Tekke country would bring Russia to within 250
of Herat. From Askabad she is in connexion with
aspian by a good line of communication, part of which
the sea to Kizil Arvat) is by rail; and hence facilities
are offered for bringing up not only the resources
Caucasus but of the whole of European Russia.
Russian troops are within 400 miles of Herat, the I
troops at Quetta are more than 500 miles from Hera

These remarks serve to explain the very n
suspicion with which Great Britain has regarde
occupation one after another of important strat
points along that route by which alone Russia can
at India, the same line by which Napoleon medit
Russo French invasion in the early part of this centu

In the matter of Merv and the neighbouring Turcoman d
diplomacy has not been idle. As early as 1869, when an
change of opinions was taking place between the Russia
British Governments with respect to the demarcation of a
zone between the two empires, Great Britain objected
Russian proposal that this zone should be Afghanistan, "t
of the next approach to India that would be thereby affor
Russian troops from the direction of the Kara-kum, the hom
Turcomans, of which Merv is the central point. In the fo
year a Russian diplomatist remarked to the British embass
St Petersburg, when discussing the Afghan frontier, that ge
would be requi tracing a line from Khoja Saleh on th
to the south, as Merv and the country of the Turcoman- w
coming "commercially important." About the same time
intimated that, if the amir of Afghanistan claimed to e
sovereignty over the Tekkes, his pretension could not be reco
After the Russian campaign against Khiva in 1873, and t
frequent operation against the Turcomans, the English
secretary early in 1874 called attention, "to the terms expre
the amir of Afghanistan as to the complications in which he
become involved with Russia were the result of a Russian
dition against Merv to be to drive the Turcomans to take re
the province of Badghees in Herat." In reply to this co
cation Prince Gortschakoff repeated the assurance that the i
Government "had no intention of sending any expedition
the Turcomans, or of occupying Merv." In 1875 the opera
General Lomakin on the northern frontier of Persia led to re
tition being made by the British ambassador at the cou
Petersburg. To these Russia replied that the czar had no
tion of extending his frontiers on the side of Bokhara or
side of Krasnovodsk. Notwithstanding the oft-repeated ass
to the contrary, large annexations have been since made in
mania by the Russians, and these proceedings, clearly in
the persistent prosecution of a concerted plan, have naturally
to disturb the harmonious relations which should subsist
the two great civilizing powers of the East.

Settlements and Inhabited Centres.—Of towns o
villages, fixed centres of habitation, there are no
cording to Mr O'Donovan, the latest European t
to Merv. The present political and military cap
Merv is Koushid Khan Kala, a fort which serves ra
a place of refuge against sudden attacks than as a
tion. It is situated on the east bank of the most w
branch of the Murghab, about 25 miles below the
Porsa Kala. In form it is oblong, measuring $1\frac{3}{4}$ mi
by $\frac{3}{4}$ mile broad, is constructed entirely of earth, r
on the exterior slope with sun dried brick; the ra
are 40 feet high, and are 60 feet at the base. The
built in a loop of the river, which protects it on two
between it and the river is an "obah," or nomad vi
huts and tents, some thousand in number, disposed i
but there is no town or settlement.

Twenty-five miles east of Koushid Khan Kala
ruins of the Greek city of Antiochia Margiana, s
traces of a high civilization. According to Strabo
the Merv oasis at this period was surrounded with
measuring 1500 stadia (185 miles). Mr O'Donovan
the trace of the fort of Iskander to have been quadra
with a length of side of 900 yards. This was proba
fort built by Alexander, about 328 B.C., on his retu

[1] Concurrently with the consolidation of her position in Tur
Russia has of late been showing less military activity on the
her Turkestan district. It is probable that her recent explor
the sources of the Oxus have demonstrated the impractica
directing any offensive movement against India from th
Hence the line of strategical advance has been shifted from T
to Tirhs.

ana after the capture of Bessus. The city was
yed in 666 A.D. by the Arabs, who built a new one,
ards known as Sultan Sanjar, about 1000 yards
and occupying an area, according to Mr O Donovan,
ut 600 yards square. The towers are still extant.
side can be seen the ruins of a most elaborate tomb,
ch the supposed bones of Sultan Sanjar are enshrined.
s always been a place of pilgrimage for the faithful
r to the south west lies the site of the last city of
that which existed up to a hundred years ago,
it was laid waste by the Bokharians. It bears tl
of its gallant defender Barram Ali.

hree ruins are that remain of that which
hed of yore as "sovereign of the universe."
the time of the visit of Burnes, Abbott, Shakespear,
Taylour Thomson, about the fourth decade of the
y, Merv was under the jurisdiction of Khiva, and
dministrative centre was at Porsa Kala, where the
s situated. This place is now also a waste of mud
uninhabited.

ers.- Heri rud (or Tejend, as the river is
l below Sarakhs) runs a course of some 280 miles
Afghan borders. On reaching the Persian from
t turns north and forces a channel through the
tain chain near Sarakhs. Beyond Sarakh the river
rcoman on both banks, runs close to the Khelat
tains, and in the latitude of Askabad loses itself
arshes formed by the spring floods. It is probably
chus of ancient geography, which watered Nissa, once
pital of Parthia, and joined the Oxus just before
tter river disembogued into the Caspian (Rennell's
lotus). The Tejend is fordable at all points below
hs except in the early spring after the melting of the
s. On the road from Meneh to Merv the river is
sh, 50 yards wide and 4 feet deep in February. The
bed is sunk 12 to 15 feet below the level of the
nding country, and has immense quantities of drift
on its banks; trees and luxuriant herbage clothe the
diate borders. At midsummer the river runs nearly
and does not reach Sarakhs. The Kashaf-rud, which
near Meshed, is one of its chief affluents.

e Murghab takes its rise in the northern slopes of the
paniisus, and runs parallel to the Heri rud at a distance
miles from it. On this river lies the plain or oasis
ery, irrigated by means of an elaborate system of dams
anals cut from the main river. Beyond the limits
oasis the Murghab "hides its streams in the sand,"
the Tejend. The river at Porsa Kala (near the
ipal dam) is 80 yards wide, at Koushid Khan Kala 30
yards wide. In summer it is much swollen by the
ng of the snows, and its stream is then barely fordable.
water is yellow in colour from suspended matter.
rmerly a great deal of the country, now a waste,
en the two rivers was also cultivated by the agency
ter derived from canals cut from the Tejend. These
s extended to Kucha Kum in the desert, rendering
ourney between the two rivers much easier than in the
nt day. From the Murghab was also cut, among
s, the Kara-i-ab canal, which ran for a distance of 10
towards the Tejend. Recent explorers affirm that there
reason why these canals should not be again filled
those rivers, when the intervening country, "an argil-
us expanse" (O'Donovan), would become culturable.

mmunication.—Merv is surrounded on all sides by desert. On
rth, west, and east this desert is sandy and arid; water is
dingly scarce, the wells being sometimes 60 or 70 miles apart.
easily choked. To the south of Merv, between the rivers
ab and Tejend, there are traces of past cultivation, of irrigating
, and of considerable settlements. Between the Tejend and
ad the road lies through a populous well-cultivated country
an territory) by way of Kahka and Lutfabad.

There are no roads in Merv,—nothing but mere tracks.
wide and deep irrigating canals have to be crossed, bridges
and bad. The inhabitants cross by inflated skins.

The following tracks lead to the Persian frontier from Me
viâ Mahmur or Chungul to Lattabad eight days on camel
Shahrdli to Mehna- 120 miles; (3) *viâ* Shahrdli to Fort Ch
and Meshed, for 85 miles between the Murghab and Teje
is scarcely any water, (4) *viâ* Sarakhs to Meshed, 9
for camels, and, according to Petrusevitch, without wate
Merv and Sarakhs 120 miles.

To Afghan frontier lead (1) the track
Herirud to Herat fit for a coach, according to Sir Char
Gregor and Mr Lessar; and (2) a practicable track, used by
and Shakespear, up the Murghab and Kushk rivers.

To the Oxus in Bokharian territory lead several tra
chief of which is that to Charjui nine marches for camels.

To Khiva by the direct track is 360 miles. Water is sca

Population. The Turcomans, according to Sir Henry Ra
and others, are descendants of the Ghuz or Komani, a race
who migrated westward from their homes in the Altai be
Christian era, and penetrated even to the Danube. Fr
sequent intermixture with Persian and Caucasian people
exhibit variation from the true Tartar type. According t
de Bode the Turcoman closely resembles both in appeara

Nor Tartar and the Tartar of Kazan on the
They are an independent race, as wild and free as thei
desert, brave and very impatient of ntrol. "Wild wa
stormy freedom bred" (Moore). They have a very evil rep
for brigandage and murder, so much so that the Bokhari
Khivans have a proverb "If you meet a viper and a Mer
mence by killing the Mervi and then despatch the viper."
years a change for the better has taken place, and recent t
state that the Mervis show an inclination to
more settled life and to establish an elementary form of gov
(Medjlis), and that it is no longer accounted an honour
them to kill their neighbours. Opium smoking and arrac
ing are apparently wide-spread vices (O'Donovan), at the sa
they are described as clever and intelligent.

The Merv Tekkes (like the Akhal Tekkes) are classed in t
divisions the Toktamish and the Otamish. Each
divisions consists of two clans, and each clan is subdivi
families. The chiefs of the Toktamish are called
Wakil; those of the Otamish, Suchmuz and Bukshi. The
Beg and Wakil are the most powerful, and occupy that po
oasis which lies on the right or east bank of the Murgh
Suchmuz and Bukshi have their tents on the left or west b

There is no machinery of government, and no taxes ar
Whatever government there be is of a patriarchal nature
family has a *kethhoda* (patriarch), who represents the f
matters of policy, but can only act in accordance with th
of the clan. The *aksakals*, or grey beards, are also useful m
intertribal disputes, but they are tolerated only so long as
not act in opposition to the tribesmen. For external affai
time of war the *kethhodas* exercise a certain amount of pow
authority of *kethhodas* and *aksakals* is, however, overrid
laws of custom or usage (*deb*) and the less respected laws of
The injunctions of deb are paramount. It sanctions the
or plundering raid, and in general regulates the Turcoma
life; its prescriptions are more binding than those of the
The Tekkes marry young. The father purchases for hi
year-old son a child-wife for 500 to 2000 krans (£20 to
young widow of twenty five is much more valuable, but a
over forty is not worth the price of a camel. On the conc
the bargain, the priest reads a prayer from the Koran,
marriage becomes valid.

The dress of the men consists of a long tunic of coarse
silk reaching below the knees, with a white sash through
stuck a dagger; an outer robe of brown camel-hair cloth
sheepskin hat, trousers and slippers or amber-coloured ku
complete the costume. The women are exceedingly fond of
rings, and amulets, which accompany their movements
sound as it were of bells. Their dress consists of the ame
robe as the men wear, with a sash round the waist, and bo
boots, red or yellow.

The religion is Sunni Mohammedan; their language J
Oriental Turk.

The numbers of Merv Tekkes on the Murghab and Te
variously estimated, but may be stated approximately a
tents, including 5000 tents of the Salor tribe. These 10,0
represent a population of 200,000 to 250,000 souls. The S
Sariks at Yulutan and Pamjeh, higher up the Murghab,
at 11,000 tents, or some 60,000 souls.

Products, Arts, and Manufactures.—The country in all t
been renowned throughout the East for its fertility. Strab
"that it was not uncommon to meet with a vine whose ste
hardly be clasped by two men with outstretched arms

of grapes might be gathered two cubits in length." The
veller Ibn Haukal, writing in the 10th century, remarks
e fruits of Merv are finer than those of any other place, and
not see in any other city such palaces with groves and
and gardens." A local proverb says, "Sow a grain to
undred." All cereals and many fruits grow in great abund-

urcomans possess a famous breed of horses, not prep
n appearance, being somewhat leggy and long in the back
, but capable of accomplishing long distances 50 or 60
or several days in succession, and with very little food.
eat peculiarity appears to be their hardiness to cold, the coat is
, the mane and tail very scanty. The breed of horses, as
he wealth of the Merv Tekkes in camels and flocks, is fast
ing.

urcomans are noted as expert workers in silver and as
s, and their carpets are second only to Persian. They also
t and a rough cloth of sheep's wool.

the chief occupations of the male adults the repair of th
d the clearing of the canals, upon the efficiency of which
istence is dependent. The services of a large number of
n are always held in readiness for the purpose. In 1878
sual mass of water in the Murghab carried away the dam,
drying up of some of the canals nearly led to a failure of
s.

. The position of Merv, in the midst of sandy deserts in
t of Asia, makes the climate in the heat of summer most
e. The least wind raises clouds of fine sand and dust,
l the air, renders it so opaque as to obscure the noonday sun,
e respiration difficult. In winter the climate is very fine.
ls rarely, and melts at once.

a. The name Merv, or some similar form, occurs at a
y period in the history of the Aryan race. Under Mouru
t mentioned with Bakhdi Balkh in the geography of the
ata *Vendidad*, Fargard i. (ed. Spiegel), which dates probably from a period anterior to the conquest of Bactria by the
s, and therefore at least one thousand two hundred years
e Christian era. Under the name of Marouth it occurs in the
n inscriptions of Darius Hystaspis, where it is referred to as
part of one of the satrapies of the ancient Persian empire
ones Ekhstani, ed. Kossowicz). It afterwards became a pro-
ἀρχιαρή) of the Graco Syrian, Parthian, and Persian king-
on the Margus, the Epiphus of Arrian and now the Murghab
the capital of the district, Antiochia Margiana, so called after
s Soter, who rebuilt the city founded by Alexander the
About the 5th century, during the dynasty of the Sasa-
ry was the seat of a Christian archbishopric of the
n Church. In the middle of the 7th century the flood of
nquest swept over the mountains of Persia to the deserts of
Asia. Merv was occupied 666 A.D. by the lieutenants of
h Othmân, and was constituted the capital of Khorasan.
s city as then bore the Arabs, under Kuteibe bin Muslim,
the 8th century brought under subjection Balkh, Bokhara,
a and Kashgaria, and penetrated into China as far as the
of Kansu. In the latter part of the 8th century Merv
obnoxious to Islam as the centre of heretical propaganda
d by Mokanna (Hacheim ben Hakem), the "Veiled
of Khorasan," who claimed to be the incarnation of the
In 8?4 Arab rule in Central Asia came to an end. Dur-
t dominion Merv, like Samarkand and Bokhara, became
the great schools of science and the celebrated historian
studied in its libraries. About 1037 the Seljukian Turks
the Oxus from the north and raised Toghrul Beg, grandson
, to the throne of Persia, founding the Seljukian dynasty,
s capital at Nishapur. A younger brother of Toghrul,
took possession of Merv and Herat. Toghrul was succeeded
renowned Alp Arslan the great lion, whose sway was so
t, according to tradition, no fewer than twelve hundred
rinces, and sons of kings and princes did homage before
ne. Alp Arslan was buried at Merv. It was about this
t Merv reached the zenith of her glory. During the reign
n Sanjar of the same house, towards the middle of the 11th
Merv was overrun by the Turcomans of Ghuz, and the
was reduced to a state of misery and desolation. These
ans, the ancestors of the present tribes of Turcomania,
obably introduced into the country by the Seljukian Turks
ary colonists. They formed the van of their armies, and
efficient service so long as the dynasty lasted, and after-
ok part in the wars of Tamerlane.

1 Merv opened its gates to Toulai, son of Jenghiz, khan
Mongols, on which occasion the inhabitants, to the number
000, are said to have been butchered. From this time
Merv, which had been the chief city of Khorasan, and
ularly supposed to contain a million inhabitants, com-
to languish in obscurity. In the early part of the 14th
Merv was again the seat of a Christian archbishopric of the
Church. On the death of the grandson of Jenghiz khan
Merv became included in the possessions of Toghluk Timur
(Tamerlane), in 1380. In 1505 the decayed city was occup
the Uzbeks, who five years later were expelled by Ismail
the founder of the Sufiavean dynasty of Persia. Merv ther
ward remained in the hands of Persia until 1787, when
attacked and captured by the emir of Bokhara. Seven
later the Bokharians razed the city to the ground, broke dow
dams, and converted the district into a waste. About 17
Sarik Turcomans pitched their tents there. When Sir Alex
Burnes travelled the country in 1832, the Khivans were the
of Merv, the nomad population being subject to them. Abou
time the Tekke Turcomans, then living at Orazkala on the Her
were forced to migrate northward in consequence of the pr
from behind of the Persians. The Khivans contested the ad
of the Tekkes, but ultimately, about the year 1856, the latt
came the sovereign power in the country, and have ever
resisted all attempts at reconquest.

Authorities.—Besides the standard travels of Wolff, Ferrier, Vambery,
Abbott, Monteith and others the following works and papers of more
date may be consulted with advantage:—Sir H. Rawlinson's *England and
in the East*; O'Donovan's correspondence with the *Daily News*, 1
O'Donovan's "Merv," *Proc. Roy. Geog. Soc.*; Col. Stewart's "Country
Tekke Turcomans," *Proc. Roy. Geog. Soc.*, with excellent map; "The New
Persian Frontier, 1881," *Proc. Roy. Geog. Soc.*; Guard de Ralle, *Memo
l'Asie Centrale*, Sir H. Rawlinson, "Road to Merv," *Proc. Roy. Geo
Col. Baker's *Oxus in the East*; Captain Napier's "Reports," *Jour. Roy
Soc.*, Hutton's *Central Asia*; Marvin's *Merve*, Col. Petto's *Steppe Cam
Sir Charles MacGregor's *Journey through Khorassan*, Boulger's *Englan
Russia in Central Asia*; Captain Butler's *Communications to the Public
Lessar's "Journeys," *Proc. Roy. Geog. Soc.*, O'Donovan's *Merv Oasis*; Pa
the Turcomans, &c., by Col. Petrusevitch, *Proc. Imp. Russ. Geog. Soc.*, C
section; Col. Grodekoff's *Journey from Tashkend to Persia*, 1880,
Kuropatkin's *Turcomania*, 1880; Col. Vennikoff's *Progress of Russia in
Asia*, 1877, and other papers by the same author; Col. Kostenko's "Turk
Journ. R. U. S. Instn.; Schuyler's *Turkistan*; correspondence on Central A
presented to parliament, &c. (F. C. B.)

MÉRYON, CHARLES (1821–1868). The nam
Méryon is associated with that spirited revival of et
in France which took place in the middle of the
century, say from 1850 to 1865, but it is rather h
individuality of his own achievements, and the streng
his artistic nature, than by the influence he exercised
Méryon best deserves fame. No doubt his work encou
others to employ the same medium of expression, a
great was his own perfection of *technique* that he may
have been made a model; but, after all, the mediu
selected, and in which he excelled, was but the accide
his art; he was driven to it in part by stress of ci
stances, by colour blindness; and, even with colour
ness, his extraordinary certainty of hand and his de
perception of light, aided by his potent imagination, w
have made him a great draughtsman not alone upo
copper.

Charles Méryon was born in Paris in 1821. His f
was an English physician, his mother a French da
It was to his mother's care that Méryon's childhood
confided. She was supplied with money, and she gav
boy passionate affection, if not a wise training. Bu
died when he was still very young, and Méryon in
time entered the French navy, and in the corvette
Rhin" made the voyage round the world. He was al
a draughtsman, for on the coast of New Zealand he
pencil drawings which he was able to employ, years
wards, as studies for etchings of the landscape of
regions. The artistic instinct developed, and, whi
was yet a lieutenant, Méryon left the navy. Finding
he was colour-blind, Méryon determined to devote hi
to etching. He entered the work-room of one Bléry,
whom he learnt something of technical matters, a
whom he always remained grateful. Méryon was b
time poor. It is said that he might have had assis
from his kindred, but he was too proud to ask it.
thus he was reduced to the need of executing for the
of daily bread much work that was wholly mechanica
irksome. Resolutely, though unwillingly, he becam
hack of his art, doing frequently, from the day wh
was first a master of it to the day when insanity dis
him, many dull commissions which paid ill, but paid
than his original works. Among learner's work, do
his own advantage, are to be counted some studies aft

etchers such as Zeeman and Adrian van de Velde. proved himself a surprising copyist, he proceeded our of his own, and began that series of etchings are the greatest embodiments of his greatest con s the series called "Eaux-fortes sur Paris." These executed from 1850 to 1854, are never to be met a set; they were never expressly published a But they none the less constituted in Meryon's mind monious series. For him their likenesses and their ts were alike studied; they had a beginning and an nd their differences were lost in their unity.

les the twenty-two etchings "sur Paris" character low, Méryon did seventy-two etchings of one sort nother, ninety four in all being catalogued in re's *Mérydn and Méryon's Paris*; but these include rks of his apprenticeship and of his decline, adroit r which his best success was in the sinking of his hvidiality, and dull and worthless portraits chiefly otten celebrities. Yet among the seventy two prints his professed series there are at least a dozen that d his fame. Three or four beautiful etchings of o not belong to the series at all. Two or three s, again, are devoted to the illustration of s, a city in which the old wooden houses were ctive to him for their own sakes as were the stone nonuments of Paris. But generally it was when engaged him that he succeeded the most. He have done more work, however, - though he could have done better work, if the material difficulties life had not pressed upon him and shortened his He was a bachelor, unhappy in love, and yet, it is almost as constantly occupied with love as with The depth of his imagination and the surprising which he achieved almost from the beginning in hnicalities of his craft were appreciated only by a ists, critics and connoisseurs, and he could not sell ings, or could sell them only for about 10d. a piece. t that his own original work was of incalculably value than his best copies of his most celebrated ners had not yet impressed itself upon anybody. ointment told upon him, and, frugal as was his way poverty must have told on him. He became subject neinations. Enemies, he said, waited for him at the of the streets; his few friends robbed him or owed at which they would never pay. A very few years he completion of his Paris series, he was lodged in dhouse of Charenton. Its order and care restored r a while to health, and he came out and did a little work, but at bottom he was exhausted. In 1867 rned to his asylum, and died there in 1868. In the years of his life, just before he was placed under con- nt, he was much associated with Bracquemond and Flameng, skilled practitioners of etching, while he nself an undeniable genius,—and the best of the ts we have of him is that one by Bracquemond which the sitter wrote that it represented "the e Méryon with the grotesque visage." And it did.

e are twenty-two pieces in the Eaux fortes sur Paris. Some n are insignificant. That is because ten out of the twenty re destined as headpiece, tailpiece, or running commentary e more important plate. But each has its value, and certain maller pieces throw great light on the aim of the entire set. ne little plate —not a picture at all —is devoted to the record s made by Méryon, the purpose of which is to lament the hte s. The misery and poverty of the town Meryon had to illus s well as its splendour. The art of Méryon is completely ceived when his etchings are spoken of as views of Paris. They n "views," but they are so just so far as is compatible with ing likewise the visions of a poet and the compositions of an It was an epic of Paris that Méryon determined to make, t strongly by his personal sentiment, and affected here and y the occurrences of the moment,—in more than one case, for e, he hurried with particular affection to etch his impression of some old world building which was on the point of destr Nearly every etching in the series is an instance of technica but even the technical skill is exercised most happily in the ings which have the advantage of impressive subjects, and the collector willingly cherishes for their mysterious stage or for their pure beauty. Of these, the Abside de Notre D the general favourite; it is commonly held to be Méryon's piece. Light and shade play wonderfully over the great f the church, seen over the spaces of the river. As a draughts architecture, Meryon was complete, his sympathy with its styles was broad, and his work on its various styles unbro of equal perfection a point in which it is curious to contra with Turner, who, in drawing Gothic, often drew it with appreciation. It is evident that architecture must enter into any representation of a city, however much such repres may be a vision, and however little a chronicle. Besides, th tectural portion even of Meryon's labour is but indirectly i tive, to the imagination he has given freer play in his dealin the figure, whether the people of the street or of the river people who, when he is most frankly or even wildly sym crowd the sky. Generally speaking, his figures are, as draughtsmanship, "landscape painter's figures." They are more with an eye to grace than to correctness. But they "landscape painter's figures" at all when what we are co with is not the method of their representation but the pu their introduction. They are seen then to be in exceptional with the sentiment of the scene. Sometimes, as in the case Morgue, it is they who tell the story of the picture. Someti in the case of La Rue des Mauvais Garçons, with the two women bent together in secret converse, they at least sug And sometimes, as in L'Arche du Pont Notre Dame, it expressive gesture and eager action that give vitality and in to the scene. Dealing perfectly with architecture, and perfe far as concerned his peculiar purpose, with humanity in Méryon was little called upon by the character of his subj deal with Nature. He drew trees but badly, never repre foliage happily, either in detail or in mass. But to render th asperities of the city, it was necessary that he should know portray a certain kind of water river-water, mostly sluggis a certain kind of sky the grey obscured and lower sky that over a world of roof and chimney. This water and this sky is thoroughly master of, he note with observant affectio changes in all lights.

Meryon's excellent draughtmanship, and his keen appreci light, shade, and tone, were, of course, helps to his becoming etcher. But a living authority, himself an eminent etch admiring Meryon thoroughly, has called Meryon by prefe great original engraver, - so little of Meryon's work accord- Haden's view of etching. Meryon was anything but a sketcher; and, if an artist's success in etching is to be gauged by the rapidity with which he records an impression, Mery cess was not great. There can be no doubt that his wo laborious and deliberate, instead of swift and impulsive, and some other virtues of the etcher "selection" and "abstract Mr Hamerton has defined them he shows small trace. genius like Méryon is a law unto himself, or rather in his of his art he makes the laws by which that art and he a judged. He was a great etcher, and by his most elaborate he seemed somehow to come the more completely for his that virtue of unity of impression which, it may well be s oftener belongs to rapid than to deliberate work. In M etchings the hand work never seems to be in arrear of the t As long as the hand-work must continue, the thought and are retained. Meryon knows the secrets of his craft as wel the older masters of it; but he turns them to his own p sel in strength precision, not is h rivalled in delicacy. These qualities, and others more t technical, which it would take too long to insist on here, find in his etchings. But the incommunicable charm of M prints and their lasting fascination are due to the fact that all technical qualities, and as their very source and spri lies the potent imagination of the artist, poetical and vis ing him what to see in his subject, and how to see it.

MESCHERYAKS, or MESCHERS, a people nub eastern Russia. Nestor regarded them as Finn even now part of the Mordvinians (of Finnish call themselves Meschers. Klaproth, on the other supposed they were a mixture of Finn- and Turk-, a Hungarian traveller Reguli discovered that the Ta Meschers of the Obi closely resembled Hungarians. formerly occupied the basin of the Oka (where th Meschersk, now Meschovsk, has maintained their and of the Sura, extending north-east to the Volga. the conquest of the Kazan empire by Russia,

igrated north eastwards to the basins of the Kama
elaya, and thus the Meschers divided into two
s. The western branch became Russified, so that
scheryak of the governments of Penza, Saratoff,
, and Vladimir have adopted the customs, language,
igion of the conquering race; but their ethnogra
characteristics can be easily distinguished in the
population of the governments of Penza and
f. The eastern branch has taken on the customs,
ge, and religion of Bashkir, with whom their fusion
more complete. They can be distinguished from
eighbours only by their more peaceful character.
-Bikir Mescheryak branch was estimated by Rittich
to number 138,000. They make 6 per cent. of
pulation of the government of Ufa, and 22 per
the district of Birsk. The number of the western
ryaks is unknown, and could hardly be estimated on
of their mixture with Russians. It is only in the
ment of Penza that they have maintained their national
s, there they make 3 per cent. of the population.

SCHOVSK, a district town of Russia, in the govern
Kaluga, 15 miles to the south-west of the capital
province. It is an old town supposed to date from
th century, and it is often mentioned in Russian
under the names of Mezetsk, Mezechevsk, or
sk. About the end of the 11th century it was
ed in Lithuania, and it was ceded to the Moscow
principality in 1494. It was often pillaged by Tar
the 16th century, and during the great disturbances
Dali it. inhabitants were killed by the Zaporoghi
ks and the fort was taken by Poles, who returned it
sia only after the treaty of Deulin. The country
Meschovsk is not fertile; but, from its position on
ablished routes to the south, the town has become
e of considerable trade. Its annual fair, which
place on the grounds of the very old Petrovsk
ery, is important to the surrounding districts for
ort sale of horses, grain, hemp, hempseed oil, and
linen, and for the import trade in cottons, woollens,
thern and glass wares, the whole turn-over reaching
2100,000. Population, 7100.

HED (properly Meshhed, *q.v.*, "place of martyr-
dom"), a city of northern Persia, capital of
ân, 472 miles east of Tehran, 201 miles north-west
t 36° 17' 10" N., 59° 35' 29" E., lies on a plain
by the Kashaf rud, a tributary of the Heri rud, and
nded by mud walls 4 miles in circumference, with
itch 10 feet deep at some points, which could be
from the neighbouring reservoir and watercourses.
this enclosure is a strong citadel, with good walls 25
gh, residence of the prince governor of Khorásán.
re five gates, from one of which, the Bala Khiaban,
aban main street runs right through the city, form-
ne boulevard planted with plane and mulberry trees,
h a stream of dirty water running down its whole

In the centre is an open parallelogram 160 yards
encircled by double-tiered cloisters, and pierced on
side by a high arched porch leading directly to
t mosque, whose gilded dome rises above the shrine
amous Imam Riza[1]. The marble tomb of the saint,
which is the most venerated spot in the whole of
and yearly visited by from 80,000 to 100,000 pilgr
surrounded by a silver railing, and approached by a
of inlaid marble steps. Eastwick, the only European
O'Donovan who penetrated as far as the parallel
describes the mosque as large enough to contain
thousand people. It is flanked by two gilded mi
one of which, 120 feet high, is extremely beautiful
an exquisitely carved capital, built by Shah Abbas.
façade is entirely covered with blue and white ena
tiles. To the mosque are attached as many as two tho
attendants and retainers of all sorts, including no les
five hundred mollahs. Beyond the dome is Gauhar
handsome mosque, surmounted by an immense blue
and also flanked by two minarets. In the main
is a public kitchen supported by the enormous re
of the shrine, where eight hundred devotees are
supplied with food gratuitously. The only other
buildings in the place are some colleges and t
two caravanserais, one of which is of great size. M
does a considerable local and transit trade to the
value of about 600,000 tomans, and its bazaars are
well stocked with silks, velvets, felts, cottons, s
carpets, lacquer work, lambskins, hardware, glass,
and other goods from South Persia, India, Turkesta
Russia. The European trade is now entirely control
Russia, and European manufactured articles are mo
from that country. The chief manufactures are silk
velvet, and checked-cotton fabrics, carpets, shawls,
sword blades, shagreen, and turquois jewellery.
the enclosures are extensive cemeteries far exceedi
local requirements, large numbers of the faithful
brought from all parts of the Shi'a world to be bu
the vicinity of Rizá's shrine under the belief tha
eternal salvation is thereby ensured.

Some 10 miles west of Meshed is a powder factory, fo
under Colonel Dolmage, where powder of excellent quality
duced. The district, although fertile, does not produce su
for the inhabitants, so that much grain has to be import
Kurdistan and Nishápúr. The climate is very severe in wint
much snow, in summer it is less sultry than might be ex
the temperature ranging from 76° F. to 90° or 92° F., and in
hours 94° to 98° F. The population is variously estim
from 15,000 (Connolly) and 60,000 (Fegrier) to 80,000 and 1
(Eastwick). The settled residents, exclusive of pilgrims and
traders, are estimated by O'Donovan at 50,000.

The main caravan routes from Khiva, Bokhara, Samarkan
Herat converge at Meshed, whence lines of traffic radiate to I
for the Atrek valley and the Caspian, to Nishapúr and Bos
Tehran, to Tabas for Isfahan, to Khaf for Sistán and Kirm
thus occupies a position in north-eastern Persia analogous
of Tabriz in the north-west.

MESHED-ALI, *i.e.*, the shrine of the "martyr"
a town of Asiatic Turkey, province of Baghdad, 50
south of Kerbela, close to the ruins of Kufa, and 2
west of the Hindiye branch of the Euphrates, the re
burial place of the caliph Ali.[2] It stands on th
scarp of the Syrian desert, and is enclosed by nearly
brick walls flanked by massive round towers datin
the time of the caliphs. Under the gilded dome
great mosque, which occupies the centre of the town,
shrine of Ali, which is held by the Shi'a as at le
holy as the Kaaba itself. Any Moslem buried
sight of the dome being certain of salvation, large nu
of bodies are yearly sent from all parts for interme
Besides the mosque with its richly decorated façad
only noteworthy building is a good bazaar supplied
Baghdad and Basra. The town itself, which Lady

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[1] Rizá (or el-Ridá), the eighth imam of the Shi'a, is the 'Ali ibn
om whom the party of Ali's heirs had such hopes under the
of Mamún (see MOHAMMEDANISM). He died at Tus,
, and was buried by Mamun under the vicinity of that
side the grave of Harun el-Rashid. To the Ali he was
being believed to have been poisoned by the caliph. Ibn Batuta,
ribes both shrines (iii. 77 *sq.*), tells how the pious visitors
me of 'Ali ibn Músa used to spurn with their feet the tomb
[2] In his time a considerable town had been formed around
n under the name of Meshhed el-Rida and ultimately the
n eclipsed the older city of Tus.

[2] Whether the place really contains the grave of Ali w
disputed, and the story given in defence of its claims is de
apocryphal. The dome was built under the Abbasids, and the
place of the caliph unknown or concealed under the Omayya
Haukal, p. 163).

Blunt describes as "an ideal Eastern city, standing in an absolute desert, and bare of all surroundings but its tombs," consists of narrow gloomy streets lined by houses closely packed together. The locality is properly named Najaf, and gives its name to the neighbouring lake, a large depression filled by an eruption of the river, and ranging from 6 to 20 feet in depth. The accumulated treasures of the shrine were carried off by the Wahhábites when they captured this place early in the present century. The population is estimated at 7000, including several Indian Mohammedans under the protection of the British resident at Baghdad.

The aspect of the shrine in the 14th century is described by Ibn Batúta, i. 114 *sq.* A plan of the town and description of its splendour before the Wahhabites pillaged it is given by Niebuhr. See also Ibn Jubair, p. 214; P. Teixeira, *Itin.*, cap. iv.

MESHED HOSEIN, properly Meshhed Hosein. See Kerbela, vol. xiv. p. 18.

MESMER, MESMERISM. See vol. xv. p. 277.

MESOPOTAMIA, the "country between the rivers," is a purely geographical expression, the countries which it comprehends never having formed a self-contained political unity.[1] It was first introduced by the Greeks at or after the time of Alexander, but probably had its origin in the earlier Aramaean name *beth nahrin* (the country between the rivers), to which again corresponds the Biblical *Aram Naharaim*.[2] As early as 700 B.C. "the country of two rivers" is mentioned on the Egyptian monuments under the name Naharina, but no such designation appears in the cuneiform inscriptions (though the territory formed part of the Assyrian as it afterwards did of the Persian empire). The most settled period in the history of Mesopotamia was probably under Persian-Greek rule. Xenophon applies the name Syria to the extremely fertile district which he traversed after having crossed the Euphrates at Thapsacus. The country beyond the Araxes (Chaboras?) he calls Arabia, a desert region in which his army had to suffer great hardships until it reached the "gates of Arabia." Even in later times Mesopotamia was included under the name Assyria, or was reckoned part of Babylonia.

These statements of Xenophon already indicate a demarcation of the territory afterwards called Mesopotamia, as well as its division into two sections. The fertile portion, inhabited by agricultural Aramaeans, stretched from the Euphrates to the Chaboras; the desert portion, the home of wandering tribes, extended to the Tigris. It would be rash, however, to conclude from this that Mesopotamia designated the whole territory between the Euphrates and Tigris; indeed it is possible that *Aram Naharaim*, the Aram of the country of the two rivers, originally meant only the main portion of the fertile country inhabited by Syrians. In this case the two boundary rivers must have been, not the Euphrates and the Tigris, but the Euphrates and the Chaboras. After the final occupation of the country by the Romans (156 A.D.), the political province of Mesopotamia was practically confined to this more limited district. Though in ordinary usage the Euphrates and Tigris are considered as the two rivers which bound Mesopotamia, the one bank of the river cannot be geographically separated from the other, and consequently narrow strips of country on the right bank of the Euphrates and on the left bank of the Tigris must be reckoned to the country "between" the rivers. On the other hand, the country between the sources of the Euphrates and the Tigris has from early times been reckoned not to Mesopotamia but to Armenia. In direction the Masius range forms the proper bound... it is only on rare occasions that theoretical ... extend the name Mesopotamia over the more ... districts, Sophene, &c. Purely theoretical too, ... be approved, is the extension of the definition ... include the land of Babylonia ('Irák 'Arabi), that ... country as far south as the confluence of the Eu... and Tigris, or even as far as their embouchure ... Persian Gulf.

From what has been said it appears that Meso... reaches its northern limits at the points where the Eu... (*q. v.*) and the Tigris break through the mountain ra... enter the lowlands. In the case of the Euphra... takes place at Sumeisát (Samosata), in that of th... near Jezíret ibn 'Omar (Bezabdá) and Mosul (N... Consequently the irregular northern boundaries are ... by the lowland limits of those spurs of the Taurus mo... known in antiquity as Mons Masius and now as ... Dágh and Túr 'Abdin. Towards the south the ... boundary was the so-called Median Wall, whic... Pirux Shapur, not much to the south of Hit (the ... Is), crossed from the Euphrates in the direction of ... (Opis) to the Tigris. There the two rivers appro... other, to diverge again lower down. At the sam... begins the network of canals connecting the tw... which rendered the country of Babylonia one of the ... in the world; there too, in a geological sense, the ... portion of the plain, consisting of strata of gyp... marl, comes to an end, there at one time ran the ... the sea coast; and there begin those alluvial for... with which the mighty rivers in the course of l... have filled up this depressed area. Mesopotam... forms a triangle lying in the north-west and so... direction, with its long sides towards the north and ... west. It extends from 37° 30′ to about 33° N. ... from 38° to 46° E. long., and has an area of some ... square miles. The points at which the rivers ... among the mountains have an absolute altitude of ... 1090 and 1150 feet, and the plain sinks rapidly ... the southern extremity of Mesopotamia, where it is ... than about 165 feet above the sea. As a whole the ... country consists of a single open stretch, save that ... north there are some branches of the Taurus, the ... Dágh near Orfá, the long limestone range of 'Abd... running north north west, and farther to the east the ... range, also of limestone, 7 miles broad and 90 mil... running north north east. Between these two range... the isolated basaltic hill of Tell Kókab (Hill of Star... the defile by which the waters of the Chabora..., by the Jaghjagha and other affluents from the Mas... their way into the heart of Mesopotamia. The ... proper, the ancient Chaboras, which rises in the ... hundred copious fountains of Rás 'ain (the ancient Ri... and ultimately falls into the Euphrates near K... (Circesium), forms the boundary between the two, ... correctly the three, great divisions of Mesopotamia. ... divisions are (1) the northern country to the wes... Khabúr, (2) the northern country to the east, and ... steppe land. In the country to the north-west ... Khábúr we must probably, as already mentioned, re... the true ancient *Aram Naharaym*. Under the d... of the Seleucids it bore the name of Osrhoene, ... Orrhoene, and was for a time the seat of a special ... which at a later date at any rate was Arabian (... The capital of this kingdom was Orfa (Roha), the ... of the Greeks and Romans, the Orrhoi of the Syr... was at a later date a Roman colony, and bore also th... of Justinopolis. This once flourishing city lies on th... river Daisan (the ancient Scirtus). South of Ed...

[1] Μεσοποταμία, more exactly ἡ μέση τῶν ποταμῶν, scil. χώρα or Συρία.

[2] In the more recent parts of Genesis Padan Aram takes the place of Aram Naharaym. But this perhaps is the name of a smaller district in the neighbourhood of Harran.

s of HARRAN (see vol. xi. p. 154). In the Mongolian Harran fell into decay, and at present it is a mere ruins. A third town of this region is Serug i. 20); in the Greek period it was called Batnæ, but ians retained the name Serug, which is still in use The town lies between Harran and the Euphrates, in to which it gives its name. On the left bank of phrates lay Apamea (the modern Birejik), connected engma on the other side by a bridge, and farther at the mouth of the Bilechas (modern Belik), trading town and fortress Nicephorium, founded mand of Alexander, and completed by Seleucus , in memory of whose victory it was named. he emperor Leo it received the designation Leonto The spot is now known as Rakka (see below). up the fruitful valley of the Belik lay the town of (Chne). Further south lay Circesium (*Chaboras* of , *Phalga* of Isidor), not to be identified, as is usually d, with Carchemish; from the time of Diocletian strongly fortified. The site is at present occupied retched place of the name Karkisiya. Carchemish ly lay near the bridge of Membij, the present el Nejm.

ncient time a highly flou district must have ed along the river Chaboras (Khabûr) to its principal at Ras'am ("Fountain-head," Syr. *Rîsh'aina*, the a of Ptolemy), a town which was for some time called topolis, because after 380 A.D. it was extended and shed by Theodosius. Justinian fortified it. The completely desert country which now stretches along er course of the Khabûr was called in antiquity itis, and corresponds to the Gozan of 2 Kings xvii. zana or Guzanu in the cuneiform inscriptions).

country to the east of the upper Khabur is in many s similar to that which has just been described. As tershed of the Tigris is not far distant, the Masius sends down into Mesopotamia only insignificant s, the most important being the Hermas, the mus of the Greeks. On its banks was situated , the chief city of the district, which commanded eat road at the foot of the mountains leadin h the steppe, which here from the scarcity of water up to the edge of the hills. In the old an empire Nasibina was the seat of one of the four dministrative officials. In the time of the Seleucids e was occupied by the flourishing Greek colony of lia Mygdonia, but the new designation, transferred river and the vicinity of Nisibis from the Mace- district of Mygdonia, afterwards passed out of use. was an important trading city, and played a great n the wars of the Romans against the Persians. red by Lucullus, surrendered by Tigranes, recovered ajan, again abandoned by Hadrian, once more occu- nder Lucius Verus, and strongly fortified by Severus, at length raised to be the capital of the province, mained the frontier fortress of the Romans till in ne of Jovian it was ceded to the Persians. After ss of Nisibis the emperor Anastasius in 507 ed to the north-west the fortress of Dara or Daras nodern Dára), also called Anastasiopolis, which from gn of Justinian, who increased its strength, remained ime the residence of the *dux Mesopotamiæ*. Besides strongholds, many fortified posts were established Byzantine empire in this district. Antoninopolis be mentioned as an important town, this was ied by Constantine under the name of Constantia, s left its ruins near Tela between Harran and Nisibis. n too was a fortress of a similar kind, and the town gara, at the southern foot of the mountain of the name, was an advanced post of the Roman power.

The south or steppe portion of Mesopotamia was early times the roaming-ground of Arabic tribes Xenophon gives the name of Arabia to the district left bank of the Euphrates to the west of the Kh and elsewhere it is frequently stated that the interio distance from the rivers was a steppe inhabited by A Scenitæ (Tent Arabs). Along the bank of the two rivers ran a belt of cultivated country, and the islands of the Euphrates were also occupied by a s population. On the Euphrates, beginning towards north, we must mention first Zaitah or Zautha, south of Circesium; next Corsothe, at the mouth of the Mas then Anatho or Anathan, the modern Ana; and f Is (Hit). On the Tigris the point of most importa Carrhæ (*Karrai* of the *Anabasis*), south from the mou the Great Zab near the present Kal'at Sherkát; an far distant towards the interior was Atræ or Hatra called Hatra, the chief town of the Arab tribe of the A It was besieged without success by Trajan and Sev by the 4th century it was already destroyed; bu nteresting ruins, which can scarcely be visited owi the plundering habits of the Bedouins, still bear the of El Hadhr. They lie in the heart of the steppe were formerly well supplied with water.

hese districts came in 610 A.D., or perhaps a earlier, into the power of the Arabs, who named Jezíra (island) or Jeziret Akúr,[1] and divided them acc to tribes into three portions, the land of Beki, of B and of Modhar. The district of Modhar ran alon side of the Euphrates, and its chief towns were Orf Rakka, the district of Rebí'a comprised the pla Mosul as far as the country on the Khábur (chief Mosul and Nisibis), and the district of Bekr (Diyár the more mountainous country to the west of the Tigris (chief town Amid or Diarbekr). In genera Arabs consider a part of the mountain territories wh between the two rivers to belong to Jezíra, as is bes from the following notice given by Abulfeda:—

"El-Jezíra is the land between the Tigris and the Euphrat many places on the other side of the Euphrates, which p belong to Syria, are also included, as well places and ev tricts on the east side of the Tigris. The exact boundary li runs from Malatia by Sumeisát, Kal'at er-Rúm (Rum Kala maps), and Bire (Birejik) to the point opposite Membij, an by Balis, Er Rakka, Karkísiyá, Er-Rahaba (on right banl Hit to Anbar. Here the Euphrates ceases to form the bou which runs across to the Tigris in the direction of Teki ascends the Tigris as far as Es-Sinn (Senna) to El-Hadit Mosul, thence to Jeziret ibn 'Omar, then to Diarbekr, and so Malatia"

From the Arabic geographers and travellers we ga impression that a great part of Mesopotamia, with t ception of the southern steppe of course, must at tha have been in a very flourishing condition; the neighbou of Nisibis especially is celebrated as a very paradis fact it is only since the Turkish conquest of the c under Sultan Selim in 1515 that it has turned into a and gradually lost its fertility. As the nomadic have continually extended their encroachments, agric has been forced to withdraw into the mountains; a is especially true of the western portions of Mesopo the district of Rás-'ain, and the plain of Harran and where huge mounds give evidence that the whole c was once covered with towns and villa Und Turks El-Jezira does not form a political unity, b longs to different pashaliks.

From this brief survey it appears that Mesopotam Syria, constitutes an intermediate territory betwe great eastern and western monarchies,—Syria in

[1] Philostratus (*c.* 200 A.D.) already reports that the Arab Mesopotamia *νῆσος*.

to the west, and Mesopotamia to the east. In
e of its position it frequently formed both the object
the scene of contest between the armies of those
y monarchies, and it is wonderful how a country so
devastated almost always recovered. The roads, it is
which traversed the territory were not mere military
ays, but the main routes of traffic for Central Asia,
ern Asia, and Europe. It is only in modern times,
since these lines of commercial intercourse have
d to be followed, that the general condition of things
en so entirely altered.

e number of roads which in ancient times traversed
ountry was very considerable; the Euphrates formed
barrier but a bond between the nations on either
at many places there were at least boat bridges
na) across. One of the most important of the
t crossing places must be sought, where in fact it still
at Birejik, the ancient Apamea-Zeugma. From this
a great road led across to Edessa (Orfa); there it
d into two branches, the northern going by Amid
ekr) and the other by Mardin and Nisibis to Mosul
veh). In quite recent times, in order to avoid the
route across the desert and through the midst of the
ins, the post-road makes a great circuit from Nisibis
ziret ibn 'Omar to Mosul. A second route crossed
uphrates somewhat more to the south, and joined the
via Harran and Rhesaena. The principal crossing
earlier times (Xenophon) was at Thapsacus, almost
te Rakka; and it will be remembered also how
tant a part Thapsacus (Tiphsah) plays in the Old
nent. Sometimes a route along the Euphrates to
ona was followed, as is still frequently done by
ns at the present day; but even in ancient times
ourse was attended by more or less difficulty, the
y being occupied by the chiefs of independent
tribes, with whom the travellers had to come to

ancient condition of things must consequently be
ered as essentially analogous to that of the present
the central districts away from the rivers were occu-
t certain seasons, according as they yielded pasture,
nadic cattle grazing tribes, the physical character of
untry being then and now the same on the whole as
f the Syrian desert, which belongs not to Syria
roperly to Arabia. On the banks of the rivers were
l half-nomadic Arab tribes,- tribes, that is, which
more or less on the way to the agricultural stage, or
having become altogether agricultural, had never
s, owing to frequent intercourse with the Bedouins,
ttle of their original character, and even maintained
ndependence. The same movement takes place over
ver again. Arab tribes migrating from Arabia, that
gentium, gradually settle down wherever circum
s prove favourable, and by this very change in their
of life make their first step towards civilization. In
way a continual stream of Arabs has flowed into
vilized countries of Mesopotamia. On the Assyrian
ments are figures of Arabs riding on camels; evidently
ssyrians had carried on war against the Bedouins
l in their territory. At an early period the Tai Arabs
he neighbours of the Aramaeans, and consequently all
bear in Syriac the name of Tayóyé. The district
n Mosul and Nisibis received the name Béth 'Arbáyé
ts being occupied by Arabs. These Tai Arabs, whose
al home was Central Arabia, are still settled partly
Nisibis and partly east of Mosul; but they have to
extent lost their old noble Bedouin manners. The
ring Arab tribe which at the present time is
ant in Mesopotamia is the Shammar; they have
back the Aneze, the most powerful tribe of the
Syrian desert. It is only two or three generatio
that the Shammar came from Nejd; but they have
broken up into two great parties. The head of
division is Ferhán, who has more or less comple
mitted to the Turks, and has consequently obtai
title of pasha; to him adhere the Shammar tribes
Mosul and Baghdad, and those also to the east of the
The head of the tribes who roam over the greater
Mesopotamia pasturing their camels and sheep
east of the Chaboras in the colder season and to th
in the hotter is the chivalrous Faris. These
tribes are totally independent of the Turkish Gove
and have offered determined opposition to the atte
the authorities at Dér to force them to a settled
life; they still lay the peasants of Mesopotamia
contribution by exacting Khuwwe, "brother mone
portion of grain. The Shammar live in almost pe
feud with their relations to the east, and especially
Aneze on the Syrian bank of the Euphrates, the s
Shammiye. Many other Bedouin tribes might
mentioned; but it may be enough to name the De
the Euphrates as an example of a tribe just in pro
becoming agricultural. In the northern parts of
tamia there are a number of tribes of mingled Kur
Arabs which have to a greater or less degree aba
their tents for fixed habitations and the tillage
ground; such are the Beruziye near Orfa, the
between Orfa and Mardin, and the Kiljye nearer
and also in the neighbourhood of Mosul. It is ex
hard to obtain trustworthy statistical information
the number of the Bedouins, the Shammar may
total strength of some 3500 tents. In the difficult
which it has to carry on with those independent
tribes, the Turkish Government acts in general
principle *divide et impera*.

The Kurdish element only appears sporadically
rue Mesopotamian plain; but the Yezidis, who
population of the Sinjar range, may be referred
stock. He who encounters the uncanny figure of
these people will hardly be able to restrain a slight
especially if he remembers the graphic description
Yezidi robbers in Morier's *Ayesha*. Of the old
peasantry there are no longer any important remain
plain, the Aramaeans having withdrawn farther i
Kurdish highlands, where, in spite of their wild
neighbours, they are more secure from exactions
kind. The plain of the northern country of the two
was at one time richly cultivated, and owed its pr
to this industrious people, who formerly played
guished a part as a connecting link between the
and the Roman empire and afterwards between the
and the Arabian world, and whose highest cultu
developed in this very region. Quite otherwise is
In the plain there are almost no remains of the
Aramaean tongue. Apart from the scattered areas i
Kurdish prevails, the ordinary language is a vulgar
dialect; but both Kurdish and Aramaean (Syria
exercised an influence on the speech of the Arab
Finally it must be mentioned that certain Turcoman
roam about the Mesopotamian territory.

In climate and in the character of its soil, as well as in
graphic history, Mesopotamia holds an intermediate po
this aspect also we must maintain the division into two qui
zones. The southern half consists mainly of grey, cha
covered with selenite, and gypsum everywhere makes its ap
a little below the surface. Bitumen is not infrequent and
there it rises in petroleum wells. In the solid strata of gyp
marl the rivers have carved out valleys, from a quarter to ha
broad and from 40 to 50 or even 100 feet deep, which with the
soil contrast with the barren surface of the more elevate
(*chól*). Especially below Balis there are marl-hills capp
gypsum, and alluvial plains so called *hauran* of considerabl

n formed The banks of the rivers are there lined with a
t growth of tamarisk Occasional swamps and marl
pecul ; and the marl shows a more or less marked efflore-
salt In this part of the country frost is rare even in
n summer the heat is of extraordinary intensity, and
he whole season, from May to the close of October it is but
modified by the night dews During the sand storms
equently blow from the West Arabian desert, the tempera
rise to 50° C (122° Fahr), and this same excess of heat will
vail through several degrees of latitude in the whole valley of
hrates and Tigris from the Persian Gulf to the foot of the
ns For, considering the strong radiation which takes
er what is now the uniform surface of the Mesopotamian
its almost complete absence of evaporation, there is
to hinder the warm zone extending in summer to the
ll of the country In winter, on the other hand, this latter
s quite a different climate From the cold coasts of the
n mean the cold increases from west to east In the spring
ourse consequently the winter cold extends far to the south,
moisture of the snow-covered ridges spreads far into the
ancan plain Snow and ice are thus not unfrequent in the
part of the plain, and the temperature may fall as low as
(4° Fahr) especially if the cold north winds are blowing
Land is soon to the east cut off from the influence of the mild an
Mediterranean by the coast ranges For this reason the
ter is of a less southern character than that of the Mediter
ean in the same latitude In the spring the green
ation dies out of existence In this way the northern district
peculiar contrast, and is a connecting link
the mountain region of western Asia and the desert of
On the other hand the country to the south of Mesopotamia
has a warm climate, and toward the Persian Gulf indeed
reaches the great extreme

per Mesopotamia, strictly so called, agriculture has suffered
orderly decline; in spite of excellent soil, very little of the
turned to account In the western district the fertile red-
mounts of the Orfa plain, derived from the lime of Nimrud
stands to about 37° N. south of Harran With a greater
and an artificial distribution of the water such as existed
times, agriculture would flourish If spring rains are only
rly abundant, wheat and barley grow to a great height,
from thirty to forty fold Rice is also grown in the richly
ll-watered district of Sering and on the banks of the

Next, millet and sesamum are the chief crops, the
er grown for the sake of its oil as the olive does not
much in region The abundance of wheat may be estimated
the fact that during Layard's residence in Mosul a camel load
s worth four shillings Durra (*Holcus Sorghum* and
, lentil, pease, beans, and vetches are also grown, as well
, allseed, tobacco, and tobacco *Nicotiana suaveol* furnishes
hot-es Among the fruits the most noteworthy are the
, melons, and water melons planted in great abundance
bank of the rivers in June The figs of the Sinjar
re celebrated for their exceptional sweetness Timber
low, plane trees and white poplars are planted along
and thicket of willow and sumach flourish on the
the Euphrates The palm-trees which appear on the
beside the river further south do not come so far north
out of the hot dry summer the orange does not succeed
ter but which existed (Great Nisibis in the time of
no trees remains, but the slopes both of the Masius
ns and of the Jebel Abdel-Aziz, as well as, more especi-
of the Sinjar range are still covered with wood.

ost characteristic of the low country of Mesopotamia are
with the steppe vegetation which prevail from Central
Mesopotamia that there is an absence of a great many of the
nt plants that grow in the richer and more irregular
of western Asia and especially of Persia. This comparative
and monotony of the flora is partly due to the surface being
composed of detritus, and partly to the cultivation of the
in remote antiquity having routed the original vegetation
behind it what is to-day only fallow ground untouched for
ds of years. Endless masses of tall weeds belonging to a few
over the face of the country large *Carduus*, *Cnicus*, and
disputing the possession of the soil in company with
mery quantities of liquorice (*Glycyrrhiza glabra* and
as well as *Lactuca* and the white cups of the *Imperata*.
m the withered weeds are torn up by the wind and driven
distances Among the aromatic plants, which even
n mentions in Mesopotamia, the first place belongs to the
wormwood (*Artemisia*), which cover wide areas, and the
Labiatæ such as species of thyme and *Satureia*, which, how-
ome rarer in the low country. With few exceptions there
but cultivated trees, and these are confined to the irrigated
on the Euphrates and the Shatt; a few willows, a *Populus*
s a *Rhus*, a *Rubus*, on the banks of the rivers, and the
ke *Populus euphratica*, which grows from Dzungaria to
Morocco, make up the list of the indigenous kinds. In t
belt of swamp which lines the Shatt el-'Arab in the low co
'Irák 'Arabi there are boundless reaches of gigantic sedge n
by a rich fauna, especially of birds such as pelicans and fla
From the south, or in other words from the true desert a
country of Arabia, the date-palm spreads up the valley
little distance above Baghdad; and especially along the
yields rich crops of fruit, which are exported to India. W
exception of a few truffles, capers, liquorice, and such like, t
few wild food-plants The cycle of vegetation begins in No
The first winter rains clothe the plain with verdure, and
beginning of the year a number of bulbous plants are in
Amaryllida, *Liliaceæ*, and *Colchicum*. The full summer
ment is reached in June; and by the end of August every
burnt up

The lion is said to roam as far as the Khábúr; but in an
is at least much less frequent than in the time of the A
when the lion hunt was a recognized form of sport. The
too is very rare; but on the other hand wild swine, hyænas,
cheetahs, and foxes are extremely abundant Wolves are
exist in the plain, and among others a variety of black wol
Lupaster) Particularly numerous in the steppe are the
species, and herds of gazelles are frequently met with Be
said to have been observed on the Euphrates. Jerboas, mo
cupines, and especially the common European rat, abound
desert, bats are numerous; and the long-haired desert ha
found. Among the domestic animals in this steppe com
camel holds the first place; and next come goats and sheep
Bedouin sheep not the ordinary fat-tailed variety. The
buffalo is often kept by the Arabs and Turcomans on the E
and the Tigris; and on the Euphrates we also find the Indi
which is still more frequent in the districts farther to th
Bird-life is very rare in the southern parts of the plain;
on the Euphrates there are vultures, owls, ravens, &c., as
falcons (*Tinnunculus alaudarius*) which are trained t
Among game-birds are some kinds of doves, francolin
ridges, wild ducks and geese, and in the steppe bustard
ostrich seems almost to have disappeared Large tort
numerous.

In conclusion it is necessary in supplement to the artic
to say something of the district of Babylonia, often (though
included under the name Mesopotamia. Here we have to
a fundamentally different region, for it consists in the
alluvial formations, a few scattered reaches of sand only
then appearing in the level depression not filled up by the a
The mass of solid matter which the rivers bring down and
is very considerable; it has been ascertained that the m
proportion for the Euphrates in the month of January is
at other times $\frac{1}{300}$; for the Tigris the maximum is
regard the physical character of the alluvia, in the most n
portion the soil is pebbly, the pebbles consisting almost
variously coloured flints and occasional small fragments of
This is succeeded by a continuous formation of clayey soil
argillaceous and argillo-calcareous, but covered with mo
sand, or the more tenacious clay of frequent inundations.

In general, the northern plains of the interior have
but well defined southerly inclination with local depression
territory undulates in the central districts, and then sinks a
mere marshes and lakes. The clay, of a deep blue colour,
with marine shells, and shows a strong efflorescence of na
sea-salt, the latter derived from the decomposition of v
matter When the soil is parched up the appearance
mirage (serab) is very common As extensive munda
spring are caused by both the rivers, especially the Tigr
alterations must have taken place in this part of the
in the course of thousands of years. It has been asserted
former times the alluvial area at the mouth of the river
one mile in the space of thirty years; and from this it
assumed that about the 6th century B.C. the Persian G
have stretched from 15 to 55 miles farther inland than at
The actual rate of increase at the present time is about 72
annum. For this reason we cannot decide much in regar
former physical configuration of southern Babylonia, but it i
certain that the Euphrates and the Tigris reached the sea
pendent rivers. Ritter estimates that in the time of Alexa
Great the embouchures were still separated by a good day's j
and, though they cannot now be traced, great alteratio
probably taken place in the upper portions of the rivers a
in the country near the mouths. Assyriologists tell us th
than thirty-five canals are known by name from the Bab
period; but it is extremely difficult, or rather it has proved
impossible, to identify them either with those actually ex
with those mentioned in classical authors, in the Bab
Talmud, or in Arabian writers. To the west of the Euphr
to be found the Pallacopas channel, and we still have the
channel in the same quarter. The country between the rive
particularly was traversed by such secondary branches. Be

Euphrates we must mention the Saklawiye channel (Nahr Nahr Melik, the Nahr Zemberániye, and especially the -Nil, structed by the famous Omayyad

Eastwards from the Tigris strikes the great Nahrawan ; and right through the country of the two rivers runs tt el Hai from Kut-el-'Amára, almost due south to the ís, parallel with the Shatt-el-Kehi Many of these have ted up; from those, however, which are still maintained derived a considerable revenue, and by the restoration y of the old channels, traces of which are met with at ep, the country might be again raised to that condition civilization which it enjoyed not only in antiquity but ven in the time of the later caliphs. The classical writers mmons in their admiration of this country, and it is at tain that nowhere else in the whole world was the principle pplication of canals to the exigencies of agriculture worked successfully. The most luxuriant vegetation was diffused whole country; and three crops were obtainable in the t is this alone which makes it intelligible how this region most remote antiquity attained a high civilization, and for s played, it may be said, one of the principal parts in the of the world In the matter of civilization, indeed, no of the ancient world was its equal, a multitude of great ace flourished within its borders. Even the Arabic writers mmons in regard to the extremely favourable influence he character of the country exercised on the intellectual , spirit, and capacity of its inhabitants. We need not the question recently started as to whether the Biblical of Eden is to be sought in this locality, two canals of the tes and Tigris being identified with the Gihon and Pison of ; but it is certain at least that this lower country of the rs might well pass in antiquity for the *ne plus ultra* of ion, and exercised the most powerful political and int influence on the surrounding regions. The question often s to whether the Semites were derived this district o be left unto Bible we know that name of the district was Shinar, though this has not been discovered in the cuneiform inscriptions. The name applied in the Bible to its oldest non-Semitic inhabitants. thern half of the country was called Akkad, the southern But it must not be forgotten that the rivers never formed aphic and political boundaries, and thus Sumer extended ast of the Persian Gulf and Akkad as far as the Lower Zab, ern affluent of the Tigris

whole country may be termed *mat Kaldu*, the country of ldeans (Hebr., *eres Kasdim*); originally Kalda is said to signated central Babylonia. Of still later date is the name from the capital, the country of Babel (*eres Babel*), as an nt of which *mat Bábilu* appears in the cuneiform inscriptions Darius lists *Babirus*. From this was developed the Greek tion Babylonia, Βαβυλωνία (as early as Xenophon). That this was densely peopled may be gathered from the fact that about eighty-nine fortified towns and eight hundred and twenty places in the Chaldean country were captured during one expedition. Of separate districts of the country we may Kardumiash, the district in the vicinity and especially to the f Babylon; and southward by the coast the important of Bít Yakín, governed by kings of its own. At a later date on the coast and at the mouth of the Pallacopas canal the e town of Teredon, which is also mentioned by the classical Besides Babylon and Borsippa, the larger cities were the ity of Sippar (Sefarvayim, 2 Kings xvii. 24, 31) and Akkad eft bank of the Euphrates on the present Nahr 'Isa; Erech, arka, on the left bank of the Euphrates, Ur on the Pallacopas not far from the place where the Shatt el Hai falls into the Nippur, *i.e.*, Tell Niffer; Kutha (2 Kings xvii. 24). Kalneh . 10°, in the north, Opis at the junction of the Adhem ss) with the Tigris Huge mounds give evidence of the of these cities. A number of the canals were navigable, the same time, when the bridges were destroyed, they defensive moats against the incursion of enemies from the And the same purpose was served by the great wall (after he Median Wall of the Greeks) which ran across the country ver to river between the points of their nearest approach.

ng the period of Greek domination a Greek city Seleneia, afterwards attained great prosperity, was founded by s I. in an extremely favourable situation on the right bank Tigris. In the south of the country, too, there was a Greek town first called Alexandria on the Tigris and afterwards ia. After the conquest of Babylonia by the Parthians) a small Arabian kingdom grew up in those parts called ene or Mesene, after the town of Charax or Meisan. It was Parthian and for a time under Roman supremacy. The city gesia, founded by Vologeses to the south-west of Babylon, lais, in the neighbourhood of the later Kúfa, was one of the s of the Parthian power. In the time of the Sasanids, too, l as in that of the Parthians, the country of the lower Euphrates and Tigris played a leading part, it formed in f main centre of the Persian kingdom. The city of Cte founded by the Greeks on the east side of the Tigris c Seleucia, was the winter residence of the Parthian kings, a imperial capital of the Sasanids. Under the name of (The Cities) it continued to flourish till the rise of Baghdad 9th century. The neighbourhood of Ctesiphon was called time of the Sasanids Surestan, a translation of the Aramaic nation Beth-Arámaye, "country of the Syrians," for the l mainly occupied by Aramaeans. By a notable substitut Arabs afterwards gave the name Nabat *i.e.*, Nabataeans, t Aramaean peasantry, who, it may be added, were already fo the e parts at the time of the Babylonian empire.

On the west side of the Tigris the Arab kingdom of Hira the bulwark of the Sasanid power. At the result mainly battle of Kadisiya (east of Hira) in 635 A.D., the whole wealthy country fell into the hands of the Moslems, and it stituted the centre of their power, especially when the Ab with true political insight, transferred thither the capital npire and founded Baghdad. The chief cities of the older period were Kuta on the neighbourhood of the earlier Hi south of an ient Babylon) and Basra (or Bassorah, *q.v.*) neighbourhood of the earlier Mesan. After these two c country was divided into the Sawad, "rich arable distri Basra and that of Kufa. Sawad was also employed as a n the whole country al me less identical with this 'Irak still means. Sometimes also the term el 'Irak is employed but at a later date the country is distin as 'Irak 'Arabi (Arabian Irak) from the Persian 'Irák Ajem erst the ancient Media. The Arabian geographer Yakút ma distinction that the country called Sawad reaches farther north (viz., to the district of the Upper Zab.

Abulfeda gives the boundaries of Irak as ows "In t of the country lie El-Jezira and the desert, in the south the the Persian Gulf, and Khuzistan in the east the mountain Holwan (the principal pass through the range). The the boundary runs again towards Mesop Thus the gr breadth of 'Irak is in the north, and it extremity is formed by the island Abbadan in the Shatt (the united Euphrates and Tigris) to the south of Basra." what has been said it appears that 'Irak extended far bey country between Euphrates and Ti Abulfeda says elsew 'Irak lies on the Tigris as Egypt on Nile; for according of the country consequently lies between 30° and 34° 30' N. lat. and betw and 48° 30' E. long., of its area it is impossible to fo under such varying conditi ne details see BAGH

From the union of the rivers upwards, in the case of the Eu as far as 26° N. lat. (above Rakka), in that of the Tigris to lat., the valleys are known as el-Ghór, the depression, in oppo the more elevated desert plateau. It has been surmised that name is to be recognized the Dúra of the Old Testament (Dan. iii. 1).

Very fr the ancient ition of the country has b served; and there are now but few remains of ancient bu scarcity of stone having all alo d to the use of brick has played its part. It is only by xpenditu sums, far beyond the financial capacity of the Turkish nent, that the ancient canals could be restored and the formed by them drained. The whole land falls into two portions, an extensive dry steppe with at any rate a desert climate, and an unhealthy region of swamps. Th good deal more agriculture along the Euphrates than al Tigris, but swamps, with almost impenetrable reed thick pered of a kind of *Typha*, are at the same time much mo ive. The slightly more elevated districts are the special of the date palm, which by itself forms dense groves borde banks particularly on the lower Euphrates, for a distance days' journey. This part of the country consequently has what monotonous but in own way imposing aspect riant vegetation of water-plants is to be found in the which are the haunt of numerous wild beasts, wild swin different kinds of aquatic animals and birds. The swa inhabited by a wild race of men, dark of hue, with many amongst them. They live in reed huts, and cultivate they weave straw mats. In the main they keep pretty fre the Turkish Government and of the semi-Bedouins and Be 'Irak. The Khazael especially who dwell to the south of Babylon often give the Government trouble, through their for independence. Less turbulent are the Bedouins in the of the country the Zobeid, the Aturi, and the Abu Muhamm on the other hand the Beni Lam (7500 tents strong, who oc great tract of country east of the Tigris to the south of B have often been a source of great annoyance to the pashas city. A still more difficult task is the management of th mar, who come and pitch their tents to the south-east of B and also the Muntefik on the southern Euphrates put the w

tive and diplomatic skill of the Turkish officials to the test. kish influence has here made at one time great advance nother lost all the ground it had gained, the rich and sheikhs of the Muntefiteh sometimes become for a season er the whole of Southern 'Irák and even over the town of The present writer once visited the great sheikh Nasir in near Súk esh-Shuyúkh; and he received the impression g to do with a very remarkable and astute personage old Syrian population of 'Irak has almost entirely dis- d; the few remnants left are distinguished by a special in regard to which see the article MANDÆANS. Ethno- lly the country is subject to a double influence. On the d the connexion with Nejd the central plateau of Arabia, s uninterrupted; the emigration from that region being directed towards 'Irak and decreases. In Baghdad en, the dozens from Central Arabia have a quarter of their own. he earnings obtained in the rich districts the emigrants o their homes. But quite as strong at least is the influ Persia. Persian customs are in fashion; in Baghdad an important Persian quarter, and Kerbela and Meshed the west of the Euphrates may be considered regular "enclaves." In these places are buried the son-in-law of med, the caliph Ali and his son Hosein (in Kerbela), the nts of the Shiite sect, and their tombs are not only shrines mage to the living, but the dead are brought by countless from Persia to be buried in ground which they have made The neighbourhood of Kerbela reeks with the odour of and from the midst of them pestilence has often begun its The whole of Irak the Shiites have many ad- for example, the Khazel already mentioned. Persian e prevail on the Arab population of 'Irak, and the inter g of the races can still be very clearly traced; in this dis- ct of the Turkish empire a more international tone prevails any other district. And, however small when compared rmer times the commercial and intellectual intercourse of nations in these regions may be at the present day, the observer must note that such intercourse does still though within restricted limits. No trace, indeed, is to be d that rich intellectual development which was produced in the caliphs through the reciprocal action of Persian dic elements. Still the quickwittedness of the inhabitants makes a decided impression on the traveller passing through Turkey; and one might venture to prophesy that the might to some extent recover its former position in the especially if English influence from India were more widely d, and should lead to the construction of a railway. The hich passes through 'Irak is even now not unimportant; ample are exported in saleable numbers from n 'Irák to India. But it might be very much improved, as ntry, it is said, could support five hundred times as many ants as it actually contains. There is also a considerable of dates, a fruit which forms the chief sustenance of a great of the inhabitants; and the breeding of cattle (especially ep) is extensively carried on. Only a few steamboats as yet e the Euphrates river. Communication by water is carried n rafts or the most primitive craft. Goods are transported so-called "terradies," moderately big high built vessels, also venture out into the Persian Gulf as far as Kuwet. ers are conveyed, especially on the Euphrates, in the , a very long and narrow boat, mostly pushed along the ank with poles. The Mesopotamian "kelleks" rafts laid kins to, later come down as far as Baghdad, where round made of plaited reeds pitched with asphalt are in use. At on the other hand, we see the "belem," boats of a large ving the appearance of being hollowed out of tree trunks, ally not so constructed. Throughout 'Irák in general influence is partially at work; in the hot summer months, tance, when the native lives in underground apartments), the Indian punkah is used in the houses of the rich. A language, the local Arabic dialect has evidently been on the one hand by Persian, on the other by the Bedouin t speech.

ture. *Die Euphrat- und Tigris-Länder* (Leipsic, 2nd ed. vol. i., 10th and 11th parts, Berlin, 4; Chesney, *Expedition to Survey the Rivers Euphrates and Tigris*, London, 1850; W. Ainsworth, *Researches in Assyria, Babylonia, and* London, 1838; F. Delitzsch, *Wo lag das Paradies?* Leipsic, 1881. Map: *Die Euphrat- und Tigris-Länder*, Berlin, 1881. (A. SO.)

SSENE, the chief city of Messenia, founded, under spices of Epaminondas, as a bulwark against the ns. After the battle of Leuctra that general sent the exiled Messenians, in Africa, Sicily, or Italy, ited them to return to the land of their fathers. came with eagerness, and in 369 B.C. the city was y the combined army of Thebans under Epaminondas rgives under Epitelès, assisted by the Messenians themselves. The site was chosen in conformity v vision which appeared to Epaminondas, and the were raised to the sound of flutes playing the a Sacadas and Pronomus. The citadel was erect the summit of Mount Ithome, and the city on its sou slope and in the adjoining valley. City and citade enclosed by a wall 47 stadia in length. Near the of the city was the agora, with a famous spring Arsinoe, and various temples and statues, among the an iron statue of Epaminondas. The Hierothysio tained many statues of gods and heroes, among t bronze statue of Epaminondas. In the gymnasium statues of Hermes, Hercules, and Theseus by Eg artists. In the stadium was a bronze statue of the hero Aristomenes, who had a sepulchral monumen where in the city. On the summit of the citadel famous spring called Clepsydra, and near it a tem Zeus Ithomatas, with a statue by the famous Argive Ageladas, executed originally for the Messenian who settled in Naupactus (see MESSENIA). It v honour of this statue that the festival of the Ithoma performed.

The situation of Messene is one of the finest and romantic in the world. The view of Mount Ithome its level summit and its ancient and mediæval ru one issues from the Langadha Pass in the Ta mountains, is beautiful beyond description. An view from the summit of the mountain itself, which steep and rugged, to the height of 2631 feet, a crowned by the ruins of fortifications of Cyclopean manship, is enchanting, hardly equalled by any o Greece. Near the middle of the ruins of the low stands a wretched village named Mavrommati (Black so called from the Turkish name of the spring A which still flows as plentifully as in the old days. ruins are the most imposing in Greece, and furni finest existing specimen of Hellenic military archit Almost the entire circuit of the ancient walls can be and in some places they are standing to their full They are built of large hewn stones laid in beau regular layers without mortar, and are surmoun towers, of which there seem to have been original thirty. Seven of these are still in a good state of vation, and bear testimony to the thoroughness of th enterprise undertaken by Epaminondas. Two gat still be distinguished, one on the slope of Mount I the other (the northern or Megalopolis gate) on the side. The latter is a dipylon or double gate, openi a circular enclosure 62 feet in diameter. The w this enclosure are built with extreme care, and th stone of the inner portal, which has been partly from its place, reminds one of the lintel of the s treasury of Atreus at Mycenæ. It is 18 ft. 8 in. × in. × 2 ft. 10 in. Within the town several ancien can still be distinguished—the stadium, the theatr several temples.

MESSENIA (in Homer Messene), a state of Gree the most westerly of the three peninsulas of the P nesus. Its area is a little over 1160 square miles. separated from Elis and Arcadia on the north by th Neda and the Nonian mountains, and from Laconia east by the lofty range of Taygetus. The other si washed by the sea, which indents its shores with fou or bays. Messenia, Phœnicus, Pylus, and Cyparissu its south west corner are the Œmussæ Islands, an site the bay of Pylus (Navarino) the famous Sph The interior is divided by mountain chains into plains, watered by rivers, the chief of which is the P (with its tributaries Leucasia, Charadrus, Amphit Aris), falling into the Messenian Gulf. The great

river is divided, near Mount Ithome, into two parts, the plain or basin of Stenyclarus on the and the plain of Macaria, so called from its extreme , on the south. The climate is delightful.

earliest inhabitants of Messenia were Leleges, whose was at Andania. After these came Ætolians, whose entre was at Pylus. After the Dorian conquest the was divided by Cresphontes into five parts, whose ities were respectively Stenyclarus, Pylus, Rhion, , and Mesola. The towns of Messenia were not ns. Homer mentions Pylus (the seat of the ian Neleids), Amphigeneia (possibly the same as ia), Dorion, Æpeia (possibly Methone), Œchalia, Antheia (probably the later Thuria), Pedasus, and later Abia). Other important towns were Asine, Limnæ, Carnasium, Cyparissia, and, finally, e.

history of Messenia before the Dorian invasion little is except a few fables related by Pausanias. Two generations Trojan war, the country was invaded by the Dorians, who the Neleids and conferred the sovereignty upon Cresphontes, ns to have been a popular king. Perhaps for this reason put to death by the chiefs along with all his sons except Æpytus was restored to the throne by the Arcadians. ngeance for his father's death, and became very popular. lasted through several generations. We know little of the ent history of Messenia until the date of the Messenian wars, gainst Sparta. The ostensible and immediate causes of these variously assigned: but the true cause was the cupidity of Our chief trustworthy authority for the history of them l elegiac poet Tyrtæus; but so little is known about them is a matter of doubt in which of them the great hero enes won his fame. The date of the first was from 743 to the second from 685 to 668 or, according to others, from 31 B.C. Ithome was the centre of action in the first, Eira econd. The result of these wars was the complete subjugaMessenia to Sparta. Its territory was parcelled out among , and its towns handed over to Penæci and Helots. Many habitants took refuge in Arcadia, but still more in Italy ly. A very large number settled in Rhegium, whose chiefs y generations were of Messenian stock. About 200,000 behind in bondage. After the second war a large number nians settled on the Sicilian coast at Zancle, to which they ntly gave the name Messana (see MESSINA). In 464 B.C. senian Helots, taking advantage of an earthquake at Sparta, and, though they were finally compelled to surrender in y did so only on condition of being allowed to retire to ns on the Corinthian Gulf. This city had been offered them idence by the Athenians, ever glad to favour the foes of Here the Messenians remained for sixty years, until the he battle of Ægospotami deprived them of the protection of enians. They were then driven out, and had to find homes allenia and Zacynthus, or among their kinsmen in Rhegium sana. Some even went to Africa, and took up their abode peride or Hesperidæ, afterwards called Berenice. Things l in this condition until 369 B.C., when Epaminondas, roken the power of Sparta, rent from her Messenia, and, g from all quarters the descendants of the exiled inhabitelped them to found the city of MESSENE (*q.v.*). Sparta ve up her claim to Messenia, and made many attempts to r it, but without success. The Messenians maintained dependence until 146 B.C., when, with the Achæans, they duced under the power of Rome. From that time they fall background of history. In the Middle Ages the country, rest of the Peloponnesus, was largely overrun by Slavic s is shown by the numerous Slavic local names occurring in the establishment of Greece as a kingdom, Messenia was ted into a province, with a governor or nomarch residing at ta (officially Kalamai), the ancient Pharæ. The country, beautiful and fertile, is still in a deplorably backward conand the population is sparse and semi barbarous. Agriculguishes, and the roads and bridges are few and bad. More violence occur in Messenia than in any other part of Greece. e exception of Kalamata, it contains no town of importance. o, on the Gulf of Pylus, was the scene of the destruction of kish fleet in 1827.

SSIAH (Dan. x. 25, 26), MESSIAS (John i. 41;), are transcriptions (the first form modified by ee to the etymology) of the Greek Μεσσίας s, Μεσείας), which in turn represents the Aramaic (*mĕshîḥâ*), answering to the Hebrew מָשִׁיחַ, "the anointed."[1] The Hebrew word with the article occurs in the Old Testament only in the phrase anointed priest" (Lev. iv. 3, 5, 16; vi. 22 [15]), "Jehovah's anointed" is a common title of the kin Israel, applied in the historical books to Saul and D in Lam. iv. 20 to Zedekiah, and in Isa. xlv. 1 exte to Cyrus. In the Psalms corresponding phrases (My, His anointed)[2] occur nine times, to which may be a the lyrical passages 1 Sam. ii. 10, Hab. iii. 13. I intention of the writers of these hymns there can gene be no doubt that it refers to the king then on the th or, in hymns of more general and timeless characte the Davidic king as such (without personal referen one king);[3] but in the Psalms the ideal aspect o kingship, its religious importance as the expression organ of Jehovah's sovereignty, is prominent. Whe Psalter became a liturgical book the historical kin had gone by, and the idea alone remained, no longer a interpretation of a present political fact, but as pa Israel's religious inheritance. It was impossible, how to think that a true idea had become obsolete n because it found no expression on earth for the time b Israel looked again for an anointed king to whom words of the sacred hymns should apply with a force realized in the imperfect kingship of the past. Th psalms, especially such psalms as the second, were sarily viewed as prophetic; and meantime, in accor with the common Hebrew representation of ideal thin existing in heaven, the true king remains hidden with The steps by which this result was reached must, hov be considered in detail.

The hope of the advent of an ideal king was onl feature of that larger hope of the salvation of Israel fr evils, the realization of perfect reconciliation with Jeh and the felicity of the righteous in Him, in a new or things free from the assaults of hostile nations an troubling of the wicked within the Hebrew comm which was constantly held forth by all the prophets, the time when the great seers of the 8th century B.C proclaimed that the true conception of Jehovah's re to His people was altogether different from wha realized, or even aimed at, by the recognized civ religious leaders of the two Hebrew kingdoms, and t could become a practical reality only through a deliverance following a sifting judgment of the terrible kind. The idea of a judgment so severe render possible an entire breach with the guilty pas of a subsequent complete realization of Jehovah's kin in a regenerate nation, is common to all the prophet is expressed in a great variety of forms and images ditioned by the present situation and needs of Israel time when each prophet spoke. As a rule the pr directly connect the final restoration with the remo the sins of their own age, and with the accomplishm such a work of judgment as lies within their own ho to Isaiah the last troubles are those of Assyrian inv to Jeremiah the restoration follows on the exile to Ba Daniel connects the future glory with the overthrow Greek monarchy. The details of the prophetic pi show a corresponding variation; but all agree in givi central place to the realization of a real effective kin of Jehovah; in fact the conception of the religious s

[1] The transcription is as in Θεσσαύρ, Θεσσίρ for נִשְׁר, *Onom* ed. Lag., pp. 217, 281, Βασ. β ii. 3. For the termination חא, see Lagarde, *Psalt. Memphit.*, p. VII.

[2] The plural is found in Psalm cv. 15, of the patriarchs as ated persons.

[3] In Ps. lxxxiv. 9 [10] it is disputed whether the anointed the king, the priest, or the nation as a whole. The second perhaps the best.

nation of Israel, with a national organization under
h as king, is common to the whole Old Testament,
rms the bond that connects prophecy proper with
called Messianic psalms and similar passages which
gians call typical, *e.g.*, with such passages as speak
religious relations of the Hebrew commonwealth,
ligious meaning of national institutions, and so
arily contain ideal elements reaching beyond the
al present. All such passages are frequently called
nic; but the term is more properly reserved as
cific designation of one particular branch of the
w hope of salvation, which becoming prominent in
nomeal Judaism, used the name of the Messiah as
nical term (which it never is in the Old Testament),
ercised a great influence on New Testament thought,
term "the Christ" (ὁ Χριστός) being itself nothing
than the translation of "the Messiah."

he period of the Hebrew monarchy the thought that
h is the divine king of Israel was associated with the
tion that the human king reigns by right only if he
by commission or "unction" from Him. Such was
ory of the kingship in Ephraim as well as in Judah
xxxiii.; 2 Kings ix. 6), till in the decadence of the
n state Amos (ix. 11) foretold the redintegration of
vidic kingdom, and Hosea (iii. 5; viii. 4) expressly
ted as similar prediction with the condemnation of the
p of Ephraim as illegitimate. So the great Judæan
t of the 8th century connect the salvation of Israel
e rise of a Davidic king, full of Jehovah's Spirit, in
all the energies of Jehovah's transcendental kingship
t were incarnate (Isa. ix. 6 *sq.*; xi. 1 *sq.*; Micah v.).
conception, however, is not one of the constant
s of prophecy, indeed the later prophecies of Isaiah
different hope, looking for the decisive interposition
hovah in the crisis of history without the instru-
lity of a kingly deliverer. Jeremiah again speaks
future David or righteous sprout of David's stem
5 *sq.*; xxx. 9); and Ezekiel uses similar language
., xxxvii.), but that such passages do not necessarily
more than that the Davidic dynasty shall be con-
in the time of restoration under a series of worthy
s seems clear from the way in which Ezekiel speaks
prince in chaps. xlv., xlvi. As yet we have no fixed
e of a personal Messiah, but only material from
such a doctrine might by and by be drawn. The
is view of the kingship is still essentially the same
2 Sam. vii., where the endless duration of the Davidic
y is set forth as part of Jehovah's plan of grace to
ation

re are other parts of the Old Testament - notably
viii., xii. - in which the very existence of a human
ip is represented as a departure from the ideal of a
t theocracy. And so, in and after the exile, when
narchy had come to an end, we find pictures of the
days in which its restoration has no place. Such is
eat prophecy of Isa. xl. lxvi., in which Cyrus is the
ol of Jehovah, and the grace promised to David is
rred to ideal Israel ("the servant of Jehovah") as a
(Isa. lv. 3). So too there is no allusion to a human
ip in Joel or in Malachi, the old forms of the
w state were broken, and religious hopes expressed
lves in other shape.[1] In the book of Daniel it is
ive Israel that appears under the symbol of a "son
n," and receives the kingdom (vii. 13, 18, 22, 27).
ntime, however, the decay and ultimate silence of the
prophetic word concurred with the prolonged
al servitude of the nation to produce a most
important change in the type of the Hebrew re
The prophets had never sought to add to the re
unity of their teaching unity in the pictorial fo
which from time to time they depicted the final ju
and future glory. For this there was a religious
To them the kingship of Jehovah was not a mer
but an actual reality. Its full manifestation indeed
eye of sense and to the unbelieving world, lay
future; but true faith found a present stay
sovereignty of Jehovah, daily exhibited in provide
interpreted to each generation by the voice of the pr
And, while Jehovah's kingship was a living and prese
it refused to be formulated in fixed invariable shape
when the prophets ceased and their place was taken
scribes, the interpreters of the written word, when
same time the yoke of foreign oppressors rested cont
on the land, Israel no longer felt itself a living natio
Jehovah's kingship, which presupposed a living
found not even the most inadequate expression i
political life. Jehovah was still the lawgiver of Isra
His law was written in a book, and He was not pre
administer it. He was still the hope of Israel,
hope was all dissevered from the present; it too wa
read in books, and these were interpreted of a
which was no longer, as it had been to the pr
the ideal development of forces already at work in
but wholly new and supernatural. The present
blank, in which religious duty was summed up in
obedience to the law and penitent submission to the
chastisements; the living realities of divine grac
but memories of the past, or visions of "the w
come." The scribes, who in this period took the
the prophets as the leaders of religious thought
mainly busied with the law; but no religion can sub
mere law; and the systematization of the prophetic
and of those more ideal parts of the other sacred lit
which, because ideal and dissevered from the preser
now set on one line with the prophecies, went on
side with the systematization of the law, by mea
harmonistic exegesis, which sought to gather up
prophetic image in one grand panorama of the is
Israel's and the world's history. The beginnings
process can probably be traced within the canon i
the book of Joel and the last chapters of Zechariah
if this be so, we see from Zech. ix. that the picture
ideal king early claimed a place in such constr
The full development of the method belongs, how
the post canonical literature, and was naturally mu
regular and rapid than the growth of the legal tra
of the scribes. The attempt to form a schematic
tology left so much room for the play of individua
that its results could not quickly take fixed de
shape; and it did not appeal to all minds alike or
at all times. It was in crises of national anguish th
turned most eagerly to the prophecies, and sought
e their teachings as a promise of speedy deliver
such elaborate schemes of the incoming of the futu
as fill the APOCALYPTIC LITERATURE (*q.v.*). Bu
books, however influential, had no public authori
when the yoke of oppression was lightened but
their enthusiasm lost much of its contagious power
not therefore safe to measure the general gro
eschatological doctrine by the apocalyptic books, o
Daniel alone attained a canonical position.
Apocrypha eschatology has a very small place; bu
is enough to show that the hope of Israel was
forgotten, and that the imagery of the prophe

[1] hopes which Haggai and Zechariah connect with the name of
bel, a descendant of David, hardly form an exception to this
nt.

[2] See JOEL, vol. xiii. p. 706, and Stade's articles "Deuteroz
Z. f. A Tliche Wiss., 1881–82. Compare Dan. ix. 2 for the a
older prophecies in the solution of new problems of faith.

led that hope into certain fixed forms which were with a literalness not contemplated by the prophets elves. It was, however, only very gradually that gure and name of the Messiah acquired the pro- ce which they have in later Jewish doctrine of the nings and in the official exegesis of the Targums. In ery developed eschatology of Daniel they are, as we seen, altogether wanting, and in the Apocrypha, both e and after the Maccabee revival, the everlasting e of David's house is a mere historical reminiscence h xlvii. 11; 1 Mac. ii. 57). So long as the wars of endence worthily occupied the energies of the Pales- Jews, and the Hasmonæan sovereignty promised a re of independence and felicity under the law, in the people were ready to acquiesce, at least, till the a new prophet (1 Mac. xiv. 41), the hope that con itself with the house of David was not likely to rise sh life, especially as a considerable proportion of the ery numerous passages of Scripture which speak ideal king might with a little straining be applied rising star of the new dynasty (comp the language Mac. xiv. 4 15). It is only in Alexandria, where ews were still subject to the yoke of the Gentile, t this time (c. 140 B.C.) we find the oldest Sibylline (iii. 652 *sq.*) proclaiming the approach of the ous king whom God shall raise up from the East xli. 2) to establish peace on earth and inaugurate the gnity of the prophets in a regenerate world. The Messiah is still lacking, and the central point of the ecy is not the reign of the deliverer but the subjec f all nations to the law and the temple.[1]

h the growing weakness and corruption of the onæan princes, and the alienation of a large part of ation from their cause, the hope of a better kingship s to appear in Judæa also; at first darkly shadowed n the *Book of Enoch* (chap. xc.), where the white the future leader of God's herd after the deliverance the heathen, stands in a certain contrast to the in- ate sovereignty of the actual dynasty (the horned); and then much more clearly, and for the first time se of the name Messiah, in the *Psalter of Solomon*, ief document of the protest of Pharisaism against its es the later Hasmonæans. The struggle between the sees and Sadducees, between the party of the scribes he party of the Hasmonæan aristocracy, has been bed in ISRAEL (vol. xiii. p. 423 *sq.*). It was a gle for mastery between a secularized hierarchy on ne hand, to whom the theocracy was only a name, and whole interests were those of their own selfish politics, n the other hand a party to which God and the law all in all, and whose influence depended on the main re of the doctrine that the exact fulfilling of the law ding to the precepts of the scribes was the absorbing on of Israel. This doctrine had grown up in the al nullity of Judæa under Persian and Grecian rule, o government that possessed or aimed at political endence could possibly show constant deference to inutilities of the schoolmen. The Pharisees themselves not but see that their principles were politically ent; the most scrupulous observance of the Sabbath, ample—and this was the culminating point of legality ld not thrust back the arms of the heathen. Thus party of the scribes, when they came into conflict an active political power, which at the same time ed to represent the theocratic interests of Israel, were elled to lay fresh stress on the doctrine that the true erance of Israel must come from God and not from We have seen indeed that the legalism which accepted Jehovah as legislator, while admitting that his ex sovereignty as judge and captain of Israel was to t dormant, would from the first have been a self dest position without the complementary hope of a vindication of divine justice and mercy, when the Israel should return to reign over his people fo Before the Maccabee revival the spirit of national so dead that this hope lay in the background, the and devotional aspects of religion under the law h first place, and the monotony of political servitude ga occasion for the observation that a true nation requires a personal leader as well as a written law now the Jews were a nation once more, and nationa came to the front. In the Hasmonæan sovereignt ideas took a political form, and the result was the ization of the kingdom of God for the sake of a har rapacious aristocracy. The nation threw itself on t of the Pharisees; but it did so in no mere sp punctilious legalism, but with the ardour of a n enthusiasm deceived in its dearest hope, and turn help from the delusive kingship of the Hasmonæ the true kingship of Jehovah, and to His vicegere king of David's house. It is in this connexion th doctrine and name of the Messiah appear in the *of Solomon*. The eternal kingship of the house of so long forgotten, is seized on as the proof th Hasmonæans have no divine right.

"Thou, Lord, art our king for ever and ever. The choose David as king over Israel, and swarest unto him con his seed for ever that his kingship should never fail befo And for our sins sinners (the Hasmonæans) have risen up taking with force the kingdom which Thou didst not pro them, profaning the throne of David in their pride. But Lord, will cast them down and root out their seed from t when a man not of our race (Pompey) rises up against the Behold, O Lord, and raise up their king the Son of David at that Thou hast appointed, to reign over Israel Thy servant, him with strength to crush unjust rulers, to cleanse Je from the heathen that tread it under foot, to cast out sinn Thy inheritance, to break the pride of sinners and all their as potter's vessels with a rod of iron (Ps. ii. 9), to destroy less nations with the word of his mouth (Isa. xi. 4), to holy nation and lead them in righteousness. . . He ha them by tribes in the land, and no stranger and foreigner sh with them; he shall judge the nations in wisdom and righte The heathen nations shall serve under his yoke, he shal the Lord before all the earth, and cleanse Jerusalem in holi the beginning. From the ends of the earth all nations sh to see his glory and bring the weary sons of Zion as gifts 3 *sq.*): to see the glory of the Lord with which God hath him, for he is over them a righteous king taught of God days there shall be no unrighteousness in their midst, for all holy, and their king the anointed of the Lord (χριστὸς κύ translation of משיח יהוה). He shall not trust on his as and bowmen, nor heap up gold and silver for war, nor put dence in a multitude for the day of war. The Lord's king his hope. . . He is pure from sin to rule a great people, t governors and destroy sinners by his mighty word. In all he is free from offence against his God, for He hath m strong by the Holy Spirit. . . His hope is in the Lo can do aught against him. Strong in deeds and mighty in of the Lord, he feedeth the flock of the Lord in truth and r ness, and suffereth not one of them to stumble in the pas So it beseemeth the king of Israel whom God hath chose the house of Israel. . . God hasten His mercy on deliver them from the uncleanness of profane foes. The Lo king for ever and ever." *Psalt. Sol.* xvii.

This conception is traced in lines too firm to be th first essay; it had doubtless grown up as an integral the religious protest against the Hasmonæans. An the polemical motive is obvious, and the anonymous prophecy against the legitimacy of a non Davidic is quite in the manner of the scribes, the spirit of th fervour which inspires the picture of the Messiah is and deeper than their narrow legalism. In a wo Jewish doctrine of the Messiah marks the fu Pharisaism with the national religious feeling

[1] In *Sibyll.*, iii. 775, *νηόν* must undoubtedly be read for *υἱόν*.

e revival. It is this national feeling that, claim-
der against the Romans as well as deliverance
Sadducee aristocracy, again sets the idea of the
rather than that of resurrection and individual
on in the central place which it had lost since the
. Henceforward the doctrine of the Messiah is
the centre of popular hope and the object of
al culture. The New Testament is the best
of its influence on the masses (see especially Matt.
and the exegesis of the Targums, which in its
gs doubtless reaches back before the time of
hows how it was fostered by the Rabbins and
in the synagogues.[1] Its diffusion far beyond
, and in circles least accessible to such ideas, is
y the fact that Philo himself (*De Præm. et Pœn.*,
es a Messianic interpretation of Num. xxiv. 27
It must not indeed be supposed that the doctrine
t the undisputed part of Hebrew faith which it
hen the fall of the state and the antithesis to
nity threw all Jewish thought into the lines of the
. It has, for example, no place in the *Assumptio*
the *Book of Jubilees*. But, as the fatal struggle
ne became more and more imminent, the eschato-
opes which increasingly absorbed the Hebrew
group themselves round the person of the
In the later parts of the *Book of Enoch* (the
" of chaps. xlv. *sq.*) the judgment day of the
(identified with Daniel's "Son of Man") stands
retront of the eschatological picture. Josephus
5, § 4) testifies that the belief in the immediate
e of the Messianic king gave the chief impulse
ar that ended in the destruction of the Jewish
ter the fall of the temple the last apocalypses
4 *Ezra*) still loudly proclaim the near victory of
sent king; and Bar Cochebas, the leader of the
inst Hadrian, was actually greeted as the Messiah
Akiba (comp. Luke xxi. 8) These hopes were
nched in blood; the political idea of the Messiah,
er of the Jewish state, still finds utterance in the
ver of every Jew (the *Shemône Esre*), and is en-
the system of Rabbinical theology; but its his-
nificance was buried in the ruins of Jerusalem.[2]
e proof written in fire and blood on the fair face
ne that the true kingdom of God could not be
n the forms of an earthly state, and under the
s of national particularism, was not the final
of the hope of the Old Testament. Amidst the
ulsions of political Judaism a new and spiritual
n of the kingdom of God, of salvation, and of the
of God's anointing, had shaped itself through the
, the death, and the resurrection of Jesus of
. As applied to Jesus the name of Messiah lost
itical and national significance, for His victory over
, whereby He approved himself the true captain
om, was consummated, not amidst the flash of
words or the lurid glare of the lightnings of Elias,
but in the atoning death through which He entered into the heavenly glory. Between the Messiah of the Jews and the Son of Man who came not to be ministered to but to minister, and to give his life a ransom for many, there was on the surface little resemblance; and from their standpoint the Pharisees reasoned not amiss that the marks of the Messiah were conspicuously absent from this Christ. But when we look at the deeper side of the Messianic conception in the *Psalter of Solomon*, at the heartfelt longing for a leader in the way of righteousness and acceptance with God which underlies the aspirations after political deliverance, we see that it was in no mere spirit of accommodation to prevailing language that Jesus did not disdain the name in which all the hopes of the Old Testament were gathered up. The kingdom of God is the centre of all spiritual faith, and the perception that that kingdom can never be realized without a personal centre, a representative of God with man and man with God, was the thought, reaching far beyond the narrow range of Pharisaic legalism, which was the last lesson of the vicissitudes of the Old Testament dispensation, the spiritual truth that lay beneath that last movement of Judaism which concentrated the hope of Israel in the person of the anointed of Jehovah.

It would carry us too far to consider in this place the details of the Jewish conception of the Messiah and the Messianic times as they appear in the later apocalypses or in Rabbinical theology. See for the former the excellent summary of Schurer, *Neutest. Zeitgeschichte*, §§ 28, 29 (Leipsic, 1874), and for the latter, besides the older books catalogued by Schurer (of which Schoettgen, *Horæ*, 1742, and Bertholdt, *Christologia Judæorum*, 1811, may be specially named), Weber, *Altsynagogale Theologie* (Leipsic, 1880). For the whole subject see also Drummond, *The Jewish Messiah* (London, 1877), and Kuenen, *Religion of Israel* chap. xii. For the Messianic hopes of the Pharisees and the *Psalter of Solomon* see especially Wellhausen, *Pharisäer und Sadducäer* (Greifswald, 1874). In its ultimate form the Messianic hope of the Jews is the centre of the whole eschatology, embracing the doctrine of the last troubles of Israel (called by the Rabbins the "birth pangs of the Messiah"), the appearing of the anointed king, the annihilation of the hostile enemy, the return of the dispersed of Israel, the glory and world-sovereignty of the elect, the new world, the resurrection of the dead, and the last judgment. But even the final form of Jewish theology shows much vacillation as to these details, especially as regards their sequence and mutual relation, thus betraying the inadequacy of the harmonistic method by which they were derived from the Old Testament and the stormy excitement in which the Messianic idea was developed. It is, for example, an open question among the Rabbins whether the days of the Messiah belong to the old or to the new world (הָעוֹלָם הַזֶּה or הָעוֹלָם הַבָּא), whether the resurrection embraces all men or only the righteous, whether it precedes or follows the Messianic age. Compare MILLENNIUM.

We must also pass over the very important questions that arise as to the gradual extrication of the New Testament idea of the Christ from the elements of Jewish political doctrine which had so strong a hold of many of the first disciples—the relation, for example, of the New Testament Apocalypse to contemporary Jewish thought. A word, however, is necessary as to the Rabbinical doctrine of the Messiah who suffers and dies for Israel, the Messiah son of Joseph or son of Ephraim, who in Jewish theology is distinguished from and subordinate to the victorious son of David. The developed form of this idea is almost certainly a product of the polemic with Christianity, in which the Rabbins were hard pressed by arguments from passages (especially Isa. liii.) which their own exegesis admitted to be Messianic, though it did not accept the Christian inferences as to the atoning death of the Messianic king. That the Jews in the time of Christ believed in a suffering and atoning Messiah is, to say the least, unproved and highly improbable. See, besides the books above cited, De Wette, *Opuscula*; Wünsche, *Die Leiden des Messias*, 1870. The opposite argument of King, *The Yoke of Zechariah* (Cambridge, 1852), App. A, does not really prove more than that the doctrine of the Messiah Ben Joseph found points of attachment in older thought. (W. R. S.)

MESSINA, a city and seaport at the north-east corner of Sicily, capital of the province of the same name,[3] is

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ngumic passage that peak of the Messiah are registered
, *Leo. Chald.*, s.v.

lessiahs have continued from time to time to appear among
Such was Serenus of Syria (*circa* 720 A.D.) Soon after,
hopes were active at the time of the fall of the Omay-
led to a serious rising under Abu 'Isa of Ispahan, who
elf forerunner of the Messiah. The false Messiah David
) appeared among the warlike Jews in Azerbijan in the
he 12th century. The Messianic claims of Abraham Abu
agossa (born 1240) had a cabalistic basis, and the same
ouraged the wildest hopes at a later time. Thus Abarbanel
the coming of the Messiah for 1503 A.D.; the year 1500
y places observed as a preparatory season of penance, and
the 16th century the Jews were much stirred and more
alse Messiah appeared. For the false Messiah Sabbathai,
. p. 681.

[3] The province occupies the north east corner of the island, and is 60 miles in length by 30 in breadth. It is chiefly occupied with mountain ranges and valleys; there are few plains. The largest river is the

d on the Straits of Messina (at this point about
s wide), 8 miles north-west of Reggio and 130
ast by north of Palermo, in 38° 15′ N. lat., 15° 30′
g. The town is built between the sea and a range
rp and rugged hills, called the Dinnamare, 2707
their highest point. It runs in a semicircle round
rbour, and presents a picturesque appearance from
, as the houses rise in tiers upon the slope of a hill,
hind are the wooded mountains.

sina is the second town of Sicily in importance and in
Its population was 97,074 in 1850, 111,854 in 1871,
6,497 in 1881. It is an archiepiscopal see, and has
ersity, founded by the Jesuits in 1548, with a public
of 56,000 volumes.

excellence of its harbour makes Messina an import-
ading town. The harbour is formed by a tongue of
nd which runs out from the shore in the form of a
and encloses a round basin, open to the north only,
the entrance channel is about 500 yards wide.
is 1¼ miles in circumference, and is of such depth
e largest vessels are able to use it. It is estimated
300 steamers, with a total of 1,000,000 tons burthen,
00 sailing ships, with a total of 500,000 tons bur-
enter the port yearly. The exports of Messina consist
of oranges, lemons, raisins, wine, oil, liquorice, and
There is no prominent manufacture, but silk stuffs
ade in considerable quantities. Many of the inhabit-
re engaged in fishing, chiefly for tunny. Sword fish
e captured with the harpoon in the Straits during
nd August. Coral fishery is a trade of the people.
ills behind Messina produce a strong dark wine,
r to that which is made in other parts of the

ssina has few buildings of importance or antiquity.
ieges and earthquakes from which the town has
d destroyed most of its monuments. After the great
uake in 1783 the city was almost entirely rebuilt.
athedral, the principal building, is a church of the
an period. It was begun in 1098 by Count Roger
finished by his son Roger II. The church is in the
f a Latin cross, 305 feet long and 145 feet wide in
ansepts. The lower half of the façade is encrusted
labs of red and white marble. It has three Gothic
s, with pointed arches and rich ornamentation,
ing to the period of the Anjou dynasty. The nave
ns twenty-six columns of Egyptian granite, said to
been brought from an ancient temple of Poseidon
stood near the Faro. The mosaics of the apses date
he year 1330. In the choir are the sarcophagi of
peror Conrad IV. (d. 1254), of Alphonso the Generous
58), and of Antonia, widow of Frederick III. of
n. In 1254 the cathedral was seriously damaged by
n 1559 the campanile was burned down; in 1783
rthquake overthrew the campanile and the transept.
uilding therefore offers a mixture of styles, first
an, then Gothic, then Early Renaissance, finally
co and Modern Gothic.

history of Messina begins very early. It is said to have been
d, on the site of a more ancient Sicilian town, by pirates
Cumæ, in 732 B.C. It took its earlier name of Zancle (a
from the shape of its harbour. The number of its inhabit-
s increased by an influx of Chalcidians under Cratæmenes;
649 B.C. the town was sufficiently prosperous and populous
blish a colony at Himera. The Samians occupied Zancle for
time after Miletus had been captured by the Persians in
. In the following year the city fell into the hands of
as, tyrant of Rhegium, who introduced a population of
ians, from Messenia in the Peloponnesus; and they changed
me of the place to Messana, in the Doric pronunciation, to

ra. The chief towns are Messina, Castroreale, Mistretta,
nd Milazzo. The population in 1854 was 380,279, in 1871
9, and in 1881 467,233.

remind them of their fatherland. The sons of Anaxilas w
pelled from the government of Messina in 466 B.C., and a r
established; and this government wa ntinued until M
fe into the hands of the Carthaginians during their wa
Dionysius the elder of Syracuse (396 B.C.). The Carthag
destroyed the city; but Dionysius recaptured and rebu
During the next fifty years Messina changed masters several
till Timoleon finally expelled the Carthaginians in 343 B.C.
wars between Agathocles of Syracuse and Carthage, Messin
the side of the Carthaginians. Agathocles's mercenari
Mamertines, treacherously seized the town in 288 B.C. and
They came to war with Hiero II. of Syracuse, after Agath
death; and Hiero's allies, the Carthaginians, helped him to
Messina. The Mamertines appealed for help to Rome, wh
granted, and this led to a collision between Rome and Ca
which ended in the First Punic War. At the close of that
241 B.C., Messina became a possession of the Romans.
the civil wars which followed the death of Julius Cæsar, 4
held with Sextus Pompeius; and in 35 B.C. it was sack
Octavian's troops. After Octavian's proclamation as emp
founded a colony here, and Messina continued to flouris
trading port. In the division of the Roman empire it belo
the emperors of the East, and in 547 A.D. Belisarius c
his fleet here before crossing into Calabria. The Saracens t
city in 831 A.D., and in 1061 it was the first permanent c
made in Sicily by the Norman under Roger d'Hauteville
1190 Richard Cœur de Lion with his crusader passed six
in Messina. He fell out with Tancred, the last of the Ha
dynasty, and sacked the town. In 1194 the city, with the
Sicily, passed to the house of Hohenstaufen under the c
Henry VI., who died there in 1197. At the time of the
Vespers (1282), which drove the French out of Sicily, M
bravely defended itself against Charles of Anjou, and repul
attack. Peter I. of Aragon, through his commander Rugg
Loria, defeated the French off the Faro; and from 1282
Messina remained a possession of the Spanish royal house.
the fleet fitted out by the Holy League against the Turk ass
at Messina, and in the same year its commander, Don J
Austria, celebrated a triumph in the city for his victory at L
Don John's statue stands in the Piazza dell' Annunziata.
hundred years, thanks to the favours and the concessions of
V., Messina enjoyed great prosperity. But the internal c
between the Merli, or aristocratic faction, and the Malv
democratic faction, fomented as they were by the Spa
helped to ruin the city (1671-78). The Messinans suspec
Spanish court of a desire to destroy the ancient senatorial
tution of the city, and sent to France to ask the aid o
XIV. in their resistance. Louis despatched a fleet into
waters, and the French occupied the city. The Spaniards
by appealing to Holland, who sent a fleet under Ruyter
Mediterranean. The French admiral, Duquesne, defea
combined fleet of Spain and Holland, but, notwithstandi
victory, the French suddenly abandoned Messina in 1678,
Spanish occupied the town once more. The senate was sup
and Messina lost its privileges. This was fatal to the imp
of the city, and it never recovered. In 1743 the plague ca
40,000 inhabitants. The city was partially destroyed by
quake in 1783. During the revolution of 1848 against the B
of Naples, Messina was bombarded for three consecutive d
1854 the deaths from cholera numbered about 15,000. G
landed in Sicily in 1860, and Messina was the last city in th
taken from the Bourbons and made of united Ital
Victor Emmanuel.

Messina was the birthplace of the following celebrate
Dicæarchus, the historian (*circ.* 322 B.C.); Aristocles, th
patetic; Euhemerus, the rationalist (*circ.* 316 B.C.),
Protonotario, Mazzeo di Ricco, and Tommaso di Sasso, poet
court of Frederick II. (1250 A.D.); and Antonello da Mes
painter (1447-99), five of whose works are preserved
university gallery. During the 15th century the gram
Constantine Lascaris taught in Messina, and Bessarion w
time archimandrite there.

METALLURGY, a branch of applied science
object is to describe and scientifically criticize the m
used industrially for the extraction of metal fr
ores. Of the large number of metals enumerated
handbooks of chemistry, the vast majority, of c
outside its range; but it is perhaps as well for us to
out that metallurgic discussion, even
"metallic," as applied to compounds, has a res
meaning, being exclusive of all the light metals, al
one of these, namely aluminium, is being manufa
industrially. The following table enumerates in th
of their importance the metals which our subject at

rstood to include; the second column in each case
he chemical characters of the native compounds
, italics indicating ores of subordinate importance.
m "oxide" must be understood to include carbon
lrate, and occasionally (when marked in the table
silicate.

Metal	Character of Ore
	Oxides, *sulphide*
	Complex sulphides, also oxides, *metal*
	Sulphide and reguline metal, *chloride*
	Reguline metal
	Sulphide metal bi-carbonate, *sul phide*, &c
	sulphide, oxide
	O ide
	sulphide reguline metal
	sulphide
	he uline metal
nel cobalt	Arsenides
	Reguline
	Oxide, sodio flue

ave separated the last two from the rest because
thod, used for their preparation are more of the
of laboratory operations, and because we do not
include these in our general exposition of metal
inciples. The history of metallurgy, up to the
ent time, is obscure. It is only since about the
ng of the century that the art has come to be at
ntifically criticized, and in the case of the most
nt processes all that science has been able to do
n merely to put her stamp upon what experience
ng found to be right. Great and brilliantly
ul scientific efforts in the synthetic line are not
, but they all belong to recent times. Science, by
nature, aim at publicity, empiricism at all times
e the reverse, hence a history of the development
art of metallurgy does not and cannot exist. A
tonical note on the discovery of certain of the useful
are given in the introduction to METALS (*q.v.*).

al Sequence of Operations. Occasionally metallic
sent themselves in the shape of practically pure
t nuggets, from which the accompanying matrix or
e can be detached by hand and hammer. But
a rare exception. In most cases the "ore," as it
ut of the mine, is simply a mixture of ore proper
gue in which the latter not unfrequently predomi
to such that it is not the gangue but the ore that
ecupies the position of what the chemist would call
parity. Hence, in general, it is necessary, or at
pedient, to purify the ore as such before the libera
the metal is attempted. Most metallic ores are
ally heavier than the impurities accompanying them,
is purification may be (and generally is) effected
nding the crude ore to a fine enough powder to
the metallic from the earthy part, and then washing
e latter by a current of water, as far as possible.
case of a "reguline" ore, such as auriferous quartz,
ance, the ore thus concentrated may consist substan
t the metal itself, and require only to be melted
nd cast into ingots to be ready for the market.
owever, in a rare case, the vast majority of ores
chemical compounds, which for the extraction of
etals demand chemical treatment. The chemical
ns involved may be classified as follow

ting Operations.—The ore, along in general with
nd of "flux," is exposed to the direct action of a
l fire. The fire in most case has a chemical, in
n to its obvious physical function. It is intended
to burn away certain components of the ore; in
ase it must be so regulated as to contain a sufficien
excess of unburned oxygen; or it is meant to de
("reduce") the ore, when the draught must be res
so as to keep the ore constantly wrapped up in comb
flame gases (carbonic oxide, hydrogen, marsh gas
The vast majority of the chemical operations of meta
fall into this category, and in these processes other
reducing agents than those naturally contained in t
(or wind) are only exceptionally employed.

2. *Amalgamation.* The ore by itself (if it happ
be a reguline one), or the ore plus certain reagents
does not), is worked up with mercury so that the m
obtained ultimately as an amalgam, which can be sep
mechanically from the dross. The purified amalg
subjected to distillation, when the mercury is recove
a distillate while the metal remains.

3. *Wet Processes.* Strictly speaking, certain anal
tion methods fall under this head; but, in its or
acceptance, the term refers to processes in which the
is extracted either from the natural ore, or from the
it is after roasting or some other preliminary treatme
means of an aqueous acid or salt solution, and fro
solution precipitated generally in the reguline form
some suitable reagent.

Few methods of metal extraction at once yield
product. What as a rule is obtained is a more
impure metal, which requires to be "refined" to b
fit for the market. We now pass to the individua
sideration of the several steps referred to.

Comminution of Ores. Assuming the ore to be given in th
of large lumps, these must first be broken up into small st
about the size of those used for macadamizing a road) before t
go to the grinding mill. This formerly used to be done by
work, nowadays it is preferably effected by means of an Am
invention called the stone breaker (fig. 1). This consists essent
two substantial vertical iron plates, one is fixed, the other is co
with an excentric worked by an engine so as to alternately dash
and recede from the former. The lumps of ore, in passing t
this jaw like contrivance, are broken up into smaller fragment

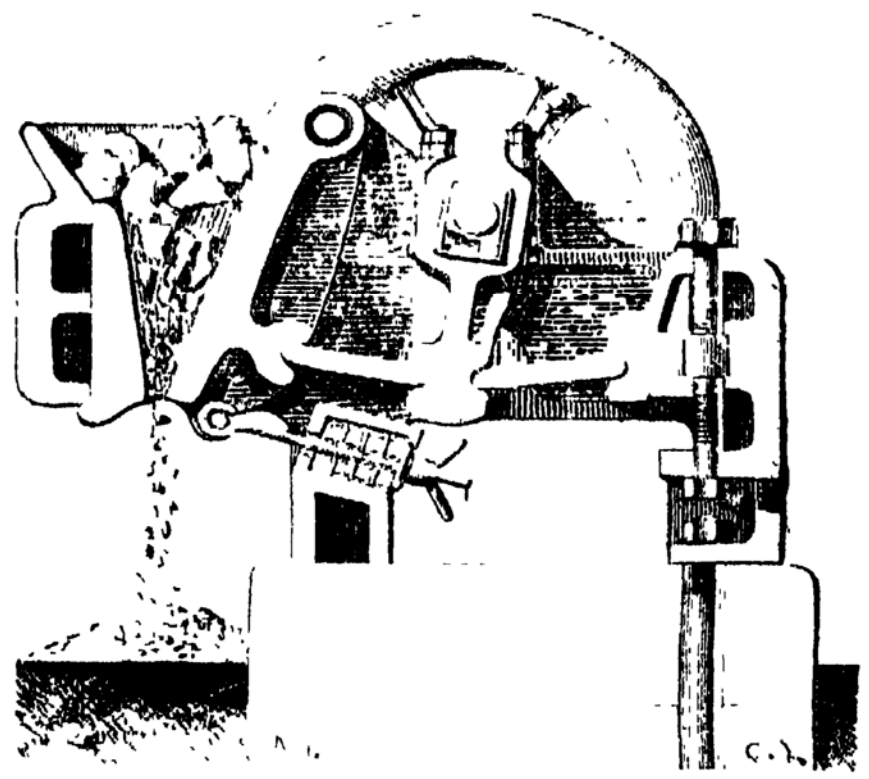


FIG. 1. American Stone Breaker.

the mill. For the production of a coarse powder revolving cy
are often employed. Two cylinders of equal diameter and
made of iron, steel, or stone, are suspended by parallel axes
proximity to each other. The width of the slit between th
be made to vary according to the requirements of the case
cylinders are made to revolve in opposite directions, so th
stones when run into the groove formed by their upper hal
drawn between them and are crushed into bits of a size dep
on the least distance between the two surfaces. Exceptional
stones might bring the machine to a standstill or cause brea
hence only one of the two axes of rotation is absolutely fixe
cushions of the other are only held in relatively fixed po
each between a couple of guiding rails, by means of powerful
at their backs. The springs are made of alternate disks o
rubber and sheet iron, and yield appreciably only to very
pressures. When an exceptionally hard stone comes on, the

ow it to pass through unerushed. Sometimes two sets of s are arranged one above the other, so that the grit from the alls into the jaws of the lower set to receive further com- n. The diameter of the cylinders is from a foot to a yard, ngth from 9 inches to a yard, the velocity of a point on the y a foot to a yard per second. The quantity of ore reduced per horse-power is about 5 cubic feet for quartz or other inerals, and about 14 cubic feet for minerals of moderate s.

he production of a relatively fine powder the pounding-mill ently used, which, in its action, is analogous to a mortar and The mortar is a rectangular trough, while the pestle is by a parallel set of heavy metal or metal-shod beams, by means of a revolving cylinder with cogs catching pro on the beams) are lifted up in succession and then by their own weight so as to pound up the ore in the trough. is supplied from a prismatic reservoir with a sloping leading into a canal through which the stones slide into gh A current of water, which constantly flows into the from below, lifts up the finer particles and carries them er the edge of the trough into a settling tank.

bject pursued in powdering an ore is to prepare it for being by washing. But the velocity with which a solid particle ough water depends on its size as well as on its specific an increase in either accelerating the fall hence, where rence in specific gravity between the things to be separated the washing must be preceded by a separation of the ore- into portions of approximately equal fineness. This is often by passing the ore through a system of sieves of different f mesh superposed over one another, the coarser sieve cupying the higher position. Sometimes the sieves are "go dry," sometimes they are aided in their action by a of water which, more effectually than mere shaking, pre- herence of dust to coarser parts

er contrivance is the "Drum" (fig. 2). A long perforated ylinder made of sheet iron, open at both ends, is suspended, ing position, by a revolving shaft passing through its axis. of the perforations is generally made to increase in passing upper to the lower belts of the cylinder. While the drum

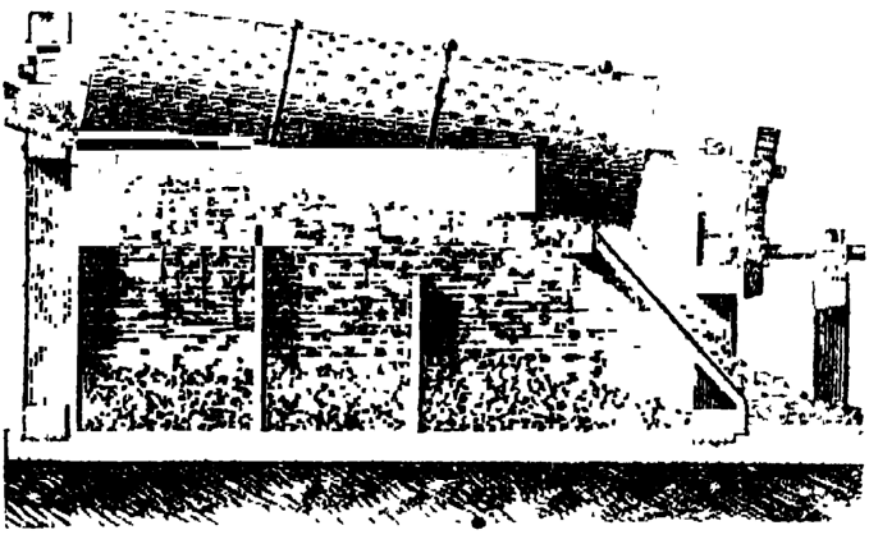


Fig. 2.—Drum.

ring, the ore, suspended in water, flows in at the upper end, travelling down it casts off first its finest and then its coarser ne coarsest only reaching the exit at the lower end. The grades of powder produced fall each into a separate division collecting tank.

drum, of course, is subject to endless modifications. A genious combination is H. E. Taylor's "Drum Dressing " (fig. 3). It consists of three truncated cone shaped , fixed co-axially to the same horizontal revolving shaft,

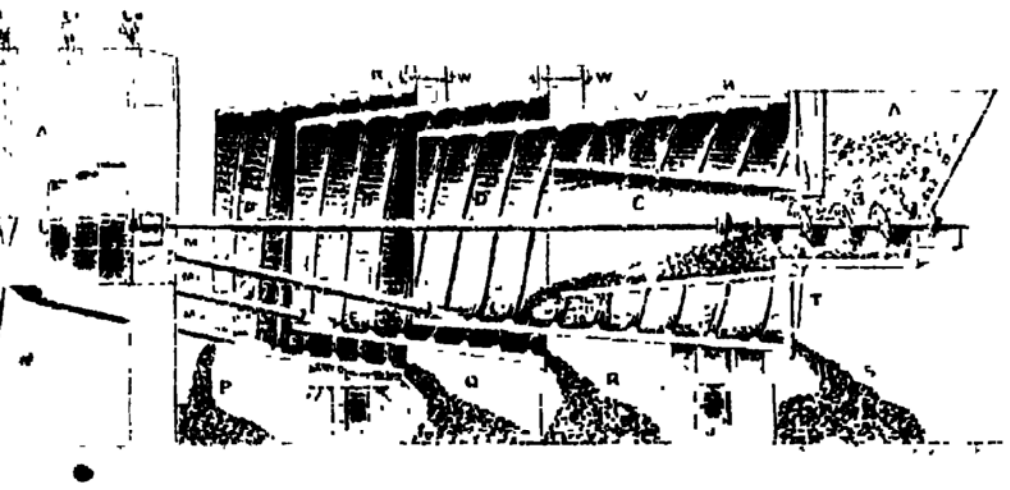


Fig. 3.—Taylor's Drum Dressing Machine.

he narrow end of No. 1 projects into the wider end of No. 2, 2 similarly into No. 3. The drums are not perforated, but ed inside with screw-threads formed of strips of sheet metal fixed edgeways to the drum. The ore grit to be dressed i in a hopper A, and from it, by a worm B fixed to the r shaft, is being screwed forward into a short fixed truncate projecting into the revolving drum No. 1, into which it a constant current. The rotary motion of the drum t convey the ore along the spiral path prescribed by the scre towards the other end, and from it into drum No. 2, an But the ore in each drum meets with a jet of water E n it the opposite way, and the effect is that, in each dr lighter parts follow the water, and with it run off entrance edge to be collected in a special tank, while the parts roll down the spiral path toward the next drum to further parting. The tank or pit for drum 1 receives t and lightest parts, that of drum 2 a heavier, that of d still heavier portion, while only the very heaviest matt its way out of the exit end of No. 3 into a fourth receptacl

Of the large number of other ore-dressers, only two need tioned here.

The "Clausthal Turn-Table" consists of a circular table, face of which rises from the periphery towards the centre form a very flat cone of about 170°, which is fixed co-axially tical rotary shaft. At the apex of the table, surrounding th but independent of its motion, there is a circular trough of sh divided into two compartments, one receives a stream carrying the ore, the other a supply of pure water. A lar lar trough of sheet zinc is placed below the periphery of th so as to receive whatever may fall over the edge. It also is into compartments, as shall be explained further on. Suppo table to be at rest, a sector of about 60° of it would be co run over by the ore mud out of the first compartment of th trough. This mud current would suffer partial separati heavier and lighter parts: such ore resting in the hig poorer in the lower latitudes, and a still poorer ore falling periphery into the lower trough. The same happens w moving table; only each sector of such partially analysed or goes further purification by passing through about 90° of shower. After passing this, it meets with a perforated fixe pipe going up radially to about half the radius of the table pipe also carries sweeping brushes, so that the belt of ore f lower latitudes of the table is swept off into the corresponding of the receiving trough. What of ore remains on the higher l subsequently meets with a similar arrangement which swee into its compartment. If the table turns from the left to th and we follow the process, beginning at the left edge of the compartment, it will be seen that a first sector of the r trough gathers the light dross, a succeeding one an inter product, a third the most highly purified ore. The "intern is generally run into the ore-mud trough of a second tab further analysed.

In the "Continuous Wash Pumps" (Continuirliche Set of the Harz, three funnel shaped vessels (one of which is s fig. 4) are set in a frame beside one another, but at differen so that any overflow from No. 1 runs into No. 2 and the No. 3. Each funnel communicates below with it own c ment of a common cistern.

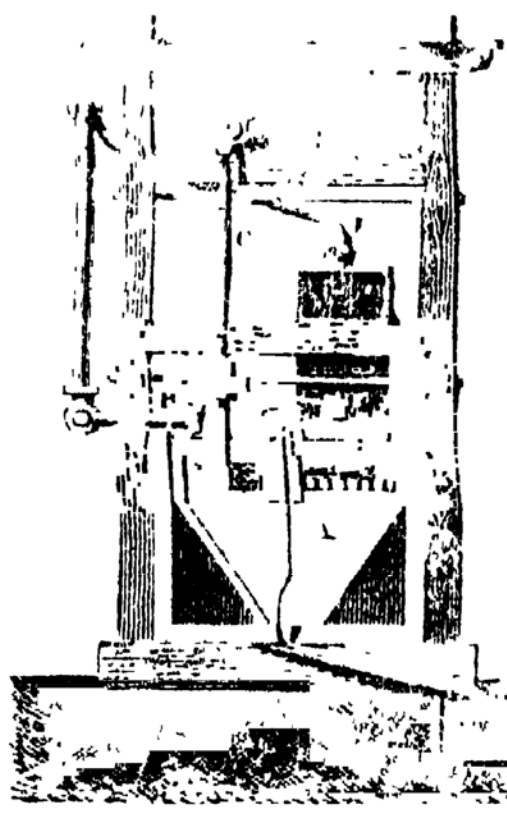


Fig. 4.—Continuous Wash

Into each funnel a riddle with narrow meshes is inserted somewhere near the upper end, while, beside the riddle, there is a pump of short range, which, by means of an excentric, is worked so that the piston alternately goes rapidly down and slowly up. The mode of working is best explained by an example. At Brunnenberg in Rhenish Prussia the apparatus serves to separate a complex ore into the following four parts, which we enumerate in the order of their specific gravities (1) galena (the heaviest), (2) pyrites, (3) blende, (4) dross. Sieve No. 1 is charged with granules of galena, just large enough not to slip through the meshes, No. 2 similarly with granules of pyrites, No. 3 with those of blende. The crude ore mad sieve 1; the jerking action of the pump alternately, t particles up into the water and allow them to fall. The naturally come down first, but whilst in motion taking nothing will pass through the bed of galena but what i as heavy as galena itself. In a similar manner No. 2 an

sift out the pyrites and the blende respectively, so that nothing but dross runs off ultimately. The apparatus is lo its work with a wonderful degree of precision, and of susceptible of wider application, but it ceases to work raw material is a slime so fine that the particles fall too

of Producing High Temperatures.—Most of what is to be this topic has already been anticipated in the articles FURNACE, and BELLOWS; but a few notes may be added ally metallurgic points.

Materials. In a metallurgic furnace the working parts must be made of special materials capable of withstanding high temperatures to which they are exposed and the the fluxes which may be used. No practically available fully meets both requirements, but there is no lack of fire proof substances.

tive stones, a pure quartzose sandstone, free from marl, named as being well adapted for the generality of structures; sandstone, or indeed any kind of fire proof stone, is not at hand. What is more readily procured, and consequently dely used, is refractory brick, made from "fire-clay." The ntial chemical feature of fire-clays is that in them the clay always some kind of hydrated silicate of alumina) is associated ly small proportions of lime, magnesia, ferrous oxide, or oxides. If the percentage of these goes beyond certain the bricks, when strongly heated, melt down into a slag sence of free silica, on the other hand, adds to their refrac-

In fact the best fire bricks in existence are the so-called ricks, which consist substantially of silica, contaminated h just enough of bases to cause it to frit together on being Dinas bricks, however, on account of their high price, are for special cases involving exceptionally high temperatures. ordinary fire bricks those from Stourbridge enjoy the reputation. It follows from what has just been said that, allurgic furnace, lime mortar cannot be used as a cement, t be replaced by fire clay paste.

construction of cupels, reverberatory furnaces, &c., only eral brick made of built bricks, and this work coated over with some kind of special fire proof and of material, such as bone ash, a mixture of baked fire-clay s or graphite, or of quartz and very highly silicated slags, &c. oldings are put on in a loose powdery form, and then stamped hey offer the advantage that, when worn out, they are easily and renewed. The powerful draught which a metallurgic ls can be produced by a chimney, where the fuel forms a y shaft layer spread on grating; but, when ked deep masses of fuel or fuel and ore have to be kept blast becomes indispensable.

Blowing Machines. The efficiency of a chimney is measured by the V with which the air ascends through it, multiplied by its and the former is in roughly approximate accordance formula

$$V = k\sqrt{2gh(T - T_0)/T_0},$$

stands for the height of the chimney, g for the acceleration ty (32·2 feet per second), and T and T_0 for the absolute tures (meaning the temperatures counted from -273° C.) of within and the air without the chimney respectively, while tor meant to account for the resistances which the air, in ress through the furnace, &c., has to overcome. In practice be mean temperature of the chimney gases, which ally is not unobjectionable, but the weakest point in the is the smallness and utter inconstancy of the factor k, according to Peclet, generally assumes some value of the , &c. Yet the formula is of some use as enabling see the way in which V depends on h and $(T - T_0)/T_0$, con- to see, for instance, how deficient chimney height may be sated for by an increase of temperature in the chimney and *vice versa*.

Blowing Machines. Of the several kinds of blowers described BELLOWS (*q.v.*), the "fans" are the best means for producing olumes of wind of relatively small but steady pressure: ws" are indicated in the case of work on a relatively small quiring moderate wind pressure: while the "cylinder blast" n where large masses of high-pressure wind are required. ghly interesting blowing machines, however, are omitted in cle, which may be shortly described here.

"Water Blast" (Wassertrommelgebläse) is interesting ally, having been used metallurgically in Hungary for enturies. A mass of water, stored up in a reservoir, is made down continuously through a high narrow vertical shaft air holes at its upper end. The vertical column of water air through these holes and carries it down with it into a inverted tub standing in a reservoir kept at a constant Air and water there separate, the former flowing away pipe into a wind-box, from which it is led to its destina-

The "Cagniardelle" (figs. 5, 6), so called from its inventor Cagniard Latour, also utilizes water to carry air, but in quite another way. By means of a round shaft passing through its axis, a cylindrical vessel of sheet metal is suspended slantingly in a mass of water, so that its lower end is fully immersed, while of the upper end the sole above the upper side of the shaft is uncovered. The space between shaft and drum is converted into a very wide screw-shaped canal by a band of sheet metal hermetically fixed edgeways to the two. Both the top and the bottom end of the drum are partially closed by

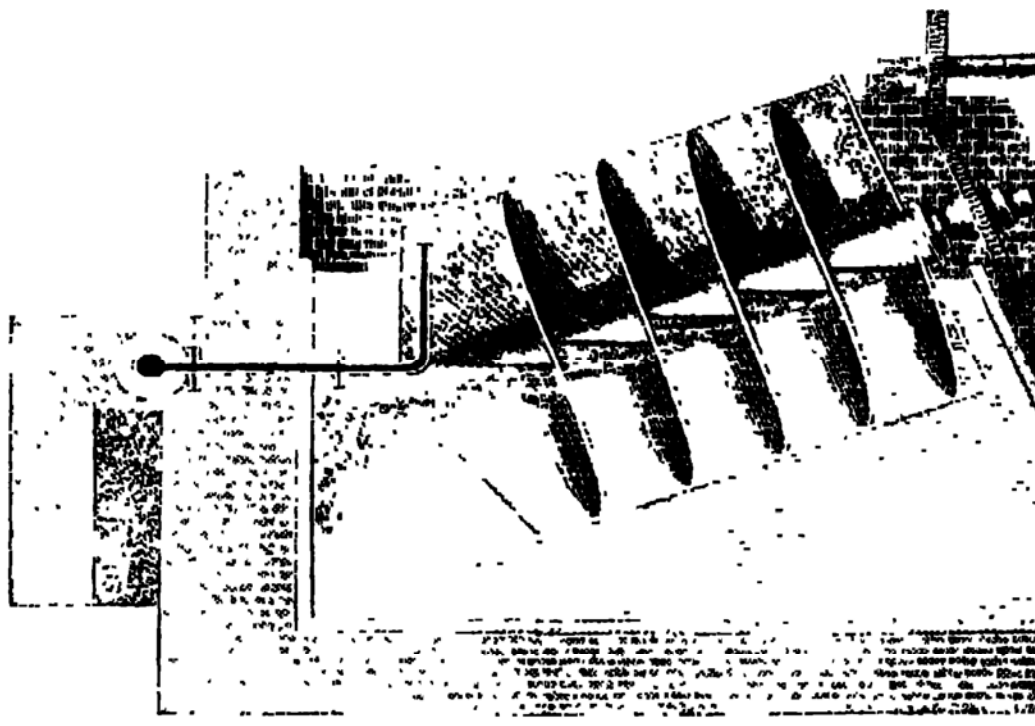


FIG. 5.—Cagniardelle.

bottoms soldered or riveted to the respective edges; the one leaves a ring-shaped opening between its edge and the which serves for the introduction of a fixed air-pipe, bent s reach up to near the top of the drum's air-space; in the bottom three quadrants are closed, the fourth is open. Sup the screw canal, traced from below, to go from the left to the the drum is made to revolve in the same sense, and the effect in each revolution, the screw-canal at its top end swallows a volume of air which, by the succeeding entrance of the water of course, moves relatively to the screw is pushed towards and ultimately into the air space at the bottom end. The Cagniardelle yields a perfectly continuous blast, and, as it is not encumbered with any dead resistances except the friction of the shaft against its bearings (which can be reduced to very little) and the very slight friction of the water against the screw-canal, it utilizes a very large percentage of the energy spent on it. This percentage, according to experiments by Schwamkrug, amounts to from 75 to 84·5; in the case of the cylinder blast it is 60 to 65 per cent.; with b about 40 per cent.; with the "Wassertrommelgebläse" 10 to cent. "Wassertrommelgebläse" stands last in efficiency; but we must not forget that it alone directly native energy, while, in the cylinder blast, for example, 10 of work done by the steam-engine involve a vastly greater spent on the engine as heat.

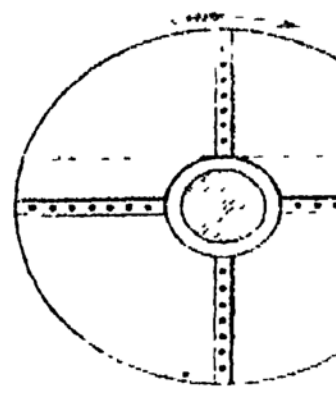


FIG. 6.

To maintain a desired temperature in a given furnace cha a certain manner, the introduction of a certain volume of unit of time is necessary. But this quantity, in a given bl machine, is determined by the over-pressure of the wi measured by a manometer, the velocity of the wind being a mately proportional to $\sqrt{M/(B + M)}$, where M stands for the of the mercury-manometer, and B for that of the baro Hence the practical metallurgist, in adjusting his blast, has n to do but to see that the manometer shows the reading wh previous trials, has been proved to yield an adequate supply o

Fuel. In some isolated cases the ore itself, by its comb supplies the necessary heat for the operation to be performe it. Thus, for instance, the roasting of blackband iron-s effected by simply piling up the ore and setting fire to it, the ore is at the same time its own furnace and fuel: Bessemer process of steel-making, the burning carbon of t iron supplies the heat necessary for its own combustion. similar process has been tried experimentally, and not success, for the working up of certain kinds of pyrites. B rule, the high temperatures required for the working of ores duced by the combustion of extraneous fuel, such as wood charcoal, coal, coke. Of these four, wood-charcoal is of the applicability, but not much used in Britain on accoun high price. High-class coke or pure anthracite, volume for

highest temperature. Wood or coal is indicated when a ous flame is one of the requisites. Obviously fuel of the d and quality gives a higher calorific intensity when, before deprived by drying of its moisture, or when it is used in ion with a hot instead of a cold blast. This latter prin every one knows, is largely discounted in the manufacture on, where nowadays coal, with the help of the hot blast, to do what formerly could only be effected with charcoal or For further information see FUEL and IRON.

cal Operations. In regard to processes of amalgamation et-way processes, we have nothing to add to what was given vious paragraph;[1] we therefore here confine ourselves, in , to pyro-chemical operations.

ethod to be adapted for the extraction of a metal from its termined chiefly, though not entirely, by the nature of the allic component with which the metal is combined. The case is that of the regulme ores where there is no non element. The important cases are those of GOLD, BISMUTH, RCURY (*q. v.*)

s, Hydrates, Carbonates, and Silicates. All iron and tin ores ll under this heading, which, besides, comprises certain ores r, of lead, and of zinc. In any case the first step consists rting the crude ore to a roasting process, the object of which ove the water and carbonic acid, and burn away, to some t least, what there may be of sulphur, arsenic, or organic The residue consists of an impure (perhaps a very impure) the respective metal, which in all cases is reduced by treatth fuel at a high temperature. Should the metal be present licate form, lime must be added in the smelting to remove a and liberate the oxide.

case of zinc the temperature required for the reduction lies e boiling point of the metal; hence the mixture of ore and agent (charcoal is generally used) must be heated in a ombined with the necessary condensing apparatus. In all r cases the reduction is effected in the fire itself, a tower blast furnace being preferably used. The furnace is charged ernate layers of fuel and ore (or rather ore and flux, see below) and the whole kindled from below. The metallic oxide, y the direct action of the carbon with which it is in contact, cipally by that of the carbonic oxide produced in the lower om the oxygen of the blast and the hot carbon there, is re- o the metallic state; the metal fuses and runs down, with , to the bottom of the furnace, whence both are withdrawn eriodic opening of plug-holes provided for the purpose.

ides.—Iron, copper, lead, zinc, mercury, silver, and antiery frequently present themselves in this state of combin components of a very numerous family of ores which may ed into two sections: (1) such as substantially consist of ulphides, as iron pyrites (FeS_2), galena (PbS), zinc blende innabar (HgS); and (2) complex sulphides, such as the kinds of sulphureous copper ores (all substantially com- or mixtures of sulphides of copper and iron); bournonite, ex sulphide of lead, antimony, and copper; rothgiltigerz, of silver, antimony, and arsenic; fahlerz, sulphides of and antimony, combined with sulphides of copper, silver, nc, mercury, silver; and mixtures of these and other sulwith one another.

e treatment of a sulphureous ore, the first step as a rule is ct it to oxidation by roasting it in a reverberatory or other which, in the first instance, leads to the burning away of at rt of the arsenic and part of the sulphur. The effect on the individual metallic sulphides (supposing only one of these esent) is as follows:—

ose of silver (Ag_2S) and mercury (HgS) yield sulphurous and metal; in the case of silver, sulphate is formed as an diate product, at low temperatures. Metallic mercury, in unstances, goes off as a vapour, which is collected and consilver remains as a regulus, but pure sulphide of silver is ver worked.

lphides of iron and zinc yield the oxides Fe_2O_3 and ZnO as ducts, some basic sulphate being formed at the earlier stages, pecially in the case of zinc. The oxides can be reduced by

e sulphides of lead and copper yield, the former a mixture and normal sulphate, the latter one of oxide and basic . Sulphate of lead is stable at a red heat; sulphate of breaks up into oxide, sulphurous acid, and oxygen. In , neither oxidation process is ever pushed to the end; it is soon as the mixture of roasting-product and unchanged contains oxygen and sulphur in the ratio of $O_2 : S$. The of air is then stopped and the whole heated to a higher ature, when the potential SO_2 actually goes off as sulphurous- and the whole of the metal is eliminated as such. This is largely utilized in the smelting of lead (from galena) and er from copper pyrites. In the latter case, however, the sulphide Cu_2S has first to be produced from the ore, which substantially as follows. The ore is roasted with silica certain proportion of the sulphur is burned away as SO_2, corresponding proportion of oxygen has gone to the metal the ore. Now it so happens that copper has a far greater affi sulphur than iron has; hence any locally produced oxide of as long as sufficient sulphide of iron is left, is sure to be reco into sulphide, and the final result is that, while a large quan oxidized iron passes into the slag, all the copper and part of separate out as a mixed regulus of Cu_2S and FeS ("mat") regulus, by being fused up repeatedly with oxidized copper rich copper slags (virtually with CuO and silica), gradually up the whole of its iron, so that ultimately a regulus of pure phide of copper, Cu_2S ("fine mat"), is obtained, which is up for metal as above explained.

4. Sulphide of antimony, when roasted in air, is convert a kind of alloy of sulphide and oxide; the same holds f only its oxysulphide is quite readily converted into th oxide Fe_2O_3 by further roasting. Oxysulphide of antimo suitable processes, can be reduced to metal, but these proce rarely used, because the same end is far more easily obta "precipitation," *i.e.*, withdrawing the sulphur by fusi metallic iron, forming metallic antimony and sulphide Both products fuse, but readily part, because fused antim far heavier than fused sulphide of iron is. A precisely method is used occasionally for the reduction of lead from Sulphide of lead when fused together with metallic iron proportion of 2Fe : 1PbS yields a regulus (2Pb) and a Fe_2S, which, however, on cooling, decomposes into FeS ordinary sulphide and Fe parts of finely divided iron. W have just been explaining are only two special cases of general metallurgic proposition. According to Fournet, an the metals copper, iron, tin, zinc, lead, silver, antimony, in general, is capable of desulphurizing or precipitating partially) any of the others that follows it in the series jus and it does so the more readily and completely the gre number of intervening terms. Hence, supposing a comple ture of these metals to be melted down under circumstance ting of only a partial sulphuration of the whole, the copper best chance of passing into the "mat," while the arsen first to be eliminated as such, or, in the presence of oxid oxide.

Arsenides. Although arsenides are amongst the com impurities of ores generally, ores consisting essentially of a are comparatively rare. The most important of them are double arsenides of cobalt and nickel, which in practice, l are always contaminated with the arsenides or other compo foreign metals, such as iron, manganese, &c. The general working these ores is as follows. The ore is first roasted l when a part of the arsenic goes off as such and as oxi volatile), while a complex of lower arsenides remains. This is now subjected to careful oxidizing fusion in the presence or some other fusible solvent for metallic bases. The diffe the several metals are oxidized away and pass into the silicates) in the following order, first the manganese, secon iron, thirdly the cobalt, lastly (and very slowly) the nick at any stage the as yet unoxidized residue of arsenide asst form of a fused regulus, which sinks down through the s "speis." (This term, as will readily be understood has t meaning in reference to arsenides as "mat" has in regard to sul By stopping the process at the right moment, we can pr speis which contains only cobalt and nickel, and if at th also the flux is renewed we can further produce a speis wh tains only nickel and a slag which substantially is one only. The composition of the speises generally varies from to $AsMe_2$, where "Me" means one atomic weight of metal so that in general $1Me \; xFe + yCo + zNi$, where $x + y + z$ silicecous cobalt is utilized as a blue pigment called "smal nickel-speis is worked up for metal, preferably by wet proc

Minor Reagents. Besides the oxidizing and reducing agen rally present in the fire, and the "fluxes" added for the pr of slags, there are various minor reagents; of which the i portant may be noticed here. One—namely, metallic n desulphurizer—has already been referred to.

Oxide of lead, PbO (litharge), is largely used as an oxidizin At a red heat, when it melts, it readily attacks all metals silver and gold, the general result being the formation of oxide and of a mixed regulus, a distribution, in other w both the lead and the metal acted on between slag and More important and more largely utilized is its action on sulphides, which, in general, results in the formation things besides sulphurous acid gas, viz., a mixed oxide slag ing the excess of litharge, a regulus of lead (which may bismuth and other more readily reducible metals, and litharge is not sufficient for a complete oxidation, a comprising the more readily sulphurizable metals. Oxide being a most powerful solvent for metallic oxides generally

[1] Examples are given in GOLD and COPPER. See also SILVER.

used for the separation of silver or gold from base metallic

ld lead is to metals generally what oxide of lead is to oxides. It accordingly is available as a solvent for so to ing up small particles of metal diffused throughout a mass or other dro and uniting them into one regulus. This y leads u to consider the process of "cupellation" which s the solvent powers of both metallic lead and its oxide. ocess a ives for the extraction of gold and silver from them ith ba e metals such a copper, antimony, &c. The first o fu e up the alloy with a certain proportion of lead, which mined by the weight of base metal to be eliminated, and s sufficient to produce a lead-alloy of low fu ing point. This heated on a shallow oval-shaped bed of bone earth to red- d at the temperature subjected to the a tion of an. The tal copper, &c are oxidized fi s the first portion as an e ium containing little oxide of lead, the latter in the form ution in molten litharge. Le ter, in general, less oxidiz- on the other ha e metals, hence the last instalment of liquid which runs off is pure, and the ultimately remaining regu- ts of silver and gold only. These latter may be separated c and or boiling oil of vitriol, which converts the silver into salts and leave the gold.

e of iron, and also binoxide of manganese, are used for the ation of pyrites. The oxygen of the reagent burn the of the pig into carbonic acid, while the metal of the become iron and FeO or MnO respectively, the oxides with the silica added as such, or formed by the oxidation lico of the pig, into a fusible slag.

pyrite FeS, is employed for the preliminary concentration of gold diffused throughout slags or base ores. The reagent, the action of the heat, give up one half of its sulphur, duces part of the metallic oxide present. The gold and ite with what is left of protosulphide of iron (FeS) into a ch ; then worked up for the noble metals.

s. Practically speaking, all ores are contaminated with s, of gangue, which in general consists of infusible and consequently, if left unheated in the reduction of ilic part of the ore, would retain more or less of the metal ated throughout or at best foul the furnace. To avoid this, as it goes into the furnace is mixed with "fluxes," so as to convert the gangue into a fusible "slag," which uns down through the fuel with the regulus and separates latter. The quality and proportion of flux should, if pos- so chosen that the formation of the slag sets in only after al has been reduced and melted, or else part of the basic the metal to be extracted may be dissolved by the slag and tion thus be prevented or retarded. Slags are not, as one inclined to think, a necessary evil, if an ore were free from we should add gangue and flux from without to produce a slag, one of its functions is to form a layer on the regulus which it against the further action of the blast or furnace gases. may be arranged under the three heads of (1) fluor-spar , (2) basic fluxes, and (3) acid fluxes.

-spar owes its name to the facility with which it fuses up at with silica, sulphates of lime and barium, and a few sible substances into homogeneous masses. It shows ndency to dissolve basic oxides, such as lime, &c. One part spar liquefies about half a part of silica, four parts of sulphate and one and a half parts of sulphate of baryta. Upon these wide application in metallurgy is founded.

nate of soda (or potash) may be said to be the most power- ux. It dissolves silica and all silicates into fusible On the other hand, borax may be taken as a type for the Most of it heat, when it forms a viscid fluid, it readily s up all basic oxides into fusible complex borates. Now gue of an ore in general consists either of some basic uch as carbonate of lime (or magnesia), ferric oxide, , &c., or of silica (quartz) or some more or less acid silicate, f a mixture of the two classes of bodies. So any kind of ught be liquefied by means of borax or by means of alkaline e, but neither of the two is used otherwise than for assay- hat the practical metal-melter does is to add to a basic the proportion of silica, and to increase or lower the proportion of indirectly, of ferrous or perhaps manganous oxide, which it l for the formation of a slag of the proper qualities. The st possess the proper degree of saturation. In other words, $SiO_2 + nMeO$ (where MeO is an equivalent of base) as a for the potential slag, n must have the proper value. If n mall, *i.e.*, if the slag is too acid, it may dissolve up part of l to be brought out as a silicate; if n is too great, *i.e.*, the basic, it may refuse to dissolve, for instance, the ferrous oxide meant to go into it, and this oxide will then be reduced, metal (iron in our example) contaminate the regulus. In to the problem under discussion, it is worth noting that f lead and copper are more readily reduced to metals than iron Fe_2O_3 is to FeO, the latter more readily to FeO than FeO itself to metal, and Fe_2O_3 more readily to metal than man oxide is. Oxide of calcium (lime) is not reducible at all order of basicity in the oxides (their readiness to go into the precisely the reverse.

Most slags being, as we have seen, complex silicates, it is important problem of scientific metallurgy to determine the re in this class of bodies between chemical composition on t hand and fusibility and solvent power for certain oxides (CaO SiO, &c.) on the other. Now the composition of a silicate stated in an infinite number of ways, but there must be one of formulation which reduces the law to its simplest terms mode adapted by metallurgists is something like the followi we start with the quantity H_2Cl_2 of muriatic acid or the qu H_2SO_4 of sulphuric acid, it is clear that to convert either normal salt we require such a quantity of base as will conve H_2 of the acid completely into water, but the quantity of ba does so is that containing one atomic weight of oxygen. It is reasonable to define the quantities K_2O of potash,[1] Na_2O of CaO of lime, MgO of magnesia, FeO of ferrous oxide, $\frac{1}{2}Al_2O_3$ of alumina, $\frac{1}{2}Fe_2O_3$ (= FeO) of ferric oxide as representing each equivalent" of base also in reference to silica, although silic characteristically indefinite basicity. Most slags are alloys pounds of silicates of Al_2O_3 or Fe_2O_3, and of silicates of pro (CaO, &c.), hence their general composition is

$$n(RO + xSiO_2) + m[(fe \text{ or } al)O + xSiO_2].$$

This introduction will enable the reader to understa following mode of classifying and naming composition in sl

Name	Formula	Oxygen Ratio	
		Base	Acid
I. Singulo silicate	$SiO_2 + 1MO$	1	1
II. Bi-silicates	$SiO_2 + 1MO$	1	2
III. Tri-silicates	$SiO_2 + 1MO$	1	3

The names are the metallurgic ones; scientific chemists de Class I as orthosilicates, Class II. as metasilicates, Class III. as silicates. In the formula M stands for Ky, Ca, Fe, &c., or $\frac{1}{2}$Al or $\frac{2}{3}$Fe, &c., or, shortly, MO for one equivalent of above defined. It should be possible to represent each quali silicate as a function of x, $''$, $'''$, and of the nature of the individu that make up the RO and (fe or al) O respectively. Our knowledge falls far short of this possibility. The problem, a very tough one, the more so as it is complicated by the ex of aluminates, compounds such as $Al_2O_3 3CaO$, in which the a plays the part of acid, and the occasional existence of com of fluorides and silicates in certain slags. The following n the fusibility of simple silicates are taken from Plattner's rese

Of the lime silicates, the tri-silicate melts at 2100° C.; silicate at 2150°.

Magnesia silicates are most refractory. The bi-silicate a silicate melt in the oxyhydrogen flame at 2250°.

Of manganous silicates, the easily fusible bi-silicate is yel red; the tri-silicate is more refractory.

Of cuprous (Cu_2O) silicates, the bi-silicate is violet, and pretty easily; the singulo silicate is red, dense, and rather refr

Cupric silicates, as slags, hardly exist, the CuO being reduced to at least Cu_2O.

Lead silicates all melt readily into yellowish transparent g But they have no standing as slags.

As regards the ferrous silicates, the singulo-silicate (orthos fuses at 1790° (this is about the composition of iron-puddling the bi-silicate is less readily fusible.

Ferric silicates (unmixed) do not exist as slags,—the Fe_2O_3 reduced in the fire to 1FeO, although Fe_2O_3 occasionally r part of the Al_2O_3 in complex silicates.

Alumina silicates are all infusible in even the hottest f fires. They begin to soften in the oxyhydrogen flame at 2400°. But certain aluminates, for instance the salt $3CaO.$ according to Sefstrom, melt at furnace heats.

The fusing points of mixtures of two simple silicates can calculated from those of the components. In many cases it is than either of the latter two. Thus for instance most mag lime silicates fuse, the bi silicate combination (Mg, Ca)OSiO readily.

Alumina silicates become fusible by addition of a sufficien portion of silicate of lime at about 1918°. The singulo-silica bi-silicate combinations melt into grey glasses. Magnesia ac lime, and so, in a more limited sense, do ferrous and mang oxides; but their double compounds with Al_2O_3 and silica ar vised when fused.

Plattner's work is a bold attempt to deal synthetically wi problem here presented, but it does not go the length of e approximate solution. No one seems to have done much t time it; hence in the meantime the metallurgist has, f

[1] Few slags contain more than traces of alkalies.

, to rely on the very numerous analyses which have been slags actually produced (by the rule of thumb) in successful gical operations. For some of such slags also Plattner has ed the fusing points. He found for (1) Freiberg lead slag, lO, $8SiO_2$; oxygen ratio, 3 : 4; melting-point at 1317° C., berg crude slag, $15RO$, $3alO$, $18SiO_2$; oxygen-ratio, 1 : 1, point at 1331° C.; (3) Freiberg black copper slag, $24FeO$, $5SiO_2$; oxygen ratio, 9 10, melting-point at 1338° C.; n-furnace slag, $6CaO$, $3alO$, $9SiO_2$; oxygen-ratio, 1 1, point at 1431° C.[1]

Large Assaying. To assay an ore originally meant to a set of tentative experiments on a small scale in order to the proper mode of working it practically. But nowadays is always used in the sense of an analysis carried out to e the money value of an ore. For this purpose, as many s suffi nt to determine the percentages of the metals for he ore is meant to be worked. But sometimes nothing a complete analysis will do. This holds more especially of on. As this metal is cheap, the value of an ore containing ds as much on the nature and relative quantities of the im- as on the percentage of metal. The proved ate-ness of sulphur sphorus may be worth more than an additional 5 per cent. which latter again would perhaps not compensate for the resence of a large percentage of uncombined silica.

say to be of any value must start with a fair sample of the l sale. The fulfilment of this condition in all cases is The general method is, from say a given shipload of ore, ut (say) half a ton of ore from a large number of different d to crush this large sample into small fragments of uniform ch are well shovelled up together. From different parts of heap a sample of the second order amounting to, say, 20 en drawn, and rendered more homogeneous by finer powder- mixing. From this sample of the second (or perhaps from he third) order quantities of 1 or 2 lb are bottled up for . At the same time the moisture of the ore is determined, e scale, by some conventional method, such as the drying of in an open basin at 100° C., and weighing of the residue as This is done at the sampling place by the firm concerned. yer further pounds up and mixes his sample, and then pro- determine the percentages of moisture and metal in his own e has always the choice between two methods, the dry and For the majority of gold or silver ores, and for cobalt and es almost as a rule, certain dry process tests are preferred ost exact analytically. In almost all other cases it may be t the wet method is susceptible of the higher degree of pre- et even in some of these cases the old dry process tests are l to the present day. For instance, all copper ores in the Isles are sold by the result of the Swansea assay, a kind tion of the process of sulphureous copper ore smelting; and gularly, is adhered to even in the case of such cupriferous s as are worked by the wet way, although the Swansea well known to lose about 1 per cent. of the copper present. r-smelter therefore had better buy 5 per cent. than 10 per pper pyrites cinders, because in the first case he pays only fifths, while in the latter he must pay for nine-tenths of per present. To compensate for this anomaly, empirical s have been contrived for calculating prices. (W. D.)

TALS. The earliest evidence of a knowledge and metals is found in the prehistoric implements of called Bronze and Iron ages. In the earliest periods tten history, however, we meet with a number of in addition to these two. The Old Testament ns six metals gold, silver, copper, iron, tin, and The Greeks, in addition to these and to bronze, lso to know mercury; and the same set of metals, t additions, forms the list of the Arabian chemists 8th and of the Western chemists of the 13th cen- During the 15th century Basilius Valentinus dis l antimony; he also speaks of zinc and bismuth, eir individuality was established only at a later period 1730-40 the Swede Brand discovered arsenic and (the former is not reckoned a metal by modern ts), while the Englishman Ward recognized the duality of platinum. Nickel was discovered in 1771 onstedt, manganese in 1774 by Scheele. The rs D'Elhujart, in 1783, prepared tungsten; Hjelm, 2, isolated molybdenum from molybdic oxide, where its existence had been conjecturally asserted by Ber in 1781. Uranium, as a new element, was discove Klaproth in 1789; but his metallic "uranium," after been accepted as a metal by all chemists until 18 then recognized as an oxide by Peligot, who subs isolated the true metal. Tellurium was discovered by von Reichenbach in 1782 (again by Klaproth in titanium, by Klaproth in 1795, chromium, by Va in 1797; tantalum, by Hatchett in 1801, and by E in 1802. Palladium, rhodium, iridium, and (which four metals always accompany platinum in i were discovered, the first two by Wollaston in 18 other two by a number of chemists; but their pec was established chiefly by Smithson Tennant.

After Davy, in 1807 and 1808, had recogniz alkalies and alkaline earths as metallic oxides, the ex of metals in all basic earths became a foregone con which was verified sooner or later in all cases. I discovery of aluminium by Wöhler in 1828, and magnesium by Bussy in 1829, claim special m Cadmium, a by no means rare heavy metal, was disc only in 1818, by Stromeyer.

Of the large number of discoveries of rare metals have been made in more recent times only a few mentioned, as marking new departures in research o ing other special points of interest. In 1861 Bunse Kirchhoff, by means of the method of spectrum an which they had worked out shortly before, discover new alkali metals which they called cæsium and rub By means of the same method Crookes, in 1861, disc thallium; Reich and Richter, in 1863, indium, and de Boisbaudran, in 1875, gallium. The existence last named metal had been maintained, theoretica Mendelejeff, as early as 1871. The existence of sca was proved in 1880 by Nelstrom; but what he, a sequently Berzelius, looked upon as the element 1867, proved to be really an oxide by Roscoe, w succeeded in isolating the true metal.

The development of earlier notions on the const of metals and their genetic relation to one anothe the most interesting chapter in the history of ch (see ALCHEMY). What modern science has to say matter is easily stated: all metals properly so call all metals not alloys) are elementary substances; chemically speaking, they are not "constituted" at no two can be related to each other genetically in a whatever. Our scientific instinct shrinks from em this proposition as final; but in the meantime it m accepted as correctly formulating our ignorance subject. All metallic elements agree in this that th each at least one basic oxide, or, what comes to th things, one chloride, stable in opposition to liquid This at once suggests an obvious definition of meta class of substances, but the definition would be artificial and objectionable on principle, because w speak of metals we think, not of their accidental c relations, but of a certain sum of mechanical and p properties which unites them all into one natural What these properties are we shall now endeav explain.

All metals, when exposed in an inert atmo-phe sufficient temperature, assume the form of liquid all present the following characteristic properties. are (at least practically) non transparent, they refle in a peculiar manner, producing what is called "m lustre." When kept in non-metal' els they t shape of a convex meniscus. These liquids, when c to higher temperatures, some sooner others later, p vapours. What these vapours are like is not kn many cases, since, as a rule, they can be produced

[1] For further information on slags, see Berthier, *Traité des essais par sèche*; Winkler, *Erfahrungssätze über die Bildung der en*, Freiberg, 1827; Plattner, *Vorlesungen über allgemeine unde*, i. 28 *sq.*; Percy, *Metallurgy*.

high temperatures, precluding the use of transparent
ls. Silver vapour is blue, potassium vapour is green,
others (mercury vapour, for instance) are colourless.
liquid metals, when cooled down sufficiently, some at
others at higher temperatures, freeze into compact
s, endowed with the (relative) non-transparency and
ustre of their liquids. These frozen metals in general
compact masses consisting of aggregates of crystals
nging to the regular or rhombic or (more rarely) the
dratic system. But in many cases the crystals are so
ly packed as to produce an apparent absence of all
ture. Compared with non-metallic solids, they in
ral are good conductors of heat and of electricity.
their most characteristic, though not perhaps their
general, property is that they combine in themselves
apparently incompatible properties of elasticity and
lity on the one hand and plasticity on the other. To
remarkable combination of properties more than to
hing else the ordinary metals owe their wide applica
in the mechanical arts. In former times a high
ific gravity used to be quoted as one of the characters
e genus; but this no longer holds, since we have come
now of a whole series of metals which float on water.
us now proceed to see to what degree the mechanical
physical properties of the genus are developed in the
ral individual metals.

Non-Transparency. Thus, in the case of even the solid
ls, is perhaps only a very low degree of transparency.
egard to gold this has been proved to be so; gold leaf,
in films of gold produced chemically on glass plates,
smit light with a green colour. On the other hand,
e infinitely thin films of silver which can be produced
nically on glass surfaces are absolutely opaque. Very
films of liquid mercury, according to Melsens, transmit
with a violet-blue colour; also thin films of copper
said to be translucent. Other metals, so far as we
w, have not been more exactly investigated in this
ction.

Colour. Gold is yellow; copper is red; silver, tin, and
others are pure white; the majority exhibit some
ification or other of grey.

Reflexion of Light. Polished metallic surfaces, like
e of other solids, divide any incident ray into two
s, of which one is refracted while the other is reflected,—
a this difference, however, that the former is completely
orbed, and that the latter, in regard to polarization, is
e differently affected.[1] The degree of absorption is
rent for different metals. According to Jamin, the
aining intensity, after one and ten successive perpen-
lar reflexions respectively from the metal-mirrors
ed, is as follows (original intensity = 1):—

	Silver.		Speculum Metal.		Steel.	
	1 R.	10 R.	1 R.	10 R.	1 R.	10 R.
d..	·929	·178	·692	·035	·609	·007
low		·339	·632	·010	·599	·006
olet..		·242	·599	·006	·599	·006

This shows the great superiority of silver as a reflecting
dium, especially in the case of repeated reflexion.

Crystalline Form. Most (perhaps all) metals are capable
rystallization, and in most cases isolated crystals can be
duced by judiciously managed partial freezing. The
tals belong to the following systems: *regular system*
lver, gold, palladium, mercury, copper, iron, lead;
dratic system tin, potassium; *rhombic system* anti-
y, bismuth, tellurium, zinc, magnesium.

Structure. Perhaps all metals, in the shape which they
me in freezing, are crystalline, only the degree of
visibility of the crystalline arrangement is very di
in different metals, and even in the same metal
according to the slowness of solidification and
circumstances.

Of the ordinary metals, antimony, bismuth, an
may be mentioned as exhibiting a very distinct crys
structure: a bar-shaped ingot readily breaks, an
crystal faces are distinctly visible on the fracture
also is crystalline: a thin bar, when bent, "c
audibly from the sliding of the crystal faces ov
another; but the bar is not easily broken, and exhi
apparently non-crystalline fracture.—Class I.

Gold, silver, copper, lead, aluminium, cadmium
(pure), nickel, and cobalt are practically amorpho
crystals (where they exist) being so closely packed
produce a virtually homogeneous mass.—Class II.

The great contrast in apparent structure between
ingots of Class I. and of Class II. appears, however
owing chiefly to the fact that, while the latter crystalliz
regular system, metals of Class I. form rhombic or qu
crystals. Regular crystals expand equally in all dire
rhombic and quadratic ores expand differently in di
directions. Hence, supposing the crystals imme
after their formation to be in absolute contact wi
another all round, then, in the case of Class II., su
tact will be maintained on cooling, while in the
Class I. the contraction along a given straight line
general have different values in any two neighb
crystals, and the crystals consequently become, h
slightly, detached from one another. The cry
structure which exists on both sides becomes visib
in the metals of the first class, and only there ma
itself as brittleness.

Closely related to the structure of metals is their
of "plasticity" (susceptibility of being constrain
new forms without breach of continuity). This t
course includes as special cases the qualities of "
ability" (capability of being flattened out und
hammer) and "ductility" (capability of being dra
wire); but it is well at once to point out that th
special qualities do not always go parallel to each
for this reason amongst others that ductility in a
degree than malleability is determined by the tena
a metal. Hence tin and lead, though very mallea
little ductile. The quality of plasticity is develo
very different degrees in different metals, and even
same species it depends on temperature, and
modified by mechanical or physical operations. A
zinc, for instance, as obtained by casting, is very
but when heated to 100° or 150° C. it becomes suffi
plastic to be rolled into the thinnest sheet or to be
into wire. Such sheet or wire then remains flexib
cooling, the originally only loosely cohering crystals
got intertwisted and forced into absolute contact w
another, an explanation supported by the fact tha
zinc has a somewhat higher specific gravity (7·2) t
original ingot (6·9). The same metal, when hea
205° C., becomes so brittle that it can be powde
mortar. Pure iron, copper, silver, and other met
easily drawn into wire, or rolled into sheet, or fi
under the hammer. But all these operations ren
metals harder, and detract from their plasticity.
original softness can be restored to them by "ann
i.e., by heating them to redness and then quenchi
in cold water. In the case of iron, however, this
only if the metal is perfectly pure. If it contains
parts of carbon per thousand, the annealing process,
of softening the metal, gives it a "temper," me
higher degree of hardness and elasticity (see below

What we have called plasticity must not be m

[1] This may be the cause of the peculiarity of metallic lustre.

e notion of softness, which means the degree of with which the plasticity of a metal can be dis- Thus lead is far softer than silver, and yet the s by far the more plastic of the two. The now experiments of Tresca (*Comptes Rendus*, lix. 754) at the plasticity of certain metals at least goes ably farther than had before been supposed. He d with lead, copper, silver, iron, and some other Round disks made of these substances were in a closely fitting cylindrical cavity drilled in of steel, the cavity having a circular aperture or four centimetres below. By means of an ic press, applied to a superimposed piston, a of 100,000 kilos was made to act upon the disks, e metal was seen to "flow" out of the hole like a quid. In spite of the immense rearrangement of ere was no breach of continuity. What came out was a compact cylinder with a rounded bottom, g of so many layers superimposed upon one Parallel experiments with layers of dough or lus some connecting material proved that the s in all cases moved along the same tracks as e followed by a flowing cylinder of liquid. Of the nown metals potassium and sodium are the softest; n be kneaded between the fingers like wax. After llow first thallium and then lead, the latter being test of the metals used in the arts. Among these ness decreases in about the following order:- lead, ver, pure gold, tin, copper, aluminium, platinum, n. As liquidity might be looked upon as the *ne ra* of softness, this is the right place for stating ile most metals, when heated up to their melting pass pretty abruptly from the solid to the liquid latinum and iron first assume, and throughout a ge of temperatures retain, a condition of viscous idity which enables two pieces of them to be d" together by pressure into one continuous mass. m and sodium might probably be welded if their could be kept clear of oxide.

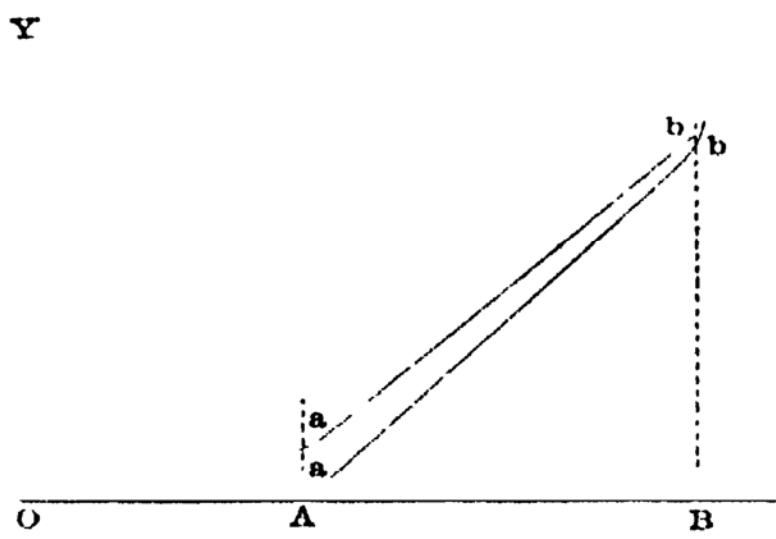
rding to Prechtl, the ordinary metals, in regard to ree of facility or perfection with which they can be red flat on the anvil, rolled out into sheet, or nto wire, form the following descending series:—

Hammering.	*Rolling into Sheet.*	*Drawing into Wire.*
ead.	Gold.	Platinum.
in.	Silver.	Silver.
old.	Copper.	Iron.
ine.	Tin.	Copper.
lver.	Lead	Gold.
opper.	Zinc.	Zinc.
latinum.	Platinum.	Tin.
on.	Iron.	Lead.

an idea of what can be done in this way, it may d that gold can be beaten out to leaf of the thick $\frac{1}{282}$ mm.; and that platinum, by judicious work, drawn into $\frac{1}{2067}$ mm. thick.

he hardness of a metal we mean the resistance t offers to the file or to the engraver's tool. Taking is sense, it does not necessarily measure, *e.g.*, the ce of a metal to abrasion by friction. Thus, for e, 10 per cent. aluminium bronze is scratched by an l made of ordinary steel as used for knife blades. t it has been found that the sets of needles used forating postage stamps last longer if made of um bronze than they do if made of steel.

city.—All metals are elastic to this extent that a change of ought about by stresses not exceeding certain limit values, ppear on the stress being removed. Strains exceeding the f elasticity" result in permanent deformation or (if sufficreat) in rupture. Where this limit lies is in no case prenown. According to Wertheim[1] (who has done more for wledge of the subject than any one else) and Hodgkinson, the real law seems to be pretty much as indicated by the two cur on the accompanying diagram, where, in reference to a metal wire, stretched by an appended weight, the abscissa always me the numerical value P of the weight, the ordinate of the upper cu the total elongation caused by P, the ordinate of the lower curve that part of the elongation which remains when P is removed, so that the piece of the ordinate between the two curves gives the temporary ("elastic") expansion. From P 0 up to a somewhat indefinite point (*a* or A) both curves are nearly straight lines, the lower almost coincidin its beginning with the axis of abscissæ; from that point onwa these two curves approach each other, and at a short distance fi the point of rupture they rapidly converge towards intersection. any value of P which lies fairly on the safe side of A, we have proximately



$$\lambda = \frac{lP}{q},$$

where λ means the elastic (or substantially the total) expansion the length, and q the square section of the wire or cylindrical operated upon. The reciprocal of ϵ (viz. E $1/\epsilon$) is called "modulus of elasticity."

Wertheim has determined this constant for a large number metals and alloys. He used three methods: one was to measure elongations produced, in a wire of given dimensions, by a succes of charges; the other two consisted in causing a measured ba give off a musical note by (*a*) longitudinal and (*b*) transversal vi tion, and counting the vibrations per second. The following t gives some of his results. Column 2 gives the constant E millimetre and kilogramme. Hence 1000/E is the elongation millimetres per metre length per kilo. Column 3 shows the ch causing a permanent elongation of 0·05 mm. per metre,- wh for practical purposes, he takes as giving the limit of elastic column 4 gives the breaking strain. Values of E in sq brackets [ ] are derived from vibration experiments; the from direct measurements of elongations. Numbers in ro brackets ( ) do not necessarily refer to the same specimen as other data.

	For Wt. of 1 Square section, Weight (a Kilos) causing		
	E	Permanent Elongation of 20 Mm.	Breaki
Lead, drawn	1,803		2
,, annealed	1,727	0·20	1
Tin, drawn	[3,923]	0·45	(2
,, annealed	[4,060]	0·20	
Cadmium, drawn	[5,757]		
,, annealed	[4,777]		
Gold, drawn	8,132	13·5	27
,, annealed	5,585	3·0	10
Silver, drawn	7,358	11·3	29
,, annealed	7,141	2·6	16
Zinc, pure, cast in mould	9,021		
Zinc, ordinary, drawn	8,735	0·75	
,, annealed	[9,467]	1·00	
Palladium, drawn	[11,759]	18	
,, annealed	9,789	under 5	27
Copper, drawn	12,449	12	40
,, annealed	10,519	under 3	30
Platinum wire, medium thickness, drawn	17,004	(26)	
,, ,, annealed	15,518	(14)	
Platinum wire, thick, drawn	15,987		31
,, annealed	15,622		23
Iron,[2] drawn	20,869	32	61
,, [2] annealed	20,794	under 5	47
Nickel,[3] drawn			3·6
Cobalt,[3] ,,			2·6
Aluminium[4]	7,040		
Aluminium bronze[4]	10,700		
Brass[5]	8,043		
German silver[6]	10,788		

The above numbers may be assumed to hold for temperatures f 15° to 20° C. Wertheim executed determinations also at other peratures; but, as his numbers do not appear to reveal the

[1] *Annales de Chimie et de Physique* [iii.], vol. xii.

[2] From Du Brery. [3] Approximate, by H. St Clair Dev

[4] From deflexion of hammered bar of 5 mm. thickness, charged in the mi determined by W. Dittmar.

[5] Composition, $ZnCu_2$ (Wertheim). [6] Composition, $Zn_1Cu_{13}Ni_3$ (Werth

between E and temperature, we quote the results of sch and Loomis, who found the following relations between ulus E_0 for 0° C. and the value E_t for $t°$ C.—

Iron	$E_t = E_0(1$	$.000483\,t$	$.0000001272\,t^2)$
Copper	$E_t = E_0(1$	$.000472\,t$	$.0000000287\,t^2)$
Brass	$E_t = E_0(1$	$.000485\,t$	$.0000001367\,t^2)$

r these three metals at least, the value of E diminishes, emperature increases, at pretty much the same rate per l temperature.

ic Gravity.—This varies in metals from ·594 (lithium) to osmium), and in one and the same specimen is a function erature and of previous physical and mechanical treat It has in general one value for the powdery metal as l by reduction of the oxide in hydrogen below the melting the metal, another for the metal in the state which es spontaneously on freezing, and the latter value again, al, as modified by hammering, rolling, or wire-drawing, &c. echanical operations do not necessarily add to the density; g, it is true, does so necessarily, but rolling or drawing ally causes a diminution of the density. Thus, for , chemically pure iron in the ingot has the specific gravity when it is rolled out into thin sheet, the value falls to n drawn into thin wire, to 7·75 (Berzelius). The follow- gives the specific gravities of all metals (except a few e ones) according to the most trustworthy modern de tions. Where special statements are not made, the numbers assumed to hold for the ordinary temperature (15° to 17° or referred to water of the same temperature (specific gravity n standard, and to hold for the natural frozen metal.

Name of Metal.	Specific Gravity.	Authority.
	·94	Bunsen
		Bunsen
		Bunsen and Matthiesen
	1·743	Bunsen
	1·88	Setterberg
	2·1	Debray.
		Mallet, 1880
	over 4	Clarke.
	4·1	Froost.
		Roscoe
		Lecoq de Boisbaudran.
	6·163	,,
	6·344	Hallebrandt and Norton.
	6·428	,, ,,
	6·715 at 16	Marchand and Scheerer.
	6·81	Wohler
	6·914	Karsten
		Bunsen.
		Various authorities.
	7·178	W. H. Miller.
	7·42	Richter
	·8 to	
	·279	Richter
		,,
		Schroder
		Debray
thin sheet	8·94 to 8·95	Marchand and Scheerer
pure	8·945	,, ,,
	9·821 at 19°	Hampe.
	10·4 to 10·5	Holzmann.
tamped	10·57	,,
ly slowly fr	11·254	G. Rose
ckly frozen	11·363	Deville
	11·4 at 22°·5	,,
	11·86	Deville and Debray.
	12·1	Crookes
		Bunsen
liquid	13·56	Deville and Debray.
solid		H. Kopp
n, compact, by H from nide vapour	16·54	Wohler, 1855.
as reduced by hydro powder.	19·13	Roscoe
	18·73	Pelgot, 1868.
got	19·265 at 15°	Matthiesen
mped	19·31 to 19·34	G. Rose
wder, precipitated by ferrous sulphate	19·32 to 19·72	
n, pure	21·46	
	22·40	
	22·477	Deville and Debray, 1876.

ic Properties.—The specific heats of most metals have been ed very carefully by Regnault. The general result is that, ably with Dulong and Petit's law, the "atomic heats" all very nearly the same value (of about 6·4); *i.e.*, atomic y specific heat ×6·4. Thus we have for silver by theory ·0593, and by experiment ·0570 for 10° to 100° C.

The expansion by heat varies greatly. The following tab the linear expansions from 0° to 100° C. according to Fizeau (*Rendus*, lxviii. 1125), the length at 0° being taken as unit

Name of Metal.	Ex 0°
Platinum, cast	·0
Gold, cast	·0
Silver, cast	·0
Copper, native (Lake Sup	·0
Copper, artificial	·0
Iron, soft, as used for electromagnets	·0
,, reduced by hydrogen and compresse	·0
Cast steel, English annealed	·0
Bismuth, in the direction of the axis	0
,, at right angles to axis	0
,, mean expansion, calculated	·0
Tin, of Malacca compressed powder	·0
Lead, cast	0
Zinc, distilled compressed powder	0
Cadmium distilled, compressed powder	0
Aluminium, cast	·0
Brass (71·5 per cent copper, 28·5 per cent. zinc)	0
Bronze (86·3 per cent copper, 9·7 per cent tin, 4·0 per cent. zinc)	·0

The coefficient of expansion is constant for such metals crystallize in the regular system; the others expand di in the directions of the different axes. To eliminate thi of uncertainty these metals were employed as compressed The cubical expansion of mercury from 0° to 100° C. is $\frac{1}{5550}$ (Regnault)

Fusibility and Volatility.—The fusibility in different is very different, as shown by the following table, besides including all the fusing points (in degrees C.) of which have been determined numerically, indicates the selection of other metals by the positions assigned to the table. Of the temperatures given, those above (say) 500° be looked upon as rough approximations.

Name of Metal.	Fusing Point.	Author
		B. Stewart.
		Setterberg
	30·1	L. de Boisba
Lithium	38·5	Bunsen
Potassium		,,
Lithium	180·0	
Iodine	176	Richter (?)
Tin	228	Rudberg.
Bismuth	264	,,
Thallium	290	Lamy
Cadmium	320	Rudberg.
Lead	325	
Antimony	425	
Zinc	415	Person.
		Daniell.
Incipient Red Heat	525	Pouillet
Magnesium		
Aluminium		
Cherry Red Heat	700	Pouillet.
Silver	1,040	Becquerel.
Gold	1,100	
Yellow Heat	1,100	Pouillet.
Copper	1,200	
Iron, wrought	1,300 to 1,400	
,, chemically pure	higher	
Cobalt	1,400	
Nickel	1,600	
Uranium	?	
Dazzling White Heat	1,500 to 1,600	Pouillet.

Palladium is barely fusible at the highest wind-furnace heat. The f melt only in the oxyhydrogen flame:

Platinum	2,000	
Iridium		
Rhodium		
Ruthenium		
Melt. Temp. of Oxyhydrogen Flame	2,870	Bunsen.[1]

Osmium does not melt at 2,870°, *i.e.*, is as yet infusible.

Of the volatility of metals we have little precise kn only the following boiling points are known numerically :—

Name of Metal.	Boiling Point	Author
Mercury	357·3	Regnault.
Cadmium	860	Deville and
Zinc	1,040	,,
Potassium	below 1,040	Dewar and
Sodium	above 1,040	

For practical purposes the volatility of metals may be s follows:

1. Distillable below redness: mercury.
2. Distillable at red heats: cadmium, alkali metals, zi nesium.
3. Volatilized more or less readily when heated beyo fusing points in open crucibles: antimony (very readil bismuth, tin, silver.

[1] Bunsen, *Jahresb. f. Chem.*, 1867, p. 41; *Phil. Mag.*, xxxiv. 48

ely so: gold, (copper).
etically non volatile: (copper), iron, nickel, cobalt, alu- also lithium, barium, strontium, and calcium.
oxyhydrogen flame silver boils, forming a blue vapour, tinum volatilizes slowly, and osmium, though infusible, lily.

Heats of Liquefaction.—Of these we know little. The fol numbers are due to Person—ice, it may be stated, being so

Metal	Latent Heat.	Metal.	Latent Heat
...	2·82	Cadmium ...	13·6
...	5·47	Silver ...	21·1
...	12·4	Zinc ...	28·1

latent heats of vaporization only that of mercury has been ned, by Marignac, who found it to be 103 to 106 units.

ctivity.—Conductivity, whether thermic or electric, is very ly developed in different metals; and, as an exact know these conductivities is of great scientific and practical nce, much attention has been given to their numerical nation. The following are the modes in which the two ivities have been defined as quantities.

ermic. Imagine one side (I) of a metallic plate, D unit be kept at the constant temperature t_1, the other (II) at r a sufficient time each point between I and II will be at nt intermediate temperature, and in every unit of time a quantity Q of heat will pass from any circumscribed area the opposite area S on II, according to the equation

$$Q = k \frac{S(t_1 - t_2)}{D}$$

ed the (internal) conductivity of the metal the plate is . It is, strictly speaking, a function of t_1 and t_2; but given small interval of temperatures it may be taken as a l.

ctric.—When a given constant battery is closed successively ent wires of the same sort, then, according to experience, ngth l of the current (as measured for instance by the heat- nt of the electricity flowing through the circuit in unit of in accordance with the equation

$$A/l = l^2 r/s,$$

is the length and s the square section of the wire, while A stant which, for our purpose, need not be defined in regard hysical meaning; r measures the specific resistance of the ar metal. Supposing a certain silver wire on the one hand ertain copper wire on the other, when substituted for each produce currents of the same strength, we have

$$r_1/s_1 = r_2/s_2,$$

$$r_1/r_2 = s_1/s_2 (= k)$$

is the computed value of the ratio on the right-hand side. taking r_2, the resistance of copper, as unity, we have ., k gives us the specific resistance of silver, that of copper aken = 1. In this relative manner resistances are usually d, silver generally being taken as the standard of compari upposing the relative resistance of a metal to be R, the re- 1/R is called its "electric conductivity." For the same R varies with the temperature, the higher temperature cor- ing to the higher resistance. The following table gives the conductivities of a number of metals as determined by sen, and the relative internal thermic conductivities of ally) the same metals as determined by Wiedemann and with rods about 5 mm. thick, of which one end was kept C., the rest of the rod in a "vacuum" (of 5 mm. tension) '. Matthiesen's results, except in the two cases noted, are s memoir in *Pogg. Ann.*, 1858, cvi. 428

Metals.	Relative Conductivities	
	Electric	Thermic.
commercial, No. 3 ...	774 at 18·8°	
„ No. 2 ...	721 „ 22·6	
chemically pure, hard drawn. ...	·934	
...		·748
ure ...	·72 „ 21·8	·548
bsolutely pure ...	·733 „ 19·0	
...		
re ...	·115 „ 21·0	
rte wire ...	·144 „ 20·4	
d ...		·101
...		·10
ure ...	·0777 „ 17·3	·079
m ...	·105 „ 20·7	·094
silver ...	·0767 „ 18·7	·073
h ...	·0119 „ 14·8	
mm ...	·196 „ 19·6	
y ...	·0163 „ 22·8	
pure ...	1·000 „ 0	

ished in 1860, and declared by Matthiesen to be more exact than the old .

Going by Matthiesen's old numbers, we find them to agree with Wiedemann and Franz's thermic conductivities, which su an obvious and pretty generally received proportion. M sen's new numbers for gold and copper, however, destroy th mony.

Magnetic Properties. Iron, nickel, and cobalt are the metals which are attracted by the magnet and can become m themselves. But in regard to their power of retaining the n netism none of them comes at all up to the compound metal

See MAGNETISM.

Chemical Changes.

The chemical changes which metals are liable to m classified according to the loss of metallicity involv them. We will adopt this principle and begin wit action of metals on metals, which, as experience s always leads to the formation of truly metallic compo

Any two or more metals when mixed together i liquid state unite chemically, or at least molecularly, i case that, although the mixture, on standing (hot) separate into layers, each layer is a homogeneous solut "alloy" of, in general, all the components in one an With binary combinations the following two cases present themselves. (1) the two metals mix perma in any proportion, or (2) either of the two metals r to take up more than a certain limit proportion o other, hence a random mixture of the two metals w general, part into two layers, one a solution of A the other a solution of B in A. The first case pr itself very frequently; it holds, for instance, for gol silver, gold and copper, copper and silver, lead an and any alloy of these two and bismuth. Many cases might be quoted. A good example of the case is lead and zinc, either of which dissolves only small percentage of the other. In the preparation alloy we need not start with the components in the state; the several metals need only be heated toget the same crucible when, in general, the liquid of th readily fusible part dissolves the more refractory ponents at temperatures far below their fusing points. lead, for instance, as many a tyro in chemical analys come to learn to his cost, readily runs through a pla crucible at little more than its own fusing point.

A homogeneous liquid alloy, when solidified sud say by pouring it drop by drop into cold water, nece yields an equally homogeneous solid. But it may so when it is allowed to freeze gradually. If, in thi we allow the process to go a certain way, and then p the still liquid portion, the frozen part generally p itself in the shape of more or less distinct crystals; w this happens or not, the rule is that its composition from that of the mother liquor, and consequently fro of the original alloy. This phenomenon of "liquati it is called, is occasionally utilized in metallurgy f approximate separation of metals from one another;[2] the manipulation of alloys made to be used as such prove very inconvenient. It does so, for instance, case of the copper silver alloy which our coins are of; in a large ingot of such sterling silver the co contain as much as 0·3 per cent. of silver more th outer shell.

The existence of crystallized alloys, as the phen of liquation generally, strongly suggests the ide alloys generally are mixtures, not of their elementar ponents, but of chemical compounds of these element one another, associated possibly with uncombined re of these. This notion is strongly supported by th that the formation of many alloys involves an e evolution of heat and a decided modification in wh would presume to be the properties of the corresp

[2] A good illustration is afforded by the process of Pattinson for concentrating the silver in argentiferous lead. See LEAD.

e. The case of sodium amalgam may be quoted orcible illustration. What goes by this name in ories is an alloy of two to three parts of sodium with ndred parts of mercury, which is easily produced by the two components into contact with each other ns of a mortar and pestle, when they unite, with ation, into an alloy which after cooling assumes the f a grey, hard, brittle solid, although mercury is a and sodium, though a solid, is softer than wax. evidence of chemical action we have in the cases of copper and zinc), bronze (copper and tin), aluminium (copper and aluminium), and in many others that be quoted. There are indeed a good many alloys mation of which is not accompanied by any obvious on of heat or any very marked change in the mean ties of the components. But in the absence of all thermic researche on the subject we are not in a n to assert the absence of chemical action in any Indeed our knowledge of the proximate composition ys is in the highest degree indefinite we do not now of a single composite metal which has been proved to be an unitary compound, and hence the ant problem of the relation in alloys between pro and composition must be attacked on a purely al basis. What has been done in this direction tly summarized in the following paragraphs.

Most metals are white or grey; so are the alloys of tals with one another. Gold alloys generally exhibit some- ke the shade of yellow which one would expect from their tion; its amalgams, however, are all white, not yellow. shows little tendency its characteristic red colour low with white or grey metals. Thus, for instance, the silver to about 30 per cent. of copper exhibits an almost pure olour. The alloys with zinc (brass) or tin (bronze) dish-yellow when the copper predominates largely. As portion of white metal increases, the colour passes succes- into dark yellow, pale yellow, and ultimately into white. um bronze, containing from 5 to 10 per cent. of aluminium, n-yellow.

ility. This quality is most highly developed in certain pure notably in gold, platinum, silver, and copper. Of platinum ittle is known. The other three, on uniting with one substantially retain their plasticities, but the addition of tal outside the group leads to deterioration. Thus, for according to Karsten, copper, by being alloyed with as little er cent. of zinc, loses its capability of being forged at a ; it cracks under the hammer. Antimony or arsenic to nt of 0·15 per cent. renders it unfit for being rolled into thin drawn out into fine wire, and makes it brittle in the heat; cent. of lead prohibits its conversion into leaf.

ss, Elasticity, Tensile Strength.—In reference to these , we shall confine ourselves to some very striking changes for er which the metals (1) gold, (2) silver, (3) copper suffer when with moderate proportions (10 per cent. or so) of (1) cop- copper, (3) tin, zinc, or aluminium respectively. Any of e combinations leads to a considerable increase in the three s named, although these are by no means highly developed lded metals; most strikingly it does so in the case of alumi- ron copper and phosphorus, which is so hard as to be fficult to file, and is said to be equal in tensile strength ght iron. To illustrate this we give in the following table, latthiesen, the breaking strains of double wires, No. 23 in lb avoirdupois, for certain alloys on the one hand and their ents on the other

Separate Metals		*Alloys.*	
... ...	25–30		
... ...	less than 4		
... ...	25–30		
... ...	20–25	Standard (22 carat) gold	70–75
... ...	10–15		
... ...	45–50	Alloys of silver, of platinum	75–80

fic Gravity. This subject has been extensively investigated thiesen, Calvert and Johnson, Kuppfer, and others. In ing the results it is convenient to compare the values (S) with the values (S_0) calculated on the assumption that the of the alloy is equal to the sum of the volumes of the com- Let p_1, p_2, p_3 stand for the relative weights of the com- P for their joint weight, S_1, S_2, S_3 for their specific s, and we have

$$\frac{P}{S_0} = \frac{p_1}{S_1} + \frac{p_2}{S_2} + \dots$$

where the expression on the right hand obviously means joint volume V_0 of the components; but the actual volum alloy formed by their union is, in general, $V = V_0(1 + e)$, means the expansion (or, when negative, the contraction) volume of mixture. Hence the real value

$$S = S_0/(1+e),$$

whence

$$e = (S_0 - S)/S.$$

Matthiesen's investigation (*Pogg. Annalen* for 1860, vol. c extends over a large number of binary alloys derived from th named in the following table. He naturally began by p pure specimens of these metals and determining their gravities. The results (each the mean of a number of de tions) were as follows:—

Name	Specific Gravity S at t° C	t
Antimony	6·713	14·3°
... ...	7·294	12·8
Cadmium.	8·655	10·5
Bismuth	9·823	12·3
	10·168	13·2
Lead	11·376	13·5
Mercury	13·573	11·5
	13·266	12·8

In these, as in all the subsequent determinations for th the weighings were reduced to the vacuum, and the valu referred to water at 4° C. as unity. From eight metals twen different kinds of binary alloys can be produced; of these ight combinations eighteen were selected; in each case the t ponents were fused together in a variety of properly chose proportions, and the specific gravities of these alloys were det The net results are summarized in the following table, w each combination A, B, in the first two columns gives t position in multiples of the "atomic-weights" given in just quoted, while column 3 gives the values of e as calcu the writer from Matthiesen's numbers for S_0 and S. H ample, in the accompanying entries the first line shows union into an alloy of twice 118 parts of tin and once 197 parts of gold involves an expansion from 1 volume into 1·004, the second that the union of once 118 parts of tin with four times 197 parts of gold involves a contraction from 1 volume into 1 – ·028.

Tin and G

Sn	A
2	1
1	4

Antimony and Tin.

		·002
1	2	·006
1	1 to 2	+ ·008
1	3 to 10	+ ·005
1	... ...	0

Antimony, Bismuth.

Bi	
1 to 12	

Antimony,

Pb	
2	1
1	1
2	1
3	1
5–25	1

Tin, Cadmium.

		+ ·004
		+ ·005
1	1 to 8	
1	12	

Tin, Bismuth.

Sn	
22	0
4	– ·002
3 1	– ·005
1	– ·005
	0

Tin, Gold.

Sn	Au	
50		
15–6		– ·002
4–2·5		+ ·002
2	1	+ ·004
3	2	+ ·008
1	1	+ ·012
1		+ ·015
1		– ·028

Tin, Lead.

Pb	
1	+ ·003
1	+ ·002
1	0
1	+ ·0015
2–4	+ ·005
6	+ ·004

Cadmium, B

Cd	Bi
3	1–36

Cadmium,

Cd	Pb
6	1–36

Bismuth, Silver.

Bi	Ag	e
		0 to
200–2		+ ·002
1		– ·003
1		– ·006
1		– ·007

Bismuth, Gold.

Bi	Au	
90	1	0
40	1	0
20	1	– ·003
8	1	– ·009
4	1	– ·017
2	1	– ·035
1	1	– ·039
1	2	– ·026

Tin, Sil

Sn	Ag

Lead, G

Pb

muth, Lead.		Lead, Silver.			Gold, Silver.		
Pb	e	Pb	Ag	e	Au	Ag	e
1	0	1	4	- 005	1	6	- 004
1	— ·003	1	2	— ·003	1	4	— 004
1	— ·005	1	1	0	1	2	— ·004
1	— ·007	2	1	+ ·003	1	1	— 002
1	— ·014	4	1	+ ·006	2	1	·0035
1	— ·024	10	1	+ ·004	4	1	0027
1	— ·040	25		+ 002	6	1	— 0024
2	— ·031						
3	— ·020						
4	— ·015	*Mercury, Tin.*			*Mercury, Lead.*		
5	— ·010						
12	— ·004	Hg	Sn	e	Hg	Pb	e
50	0	1	2	— 009	1	2	+ 002
		1	1	— ·005	1	1	010
		2	1	·007	2	1	— 016

ke these numbers trustworthy it would be necessary to de- their probable errors; and this Matthiesen has not done appear that any value of e from 0 to (say) + ·002 counts for and anything up to ·004 certainly must be taken as not much either way. If this is correct, then

o contraction or expansion is proved in the cases S Bi; Cd, Pb; Au, Ag;

contraction (from 0·5 to 4·7 per cent.) is proved for ; Bi, Ag; Bi, Au; Pb, Au; Pb, Bi; Hg, Sn, Hg, Pb; ?); Au, Ag (?);

expansion (from ·5 to 0·8 per cent.) is proved for Sb, Sn; Sn, Cd (?); Sn, Pb (?); certain cases of Sn, Au and Pb, Ag; the two series Sn, Au and Pb, Ag, there are cases both of on and of contraction.

ic and Electric Properties. The specific heat of an alloy, so know, is always in approximate accordance with Dulong t's law. Thus the specific heat of Cu_3Al_2 is

$$\frac{6\cdot4 + 1\cdot0 + 6\cdot4}{5} = \frac{63\cdot5 + 1 + 27}{7},$$

ut the same degree of correctness as the "constant" 6·4 n for itself.

sion.— Matthiesen, from numerous determinations made ys and their components, concludes that the expansion of (from 0° to 100° C.) is nearly equal to the sum of the ex- of its components. Supposing, for instance, one volume of expand (from 0° to t) by α, and one volume of silver by β; alloy of four volumes of gold and three volumes of silver by $(4\alpha + 3\beta)/7$ per unit.

lity. In the case of an alloy the melting point and the point are, in general, separated by a greater or less interval rature, and the latter in itself may have two values as shown berg, who found that when a fused alloy of tin and lead is to freeze the thermometer becomes stationary at two suc- points, as shown in the following table, where x means the of atomic weights of tin united with y of lead in the given the temperatures are in centigrade degrees.

	1	1	3	4	12	∞
∞	3	1	1	1	1	0
(325°)	280°	240	187	187	210°	(228)
(325)	187°	187°	187°	187°	187	(228)

e that the first point varies with, while the second, within e of the experiments, proved independent of, the proportion the two metals are united.

elting-point of many alloys lies below that of even the most omponent, as illustrated in the following tables, where the mean parts by weight.

Tin and Lead (Rudberg).

cent. of Tin.	Per cent. of Lead.	Melting
100	0	228
0	100	325
74	26	194
63	37	186
53	47	196
36	64	241
16	84	280

Name of Alloy.	Tin.	Lead.	Bismuth.	Cadmium.	Melting point
s	3	2	5	0	100°
	3	8	8	0	95
s	1	1	2	0	93·7
	2	4	7	1	70
um)	0	0	0	1	(320)

e alloys melt in boiling water.

lectric conductivity of alloys *qua* alloys has been investi- Matthiesen. He confined himself to binary alloys derived ertain set of elementary metals. The main results of his researches are given in ELECTRICITY, vol. viii. p. 51. practical electrician it is important to observe how very m conductivity of copper is impaired by very minute admixtu of metals that are good conductors, and also by non meta tamination, especially with oxygen (present as Cu_2O).

Metallic Substances Produced by the Union of Met Small Proportions of Non Metallic Elements.

Hydrogen, as was shown by Graham, is capa uniting with (always very large proportions of) metals, notably with palladium, into metal-like comp But those hydrogen alloys, being devoid of met interest, fall better under the heading PALLADIUM.

Oxygen.— Mercury and copper (perhaps also metals) are capable of dissolving their own oxide formation of alloys. Mercury, by doing so, become and unfit for its ordinary applications. Copper pure to start with, suffers considerable deteriora plasticity. But the presence of moderate proport cuprous oxide has been found to correct the evil i of small contaminations by arsenic, antimony, le other foreign metals. Most commercial coppers ow good qualities to this compensating influence.

Arsenic combines readily with all metals int arsenides, which latter, in general, are soluble in th itself. The presence in a metal of even small prop of arsenide generally leads to considerable deteri in mechanical qualities.

Phosphorus.—The remark just made might be hold for phosphorus were it not for the existence is called "phosphorus bronze," an alloy of coppe phosphorus (*i.e.*, its own phosphide), which possesse able properties. According to Abel, the most fav effect is produced by from 1 to 1½ per cent. of phos Such an alloy can be cast like ordinary bronze, but the latter in hardness, elasticity, toughness, and strength. See PHOSPHORUS.

Carbon.— Most metals when in a molten st capable of dissolving at least small proportions of which, in general, leads to a deterioration in met except in the case of iron, which by the addition o percentages of carbon gains in elasticity and tensile s with little loss of plasticity (see IRON).

Silicon, so far as we know, behaves to metals much like carbon, but our knowledge of facts is What is known as "cast iron" is essentially an iron proper with 2 to 6 per cent. of carbon and less of silicon (see IRON). Alloys of copper and were prepared by Deville in 1863. The alloy with cent. of silicon is white, hard, and brittle. When down to 4·8 per cent., it assumes the colour and fu of bronze, but, unlike it, is tenacious and ductile li

Action of the More Ordinary Chemical Agents Simple Metals.

To avoid repetition, let us state beforehand t metals to be referred to are always understood to b in the compact (frozen) condition, and that, whe series of metals are enumerated as being similarly a the degree of readiness in the action is (so far knowledge goes) indicated by the order in which the members are named, the more readily changed always standing first.

Water, at ordinary or slightly elevated tempe is decomposed more or less readily, with evolu hydrogen gas and formation of a basic hydrate, potassium (formation of KHO), sodium (NaHO), (LiOH), barium, strontium, calcium (BaO_2H_2, &c magnesium, zinc, manganese (MgO_2H_2, &c.).

In the case of group 1 the action is more or less and the hydroxides formed are soluble in water a

y basylous; metals of group 2 are only slowly
d, with formation of relatively feebly basylous
ctically insoluble hydrates. Disregarding the rarer
ts (as we propose to do in this section), the metals
med so far may be said to be proof against the
ot pure water in the absence of free oxygen (air).
he conjoint action of water and air, thallium, lead,
h are oxidized, with formation of more or less
ly soluble hydrates (ThHO, PbO_2H_2, BiO_3H_3),
in the presence of carbonic acid, pass into still less
basic carbonates.
, as everybody knows, when exposed to moisture and
usts,' that is, undergoes gradual conversion into a
ferric hydrate, $Fe_2O_3.nH_2O$; but this process never
place in the absence of air, and it is questionable
er it ever set in in the absence of carbonic acid.
is known that iron never rusts in solutions of
alkalies or lime (which reagents preclude the pre
of free carbonic acid), while it does so readily in
y moist air containing CO_2. When once started
ocess proceeds with increasing rapidity, the ferric
e produced acting as a carrier of oxygen; it gives
t of its oxygen to the adjoining metal, being itself
d to (perhaps) Fe_2O_3, which latter again absorbs
from the air to become ferric hydrate and so on
nann)
per, in the present connexion, is intermediate between
d the following group of metals.
cury, if pure, and all the "noble" metals (silver, gold,
m, and platinum metals), are absolutely proof against
even in the presence of oxygen and carbonic acid.
metals grouped together above under 1 and 2 act
am pretty much as they do on liquid water. Of
st, the following are readily oxidized by steam at a
eat, with formation of hydrogen gas,—zinc, iron,
m, cobalt, nickel, tin. Bismuth is similarly attacked,
owly, at a white heat. Aluminium is barely affected
t a white heat, if it is pure; the ordinary impure
is liable to be very readily oxidized.
ous Sulphuric or Hydrochloric Acid, of course,
dissolve groups 1 and 2, with evolution of hydro
d formation of chlorides or sulphates. The same
for the following group (A):—[manganese, zinc,
-ium] iron, aluminium, cobalt, nickel, cadmium.
ssolves readily in strong hot hydrochloric acid as
, aqueous vitriol does not act on it appreciably in
ld, at 150° it attacks it more or less quickly, accord-
the strength of the acid, with evolution of sul-
ted hydrogen or, when the acid is stronger, of
iron acid gas and deposition of sulphur (Calvert
ohnson). A group (B), comprising copper, are,
ntually, attacked only in the presence of oxygen or
Lead, in sufficiently dilute acid, or in stronger acid if
oo hot, remains unchanged. A group (C) may be
d of mercury, silver, gold, and platinum, which are
uched by either aqueous acid in any circumstances.
(concentrated) oil of vitriol does not attack gold,
um, and platinum-metals generally; all other metals
ding even silver) are converted into sulphates, with
ion of sulphurous acid. In the case of iron, ferric
ate, $Fe_2(SO_4)_3$, is produced: tin yields a somewhat
ite sulphate of its binoxide SnO_2.
ric Acid (*Aqueous*). Gold platinum, iridium, and
um only are proof against the action of this powerful
er. Tin and antimony (also arsenic) are converted by
imately) into hydrates of their highest oxides SnO_2,
(As_2O_5),—the oxides of tin and antimony being
ble in water and in the acid itself. All other metals,
ing palladium, are dissolved as nitrates, the oxidiz-
rt of the reagent being generally reduced to nitric
oxide, NO, or sometimes to N_2O_3 or N_2O_4. Iron
cadmium, also tin under certain conditions, redu
dilute acid, partially at least, to nitrous oxide, N
nitrate of ammonia, $NH_4.NO_3 = N_2O + 2H_2O$.

Aqua Regia, a mixture of nitric and hydrochloric
converts all metals (even gold, the "king of metals," w
the name) into chlorides, except only rhodium, ir
and ruthenium, which, when pure, are not attacked

Caustic Alkalies. Of metals not decomposing
pure water, only a few dissolve in aqueous
potash or soda, with evolution of hydrogen. The
important of these are aluminium and zinc, whi
converted into aluminate, $Al_2O_3.3(K_2$ or $Na_2)O$
zincate, $ZnO.R_2HO$, where R = K or Na respec
But of the rest the majority, when treated with
sufficiently strong alkali, are attacked at least superf
of ordinary metals only gold, platinum, and silv
perfectly proof against the reagents under conside
and these accordingly are used preferably for the co
tion of vessels intended for analytical operations inv
the use of aqueous caustic alkalies. For prep
purposes iron is universally employed and works we
it is not available analytically, because a superficial
tion of the empty part of the vessel (by the water a
cannot be prevented. According to the writer's exp
basins made of pure malleable nickel are free fr
drawback; they work as well as platinum, and rathe
than silver ones do. There is hardly a single meta
holds out against the alkalies themselves when in th
of fiery fusion; even platinum is most violently at
In chemical laboratories fusions with caustic alkal
always effected in vessels made of gold or silver
metals holding out fairly well even in the presence
Gold is the better of the two. Iron, which stands
against aqueous alkalies, is most violently attacked
fused reagents. Yet tons of caustic soda are fuse
in chemical works in iron pots without thereby su
contamination, which seems to show that (clean
like gold and silver, is attacked only by the c
action of fused alkali and air, the influence of the
being of course minimized in large scale operations.

Oxygen or Air. The noble metals (from silver up
do not combine directly with oxygen given as oxyg
(O_2), although, like silver, they may absorb this gas
when in the fused condition, and may not be proof
ozone, O_3. Mercury, within a certain range of te
tures situated close to its boiling point, combines
with oxygen into the red oxide, which, however, br
again at higher temperatures. All other metals
heated in oxygen or air, are converted, more or less
into stable oxides. Potassium, for example, yields pe
K_2O_2 or K_2O_4; sodium gives Na_2O_2; the barium
metals, as well as magnesium, cadmium, zinc, lead,
are converted into their monoxides MeO. Bismu
antimony give (the latter very readily) sesquioxide
and Sb_2O_3, the latter being capable of passin
Sb_2O_4). Aluminium, when pure and kept out of
with siliceous matter, is only oxidized at a whi
and then very slowly, into alumina, Al_2O_3. Tin,
temperatures, passes slowly into binoxide, SnO_2.

Sulphur.—Amongst the better known metals, go
aluminium are the only ones which, when heate
sulphur or in sulphur vapour, remain unchanged.
rest, under these circumstances, are converted into su
The metals of the alkalies and alkaline earth
magnesium, burn in sulphur-vapour as they do in
Of the heavy metals, copper is the one which exh
far the greatest avidity for sulphur, its subsulphi
being the stablest of all heavy metallic sulph
opposition to dry reactions. See METALLURGY

lorine.—All metals, when treated with chlorine gas at proper temperatures, pass into chlorides. In some the chlorine is taken up in two instalments, a lower de being produced first, to pass ultimately into a r chloride. Iron, for instance, is converted first $FeCl_2$, ultimately into Fe_2Cl_6, which practically means ture of the two chlorides, or pure Fe_2Cl_6 as a final ct. Of the several products, the chlorides of gold latinum ($AuCl_3$ and $PtCl_4$) are the only ones which heated beyond their temperature of formation iate into metal and chlorine. The ultimate chlorina product of copper, $CuCl_2$, when heated to redness, poses into the lower chloride, Cu_2Cl_2, and chlorine. e rest, when heated by themselves, volatilize, some er, others at higher temperatures.

the several individual chlorides, the following are s or solids, volatile enough to be distilled from out ss vessels: $AsCl_3$, $SbCl_3$, $SnCl_4$, $BiCl_3$, $HgCl$, the des of arsenic, antimony, tin, bismuth, mercury re vely. The following are readily volatilized in a t of chlorine, at a red heat: Al_2Cl_6, Cr_2Cl_6, Fe_2Cl_6, lorides of aluminium, chromium, iron. The follow hough volatile at higher temperatures, are not vola d at dull redness: KCl, NaCl, LiCl, $NiCl_2$, $CoCl_2$, , $ZnCl_2$, $MgCl_2$, $PbCl_2$, AgCl, the chlorides of sium, sodium, lithium, nickel, cobalt, manganese, magnesium, lead, silver. Somewhat less volatile the last-named group are the chlorides (MCl_2) of m, strontium, and calcium.

tallic chlorides, as a class, are readily . The following are the most important exceptions: oride of silver, AgCl, and subchloride of mercury, l_2, are absolutely insoluble; chloride of lead, $PbCl_2$, subchloride of copper, Cu_2Cl_2, are very sparingly le in water. The chlorides $AsCl_3$, $SbCl_3$, $BiCl_3$, are at decomposed by (liquid) water, with formation of (As_2O_3) or oxychlorides (SbOCl, BiOCl) and hydro- c acid. The chlorides $MgCl_2$, Al_2Cl_6, Cr_2Cl_6, Fe_2Cl_6 a similar decomposition when evaporated with water heat. The same holds in a limited sense for $ZnCl_2$, , $NiCl_2$, and even $CaCl_2$. All chlorides, except those ver and mercury (and, of course, those of gold and um), are oxidized by steam at high temperatures, elimination of hydrochloric acid.

e above statements concerning the volatilities and ilities of metallic chlorides form the basis of a er of important analytical methods for the separation respective metals.

r the characters of metals as chemical elements the r is referred to the article CHEMISTRY and to the l articles on the different metals. (W. D.)

ETAL-WORK. Among the many stages in the de ment of primeval man, none can have been of greater en in his struggle for existence than the discovery e metals, and the means of working them. The s generally given to the three prehistoric periods of life on the earth the Stone, the Bronze, and the Iron imply the vast importance of the progressive steps the flint knife to the bronze celt, and lastly to the edged elastic iron weapon or tool. The length of during which each of these ages lasted must of cours been different in every country and race in the world. Digger Indians of South California have even now rogressed beyond the Stone Age; while some of the of Central Africa are acquainted with the use of r and bronze, though they are unable to smelt or iron.

e metals chiefly used have been gold, silver, copper in (the last two generally mixed, forming an alloy l bronze), iron, and lead. The peculiarities of these various metals have naturally marked out each of th special uses and methods of treatment. The durabil the extraordinary ductility and pliancy of gold, its p being subdivided, drawn out, or flattened into wire of almost infinite fineness, have led to its being u works where great minuteness and delicacy of ex were required; while its beauty and rarity have, most part, limited its use to objects of adornm luxury, as distinct from those of utility. In a degree most of the qualities of gold are shared by and consequently the treatment of these two met always been very similar, though the greater abu of the latter metal has allowed it to be used on a scale and for a greater variety of purposes.

Bronze is an alloy of copper and tin in varying tions, the proportion of tin being from 8 to 20 p The great fluidity of bronze when melted, the slight its contraction on solidifying, together with its dens hardness, make it especially suitable for casting, an of its taking the impress of the mould with extreme ness and delicacy. In the form of plate it can be te and annealed till its elasticity and toughness are increased, and it can then be formed into almost an under the hammer and punch. By other meth treatment, known to the ancient Egyptians, Greek others, but now forgotten, it could be hardened and into knife and razor edges of the utmost keenne many specimens of ancient bronze small quanti silver, lead, and zinc have been found, but their p is probably accidental.

In modern times, after the discovery of zinc, an copper and zinc called brass has been much used, for the sake of its cheapness as compared with bron beauty, durability, and delicacy of surface it is very to bronze, and, though of some commercial importa been of but little use in the production of works of

To some extent copper was used in an almost pu during mediaeval times, especially from the 12th 15th century, mainly for objects of ecclesiastical u as pyxes, monstrances, reliquaries, and croziers, p account of its softness under the tool, and also be was slightly easier to apply enamel and gilding copper than to bronze (see fig. 1). In the m period it was used to some extent in the shape sheeting for roofs, as at St Mark's, Venice; while the 16th and 17th centuries it was largely emplo ornamental domestic vessels of various sorts.

Iron.[1] The abundance in which iron is foun many places, its great strength, its remarkable d and malleability in a red hot state, and the ea which two heated surfaces of iron can be welded t under the hammer combine to make it specially for works on a large scale where strength with l are required things such as screens, window grill mental hinges, and the like.

In its hot plastic state iron can be formed and u under the hammer to almost any degree of refi while its great strength allows it to be beaten leaves and ornaments of almost paper-like thinn delicacy. With repeated hammering, drawing o annealing, it gains much in strength and toughn the addition of a very minute quantity of carbon

[1] Some recent analyses of the iron of prehistoric weap brought to light the interesting fact that many of the specimens of iron manufacture contain a considerable perce nickel. This special alloy does not occur in any known i but is invariably found in meteoric iron. It thus appears was manufactured from meteorolites which had fallen to the an almost pure metallic state, possibly long before prehist had learnt how to dig for and smelt iron in any of the form which are found on the planet.

eel, less tough, but of the keenest hardness. The ployment of cast iron is comparatively modern, in at least only dating from the 16th century: it is ever, incapable of artistic treatment if due regard to the necessities of casting, and if no attempt is imitate the fine-drawn lightness to which wrought eadily lends itself. At the best, however, it is not y suited for the finest work, as the great contrac- ron in passing from the fluid to the solid state the cast somewhat blunt and spiritless.

g the Assyrians, Egyptians, and Greeks the use of her cast or wrought, was very limited, bronze being urite metal for all purposes. culty of smelt ore was prob e reason for well as the rgotten skill nabled bronze empered to a edge. It had, its value, of proof occurs er (*Il.* xxiii.), mass of iron oned as being the prizes at eral games of s.

ds of Manipu Metal Work. silver, and nay be treated ous ways, the which are (1) in a mould, treatment by ing and punch- nch, *repousse*). first of these, is chiefly l to bronze, e case of the ecious metals they are used y small scale. son of this is repoussé relief much thinner ce than it the sign were cast, by the most metal worker, a large surface produced with small expendi valuable metal. ing is probably ost primitive of metal-work.

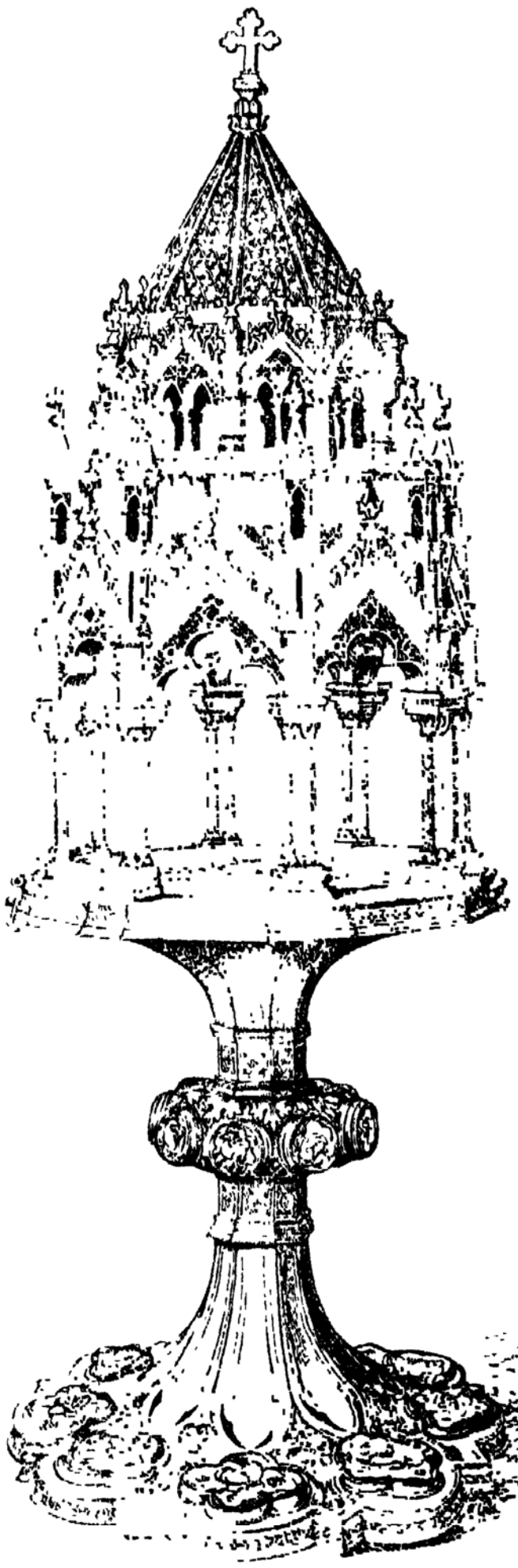


Fig. 1.—Monstrance of Copper Gilt; Italian work of the 15th century

as passed through three stages, the first being ted by solid castings, such as are most celts and mplements of the prehistoric time; the mould rmed of clay, sand, or stone, and the fluid metal ured in till the hollow was full. The next stage the case of bronze, to introduce an iron core, prob- save needless expenditure of the more valuable The British Museum possesses an interesting n or Archaic Italian example of this primitive device. It is a bronze statuette from Sessa on the Volturno, about 2 feet high, of a female standing, robed in a close-fitting chiton. The presence of the iron core has been made visible by the splitting of the figure, owing to the unequal contraction of the two metals. The forearms, which are extended, have been cast separately and soldered or brazed on to the elbows.

The third and last stage in the progress of the art of casting was the employment of a core, generally of clay, round which the metal was cast in a mere skin, only thick enough for strength, without waste of metal. The Greeks and Romans attained to the greatest possible skill in this process. Their exact method is not certainly known, but it appears probable that they were acquainted with the process now called *à cire perdue*—the same as that employed by the great Italian artists in bronze, and still unimproved upon even at the present day. Cellini, the great Florentine artist of the 16th century, has described it fully in his *Trattato della Scultura*. If a statue was to be cast, the figure was first roughly modelled in clay—only rather smaller in all its dimensions than the future bronze; all over this a skin of wax was laid, and worked by the sculptor with modelling tools to the required form and finish. A mixture of pounded brick, clay, and ashes was then ground finely in water to the consistence of cream, and successive coats of this mixture were then applied with a brush, till a second skin was formed all over the wax, fitting closely into every line and depression of the modelling. Soft clay was then carefully laid on to strengthen the mould, in considerable thickness, till the whole statue appeared like a shapeless mass of clay, round which iron hoops were bound to hold it all together. The whole was then thoroughly dried, and placed in a hot oven, which baked the clay, both of the core and the outside mould, and melted the wax, which was allowed to run out from small holes made for the purpose. Thus a hollow was left, corresponding to the skin of wax between the core and the mould, the relative positions of which were preserved by various small rods of bronze, which had previously been driven through from the outer mould to the rough core. The mould was now ready, and melted bronze was poured in till the whole space between the core and the outer mould was full. After slowly cooling, the outer mould was broken away from outside the statue, and the inner core as much as possible broken up and raked out through a hole in the foot or some other part of the statue. The projecting rods of bronze were then cut away, and the whole finished by rubbing down and polishing over any roughnesses or defective places. The most skilful sculptors, however, had but little of this after-touching to do, the final modelling and even polish which they had put upon the wax being faithfully reproduced in the bronze casting.

The further enrichment of the object by enamels and inlay of other metals was practised at a very early period by Assyrian, Egyptian, and Greek metal-workers, as well as by the artists of Persia and mediæval Europe.

The second chief process, that of hammered work (Greek, *sphyrelata*: French, *repoussé*), was probably adopted for bronze work on a large scale, before the art of forming large castings was discovered. In the most primitive method thin plates of bronze were hammered over a wooden core, rudely cut into the required shape, the core serving the double purpose of giving shape to and strengthening the thin metal.

A further development in the art of hammered work consisted in laying the metal plate on a soft and elastic bed of cement made of pitch and pounded brick. The design was then beaten into relief from the back with hammers and punches, the pitch bed yielding to the protuberances which were thus formed, and serving to pre-

he punch from breaking the metal into holes. The was then melted away from the front of the embossed and applied in a similar way to the back, so that the ling could be completed on the face of the relief, al touches being given by the graver. This process hiefly applied by mediæval artists to the precious , but by the Assyrians, Greeks, and other early s it was largely used for bronze.

great gates of Shalmaneser II., 859–824 B.C., from at, now in the British Museum, are a remarkable le of this sort of work on a large scale, though the ent of the reliefs is minute and delicate. The "Siris s," in the same museum, are a most astonishing le of the skill attained by Greek artists in this ssé work (see Brönsted's *Bronzes of Siris*, 1836). are a pair of shoulder-pieces from a suit of bronze r, and each has in very high relief a combat between ek warrior and an Amazon. No work of art in has probably ever surpassed these little figures for , vigour, and expression, while the skill with which ist has beaten these high reliefs out of a flat plate tal appears almost miraculous. The heads of the are nearly detached from the ground, their sub is little thicker than paper, and yet in no place e metal been broken through by the punch. They obably of the school of Praxiteles, and date from the ntury B.C. (see fig. 2).

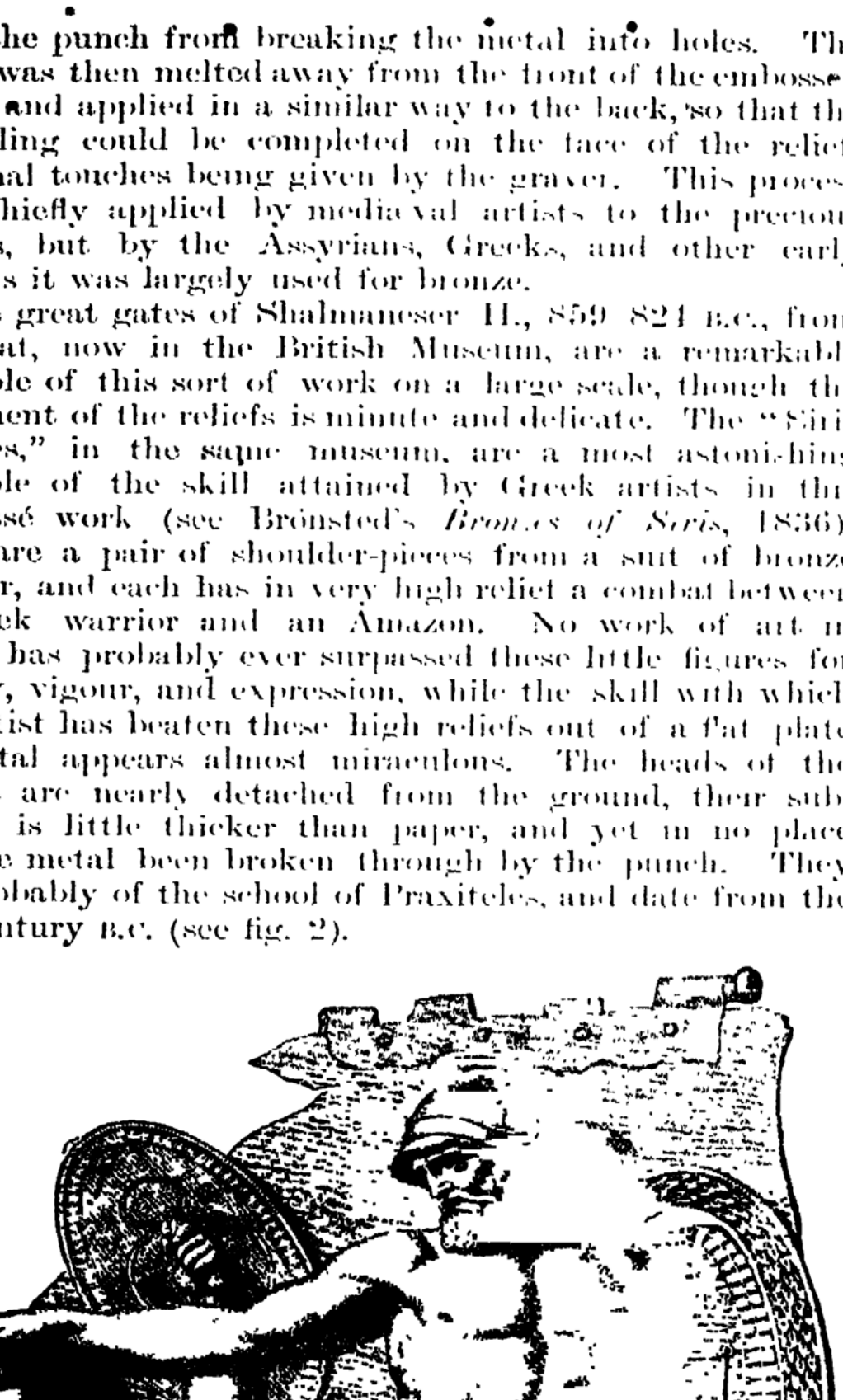


FIG. 2.—One of the Siris Bronzes.

er and tin have been but little used separately. in its pure state may be worked by the same s as bronze, but it is inferior to it in hardness, h, and beauty of surface. Tin is too weak and brittle a metal to be employed alone for any bu objects. Some considerable number of tin drinki and bowls of the Celtic period have been found i wall in the neighbourhood of the celebrated tin and mines, which appear to have been worked from a ve period. The existence of these mines was known Phœnicians, who carried on a considerable trade m with the south west corner of England and the Sci probably the Cassiterides of Pliny and other writers.

The use of lead has been more extended. In sl forms the best of all coverings for roofs and even In the Roman and mediæval periods it was large for coffins, which were often richly ornamented wi work in relief. Though fusible at a very low tempe and very soft, it has great power of resisting deca damp or exposure. Its most important use in an ·en has been in the shape of baptismal fonts, between the 11th and the 14th centuries. The s beauty of colour and durability of old specimens of owing to the natural presence of a small propor silver. Modern smelters carefully extract this silve the lead ore, thereby greatly impairing the durabil beauty of the metal.

As in almost all the arts, the ancient Egyptians e in their metal work, especially in the use of bron the precious metals. These were worked by castin hammering, and ornamented by inlay, gilding, and e with the greatest possible skill.

From Egypt perhaps was derived the early skill Hebrews. Further instruction in the art of metal w came probably to the Jews from the neighbouring c of Tyre. The description of the great gold li Solomon's throne, and the laver of cast bronze sup on figures of oxen, shows that the artificers of that ti overcome the difficulties of metal working and fo on a large scale. The Assyrians were perhaps the remarkable of all ancient nations for the colossal si splendour of their works in metal; whole circuit w great cities, such as Ecbatana, are said to have covered with metal plates, gilt or silvered.

Herodotus, Athenæus, and other Greek and writers have recorded the enormous number of c statues and other works of art for which Babylo Nineveh were so famed. The numerous objects of and other metals brought to light by the excavati the last forty years in the Tigris and Euphrates v though mostly on a small scale, bear witness to the skill and artistic power of the people who produced while the recent discovery of some bronze stat shown by inscriptions on them to be not later than B.C., proves how early was the development of this of art among the people of Assyria.

The Metal-Work of Greece.— The poems of Hom full of descriptions of elaborate works in bronze, iron and silver, which, even when full allowance is ma poetic fancy, show clearly enough a very advanced a of skill in the working and ornamenting of these among the Greeks of his time. His description shield of Achilles, made of bronze, enriched with ba figure reliefs in gold, silver, and tin, could hardly been written by a man who had not some pe acquaintance with works in metal of a very elaborate Again, the accuracy of his descriptions of brazen hou such as that of Alcinous, *Od.* vii. 81—is borne witness Pausanias's mention of the bronze temple of A Χαλκίοικος in Sparta, and the bronze chamber ded to Myron in 618 B.C., as well as by the discovery stains and bronze nails, which show that the whole in of the so-called treasury of Atreus at Mycenæ was

covered with a lining of bronze plates. Of the two chief methods of working bronze, gold, and silver, it is probable that the hammer process was first practised, at least for statues, among the Greeks, who themselves attributed the invention of the art of hollow casting to Theodorus and Rhœcus, both Samian sculptors, about the middle of the 6th century B.C. Pausanias specially mentions that one of the oldest statues he had ever seen was a large figure of Zeus in Sparta, made of hammered bronze plates riveted together. With increased skill in large castings, and the discovery of the use of cores, by which the fluid bronze was poured into a mere skin-like cavity, hammered or repoussé work (Greek, *sphyrelata*) was only used for small objects where lightness was desirable, or for the precious metals in order to avoid large expenditure of metal. The colossal statues of ivory and gold by Phidias were the most notable examples of this use of gold, especially his statue of Athena in the Parthenon, and the one of Zeus at Olympia. The nude parts, such as face and hands, were of ivory, while the armour and drapery were of beaten gold. The comparatively small weight of gold used by Phidias is very remarkable when the great size of the statues is considered.

A graphic representation of the workshop of a Greek sculptor in bronze is given on a fictile vase now in the Berlin Museum (see Gerhard's *Trinkschalen*, plates xii., xiii.). One man is raking out the fire in a high furnace, while another behind is blowing the bellows. Two others are smoothing the surface of a statue with scraping tools, formed like a strigil. A fourth is beating the arm of an unfinished figure, the head of which lies at the workman's feet. Perhaps the most important of early Greek works in cast bronze, both from its size and great historical interest, is the bronze pillar (now in the Hippodrome at Constantinople) which was erected to commemorate the victory of the allied Greek states over the Persians at Platæa in 479 B.C. (see Newton's *Travels in the Levant*). It is in the form of three serpents twisted together, and before the heads were broken off was at least 20 feet high. It is cast hollow, all in one piece, and has the names of the allied states engraved on the lower part of the coils. Its size and the beauty of its surface show great technical skill in the founder's art. On it once stood the gold tripod dedicated to Apollo as a tenth of the spoils. It is described both by Herodotus and Pausanias.

Marble was comparatively but little used by the earlier Greek sculptors, and even Myron, a rather older man than Phidias, seems to have executed nearly all his most important statues in metal.

Additional richness was given to Greek bronze-work by gold or silver inlay on lips, eyes, and borders of the dress; one remarkable statuette in the British Museum has eyes inlaid with diamonds, and fret-work inlay in silver on the border of the chiton.

The mirrors of the Greeks are among the most important specimens of their artistic metal-work. These are bronze disks, one side polished to serve as a reflector, and the back ornamented with engraved outline drawings, often of great beauty (see Gerhard, *Etruskische Spiegel*, 1843–67).

The Greek workman, in fact, was incapable of making an ugly thing. Whatever the metal or whatever the object formed, whether armour, personal ornaments, or domestic vessels, the form was always specially adapted to its use, the ornament natural and graceful, so that the commonest water-jar was a delight alike to him who made it and those who used it.

In metal-work, as in other arts, the Romans were pupils and imitators of the Greeks. Owing to the growth of that spirit of luxury which in time caused the extinction of the Roman empire, a considerable demand arose for magnificent articles of gold and silver plate. The finest examples of these that still exist are the very beautiful silver plate found buried near Hildesheim in 1869, now in the Berlin Museum. They consist of drinking cups, bowls, vases, ladles, and other objects of silver, partly gilt and exquisitely decorated with figures in relief, both chased and repoussé. There are electrotypes of these in the South Kensington Museum.

When the seat of the empire was changed from Rome to Byzantium, the latter city became the chief centre for the production of artistic metal-work. From Byzantium the special skill in this art was transmitted in the 9th and 10th centuries to the Rhenish provinces of Germany, and thence to Italy, and thence to the whole of Western Europe. In this way the 18th-century smith who wrought the famous Versailles Court iron gates was the heir to the mechanical skill of the ancient metal-workers of Phœnicia and Greece.

In that period of extreme degradation into which the higher arts fell after the destruction of the Roman empire, though true feeling for beauty and knowledge of the subtleties of the human form remained for centuries dormant, yet at Byzantium at least there still existed great technical skill and power in the production of all sorts of metal-work. In the age of Justinian (first half of the 6th century) the great church of St Sophia at Constantinople was adorned with an almost incredible amount of wealth and splendour in the form of gold altars, candlesticks, and other ecclesiastical furniture of massive gold and silver.

Metal-Work in Italy.—It was therefore to Byzantium that Italy turned for metal workers, and especially for smiths, when, in the 6th to the 8th centuries, the great church of St Peter's in Rome was enriched with masses of gold and silver for decorations and fittings, the gifts of successive donors from Belisarius to Leo III., the mere catalogue of which reads like a tale from the *Arabian Nights*. The gorgeous Pala d'Oro, still in St Mark's at Venice, a magnificent retable covered with delicate reliefs and enriched with fine enamels and jewels, was the work of Byzantine artists during the 11th century. This work was in progress for more than a hundred years, and was set in its present form in 1106 A.D., though still unfinished (see Bellomo, *Pala d'Oro di S. Marco*, 1847).

It was, however, especially for the production of bronze doors for churches, ornamented with panels of figures in high relief, that Italy obtained the services of Byzantine workmen (see Garrucci, *Arte Cristiana*, 1872–82). An artist named Staurachios produced many works of this class, some of which still exist, such as the bronze doors of the cathedral at Amalfi, dated 1066 A.D. Those by the same artist, though his name was spelt differently, were the bronze doors of San Paolo fuori le Mura, Rome, careful drawings of which exist, though the originals were destroyed in the fire of 1824. Other important examples exist at Ravello (1197), Monreale (1099), Amalfi (1062), Atrani (1087); and doors of Monreale in Sicily and at Trani, signed by an artist named Barisanos (end of the 12th century); the reliefs of the last are remarkable for expression and dignity, in spite of their early rudeness of modelling and ignorance of the human figure.

Most of these works in bronze were enriched with lines inlaid in silver, and in some cases with a black niello or enamel. The technical skill of these Byzantine metal-workers was soon acquired by native Italians, who produced many important works in bronze similar in style and execution to those of the Byzantines. Such, for example, are the bronze doors of San Zeno at Verona (unlike the others, of repoussé not cast work) and of the Duomo of Pisa, cast in 1180 by Bonannus, and

of Troia, the last made in the beginning of the 12th by Oderisius of Benevento. Another artist named f Amalfi worked in the same way; and in the 9 the brothers Hubertus and Petrus of Piacenza bronze door for one of the side chapels in San i in Laterano. One of the most important early ns of metal-work is the gold and silver altar of mbrogio in Milan. In character of work and it resembles the Venice Pala d'Oro, but is still n date, being a gift to the church from Arch- Angilbert II. in 835 A.D. (see Du Sommerard, Agincourt, *Moyen Âge*). It is signed WOLVINIVS R PHABER; nothing is known of the artist, but he y belonged to the semi Byzantine school of the rovinces; according to Dr Rock he was an Anglo- oldsmith. It is a very sumptuous work, the front altar being entirely of gold, with repoussé reliefs soudée enamels; the back and ends are of silver, ld ornaments. On the front are figures of Christ twelves apostles; the ends and back have reliefs ing the life of St Ambrose.

most important existing work of art in metal of the ntury is the great candelabrum now in Milan al. It is of gilt bronze, more than 14 feet high; seven branches for candles, and its upright stem orted on four winged dragons. For delicate and execution, together with refined gracefulness of it is unsurpassed by any similar work of art. Every the numerous little figures with which it is adorned ry of study for the beauty and expression of the face, dignified arrangement of the drapery (see fig. 3).

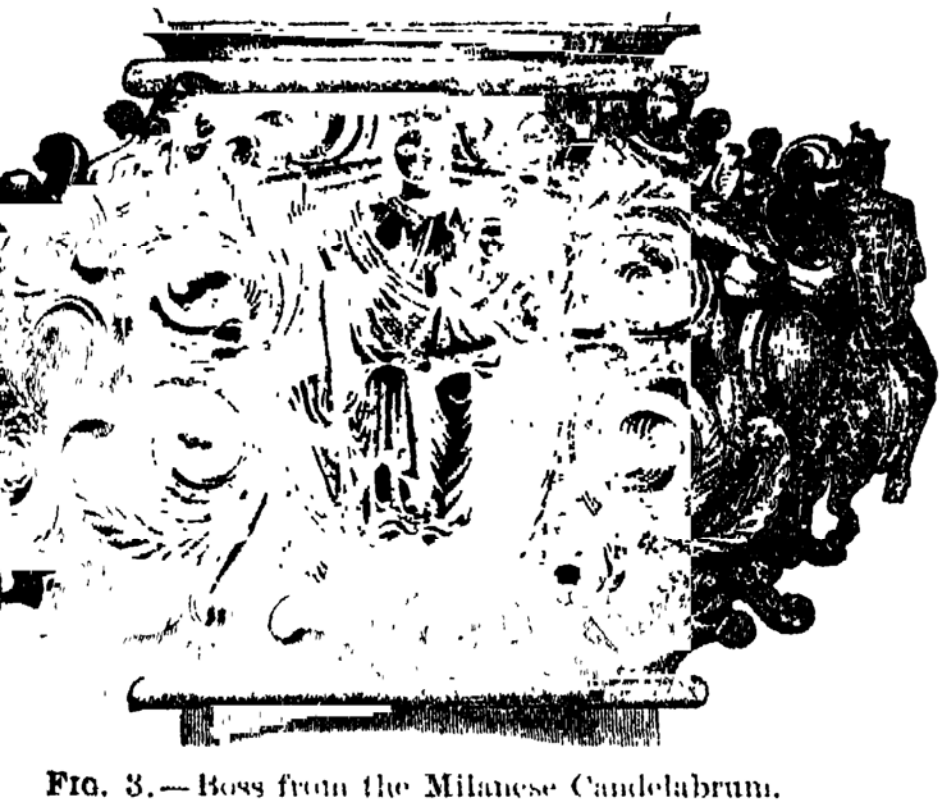


FIG. 3.—Boss from the Milanese Candelabrum.

mi-conventional open scroll-work of branches and hich wind around and frame each figure or group is with the most perfect taste and richness of fancy, ach minute part of this great piece of metal-work hed with all the care that could have been bestowed smallest article of gold jewellery. Though some- in the grotesque dragons of the base recalls the ine school, yet the beauty of the figures and the eling for graceful curves and folds in the drapery o a native Italian as being the artist who produced onderful work of art. There is a cast in the South gton Museum.

ing the 13th and 14th centuries in Italy the wide- influence of Niccolo Pisano and his school encouraged lptor to use marble rather than bronze for his work. s period wrought iron came into general use in the f screens for chapels and tombs, and grills for ws. These are mostly of great beauty, and show table skill in the use of the hammer, as well as power in adapting the design to the requirements of the material. Among the finest examples of this sort of work are the screens round the tombs of the Scala family at Verona, 1350 75, - a sort of net work of light cusped quatrefoils, each filled up with a small ladder (scala) in allusion to the name of the family. The most elaborate specimen of this wrought work is the screen to the Rinuccini chapel in Santa Croce, Florence, of 1371, in which moulded pillars and window like tracery have been wrought and modelled by the hammer with extraordinary skill (see Wyatt, *Metal-Work of Middle Ages*). Of about the same date are the almost equally magnificent screens in Sta Trinita, Florence, and at Siena across the chapel in the Palazzo Pubblico. The main part of most of these screens is filled in with quatre-foils, and at the top is an open frieze formed of plate iron pierced, repoussé, and enriched with engraving.

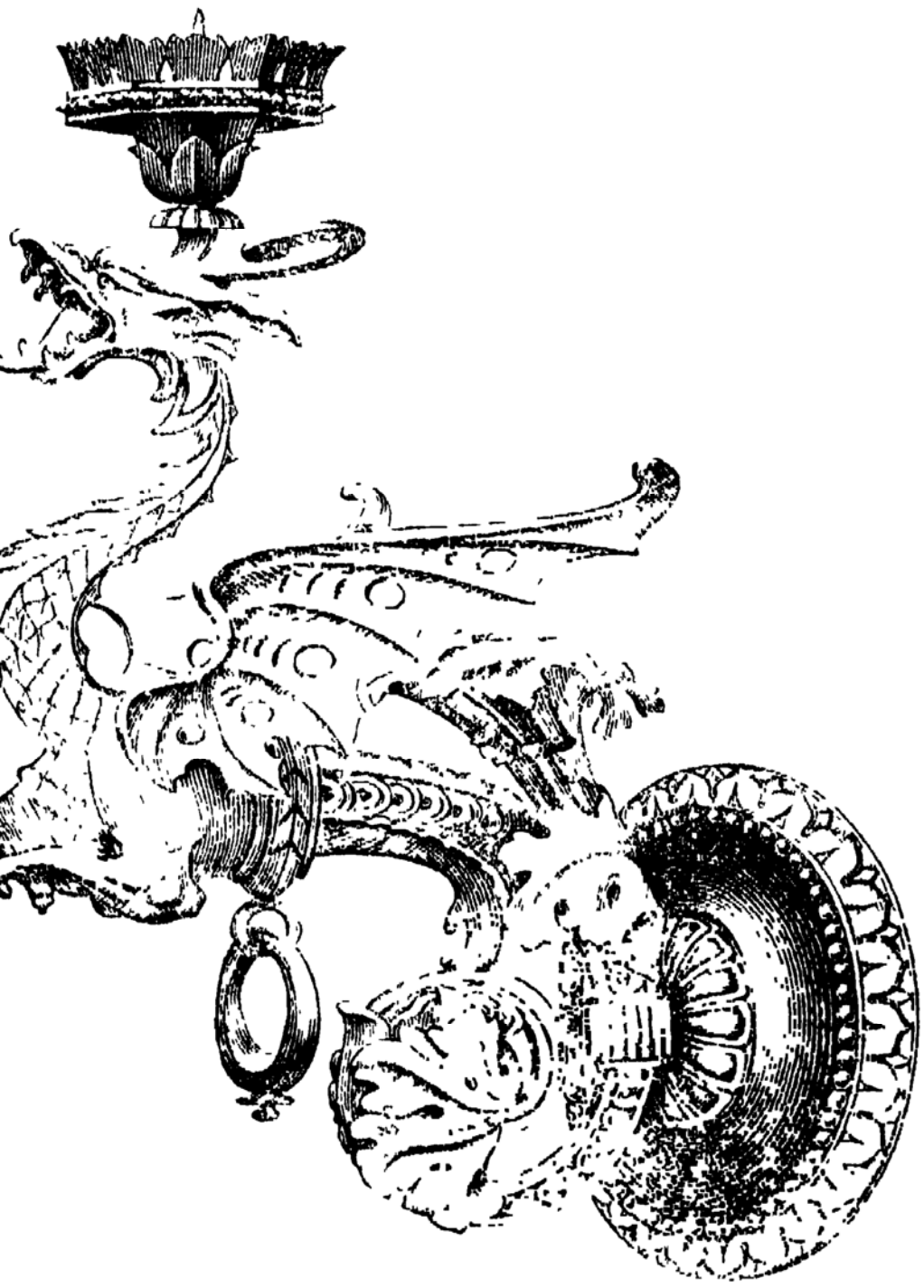
In the 14th century great quantities of objects for ecclesiastical use were produced in Italy, some on a large scale, and mostly the works of the best artists of the time.

FIG. 4.—Silver Reliefs from the Pistoia Retable.

The silver altar of the Florence baptistery is one chief of these; it was begun in the first half of the 14th century, and not completed till after 1477 (see *Gaz. des Beaux Arts*, Jan. 1883). A whole series of the greatest artists in metal laboured on it in succession, among whom were Orcagna, Ghiberti, Verrocchio, Ant. Pollajuolo, and many others. It has elaborate reliefs in repousse work, cast canopies, and minute statuettes, with the further enrichment of translucent coloured enamels. The silver altar and retable of Pistoia cathedral (see fig. 4), and the great shrine at Orvieto, are works of the same class, and of equal importance.

Whole volumes might be devoted to the magnificent works in bronze produced by the Florentine artists of this century, works such as the baptistery gates by Ghiberti, and the statues of Verrocchio, Donatello, and many others, but these come rather under the head of sculpture.

very magnificent bronze screens were produced at
ne, especially that in Prato cathedral by Simone,
of Donatello, in 1444-61, and the screen and bronze
nts of the tomb of Piero and Giovanni dei Medici
Lorenzo, Florence, by Verrocchio, in 1472
he latter part of the 15th century and the beginning
16th the Pollajuoli, Ricci, and other artists devoted
labour and artistic skill to the production of candle-
and smaller objects of bronze, such as door knockers,
ot which are works of the greatest beauty. The
sticks in the Certosa near Pavia, and in the cathedrals
ice and Padua, are the finest examples of these.
olò Grossi, who worked in wrought iron under the
gge of Lorenzo dei Medici, produced some wonderful
ens of metal work, such as the candle-sticks, lanterns,
gs fixed at intervals round the outside of the great
(see fig. 5). The Strozzi palace in Florence and



s. 5.—Wrought Iron Candle-Bracket, late 15th century.
Florentine work.

lazzo del Magnifico at Siena have fine specimens of
the former of wrought iron, the latter in cast bronze.
Venice fine work in metal, such as salvers and vases,
ing produced, of almost Oriental design, and in
ases the work of resident Arab artificers. In the
entury Benvenuto Cellini was supreme for skill in
duction of enamelled jewellery, plate, and even larger
of sculpture (see Plon's *Ben. Cellini*, 1882), and John
gna in the latter part of the same century inherited
extent the skill and artistic power of the great
ntury artists. Since that time Italy, like other
es, has produced little metal-work of real value.
n.—From a very early period the metal-workers of
ave been distinguished for their skill, especially in
of the precious metals. A very remarkable set of
ens of goldsmith's work of the 7th century are the
votive crowns, two crosses, and other objects found
in 1858 at Guarrazar, and now preserved at Madrid
Paris in the Cluny Museum (see Du Sommerard, *L*
Cluny, 1852). Magnificent works in silver, such as
altar crosses, and church vessels of all kinds, we
duced in Spain from the 11th to the 16th cen
especially a number of sumptuous tabernacles (*c*
for the host, magnificent examples of which stil
in the cathedrals of Toledo and Seville. The
and wrought iron screens *rejas*, mostly of th
and 16th centuries to be found in almost eve
portant church in Spain are very fine examples of
work. They generally have moulded rails or bal
and rich friezes of pierced and repoussé work, the
being often thickly plated with silver. The comm
of metal for pulpits is a peculiarity of Spain; t
sometimes of bronze, as the pairs in Burgos and
cathedrals, or in wrought iron, like those at Zam
in the church of San Gil, Burgos. The great candl
or *tenebrarium* in Seville cathedral is the finest
men of 16th century metal work in Spain; it was
the work of Bart. Morel in 1562. It is of cast
enriched with delicate scroll-work foliage, and wit
bers of well modelled statuettes, the general effec
very rich and graceful. Especially in the art of
work Spain was much influenced in the 15th an
centuries by both Italy and Germany, so that num
Spanish objects produced at that time owe little or
to native designers. At an earlier period Arab and
ish influence is no less apparent.

England. In Saxon times the English metal-w
especially of the precious metals, possessed great sk
appear to have produced shrines, altar-frontals, r
and other ecclesiastical furniture of considerable s
magnificence.

Dunstan, archbishop of Canterbury (925 98
Bernward, bishop of Hildesheim a few years later,
Eloi of France three centuries earlier, was himself a
worker in all kinds of metal. The description of t
and silver retable given to the high altar of Ely by
Theodwin in the 11th century, shows it to have been
and elaborate piece of work decorated with many
and figures in the round. In 1241 Henry III. g
order for the great gold shrine to contain the b
Edward the Confessor (see W. Burges in *Gleanin*
Westminster). It was the work of members of th
family, among whom the goldsmith's and coiner's
appear to have been long hereditary. Countless
important works in the precious metals adorned
abbey and cathedral church in the kingdom.

In the 13th century the English workers in w
iron were especially skilful. The grill over the t
Queen Eleanor at Westminster, by Thomas de L
made about 1294, is a remarkable example of skill i
ing and modelling with the hammer (see fig. 6).

The rich and graceful iron hinges, made often fo
and out-of-the-way country churches, are a larg
important class in the list of English wrought iro
Those on the refectory door of Merton College, Oxf
a beautiful and well-preserved example dating fr
14th century.

More mechanical in execution, though still very
effect, is that sort of iron tracery work produced by
out patterns in plate, and superimposing one pla
the other, so as to give richness of effect by the s
produced by these varying planes. The screen by
V.'s tomb at Westminster is a good early specimen
kind of work.

The screen to Bishop West's chapel at Ely, a
round Edward IV.'s tomb at Windsor, both made t
the end of the 15th century, are the most mag

sh examples of wrought iron, in which every art and
f skill known to the smith has been brought into
o give variety and richness to the work.
ch wrought-iron work of great beauty was produced
beginning of the 18th century, especially under the
ntendence of Sir Christopher Wren (see Elbetts,
Work of 17th and 18th Centuries, 1880). Large
g leaves of acanthus and other plants were beaten
vith wonderful spirit and beauty of curve. The
from Hampton Court are the finest examples of
ass of work (see fig. 7).
m an early period bronze and latten (a variety of
were much used in England for the smaller objects
of ecclesiastical and domestic use, but except for
and lecterns were but little used on a large scale till
5th century. The full length recumbent effigies of
III. and Queen Eleanor at Westminster, cast in
by the "cire perdue" process, and thickly gilt, are
if not superior, in artistic beauty to any sculptor's
of the same period (end of the 13th century) that was
ced in Italy or elsewhere. These effigies are the work

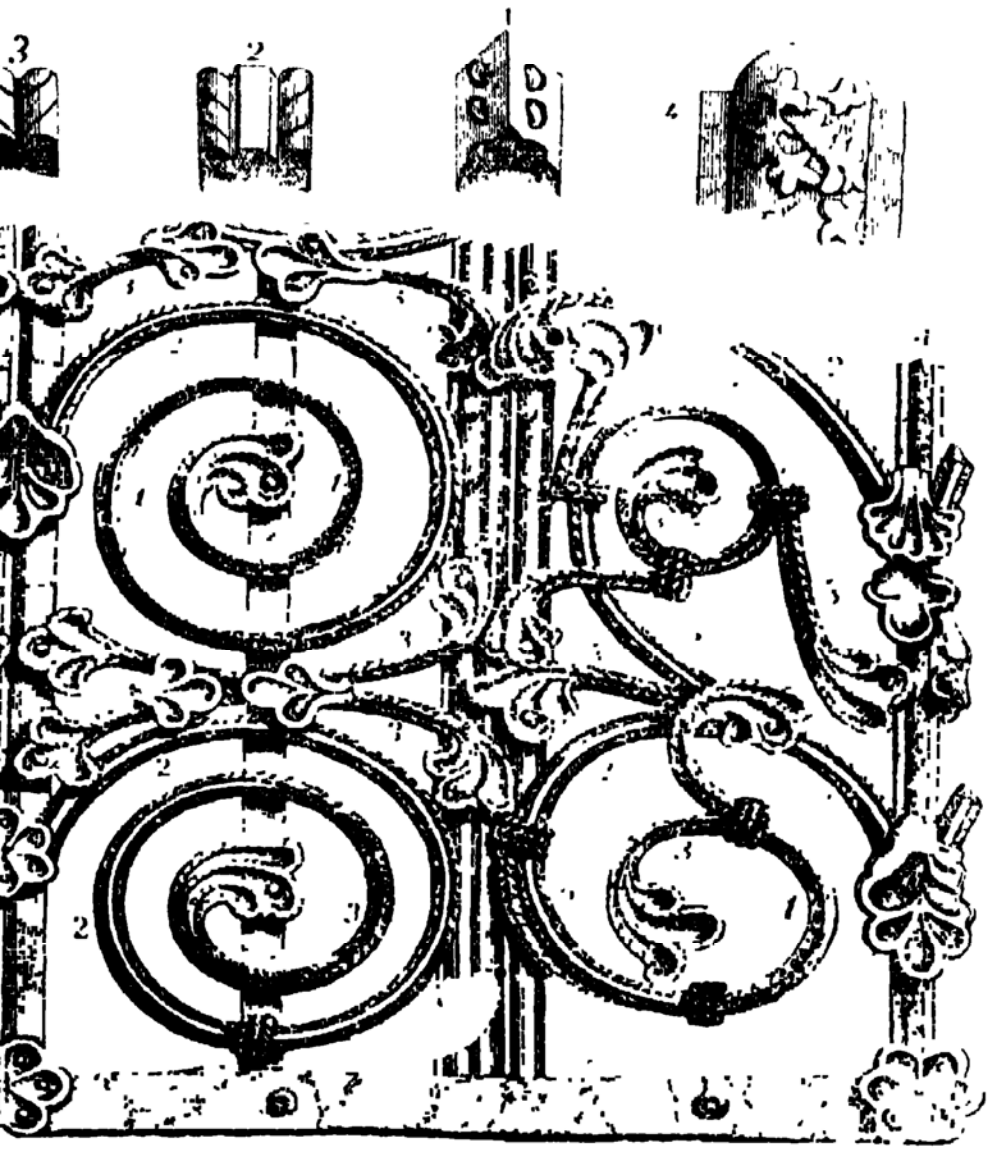


Fig. 6.—Part of the "Eleanor Grill."

Englishman named William Torel (see *Westminster*
ngs). The gates to Henry VII.'s chapel, and the
round his tomb at Westminster (see fig. 8), are very
ate and beautiful examples of "latten" work, show
greatest technical skill in the founder's art. In
also were produced the numerous monumental
of which about two thousand still exist in England.
a few were made in the 13th century, yet it was
the 14th that they came into general use. They
de of cast plates of brass, with the design worked
hem with the chisel and graver. All those, how-
o be seen in English churches are not of native
great quantities of them being Flemish imports (see
n, Waller, and Boutell on Monumental Brasses).
ddition to its chief use as a roof covering, lead was
nes used in England for making fonts, generally
aped, with figures cast in relief. Many examples
e.g., at Tidenham, Gloucestershire; Warborough and
ster, Oxon; Chirton, Wilts; and other places.

Germany.—Unlike England, Germany in the 1
11th centuries produced large and elaborate works
bronze, especially doors for churches, much res
the contemporary doors made in Italy under By
influence. Bernward, bishop of Hildesheim, 99
was especially skilled in this work, and was much in
in design by a visit to Rome in the suite of Otho II
bronze column with winding reliefs now at Hil
was the result of his study of Trajan's column,
bronze door which he made for his own cathedra
classical influence, especially in the composition
drapery of the figures in the panels.

Fig. 7. Part of one of the Hampton Court Gates.

The bronze doors of Augsburg (1017–72) are
in style. The bronze tomb of Rudolph of Swa
Mersburg cathedral (1080) is another fine work
same school. The production of works in gold and
was also carried on vigorously in Germany. The sh
the three kings at Cologne is the finest surviving ex

At a later time Augsburg and Nuremberg were th
centres for the production of artistic works in the
metals. Herman Vischer, in the 15th century, and
and grandsons were very remarkable as bronze founder
font at Wittenberg, decorated with reliefs of the ap
was the work of the elder Vischer, while Peter and
produced, among other important work, the bron
Sebald at Nuremberg, a work of great finish a
astonishing richness of fancy in its design (see De
Christliches Kunstblatt, 1866, Nos. 10–12). The
of Maximilian I., and the statue round it, at Inns
begun in 1521, are perhaps the most meritorious
work of this class in the 16th century, and show co
able Italian influence.

rought iron the German smiths, especially during th century, greatly excelled. Almost peculiar to ıy is the use of wrought iron for grave crosses and ral monuments, of which the Nuremberg and other ries contain fine examples. Many elaborate well-s were made in wrought iron, and gave full play to

Fig. 8. Part of Henry VII.'s Bronze Screen.

ney and invention of the smith. The celebrated ntury example over the well at Antwerp, attributed ntin Massys, is the finest of these.

ce.—From the time of the Romans the city of s has been celebrated for all sorts of metal-work, pecially for brass enriched with enamel. In the d 14th centuries many life-size sepulchral effigies ade of beaten copper or bronze, and ornamented by coloured "champlevé" enamels. The beauty of effigies led to their being imported into England;

most are now destroyed, but a fine specimen still at Westminster on the tomb of William de Valence In ornamental iron-work for doors the French smith pre-eminent for the richness of design and skilful tre of their metal No examples probably surpass th the west doors of Notre Dame in Paris—now un much falsified by restoration. The crockets and on the flèches of Amiens and Rheims are beautifu mens of a highly ornamental treatment of cast le which France was especially celebrated. In most r however, the development of the various kinds of working went through much the same stages as in E

Persia and Damascus.—The metal-workers of th especially in brass and steel, were renowned for th

Fig. 9.—Brass Vase, pierced and gilt; 17th century Persia

even in the time of Theophilus, the monkish writer subject in the 13th century. But it was during th of Shah Abbas I. (d. 1628) that the greatest am skill both in design and execution was reached Persian workmen. Delicate pierced vessels of gilt enriched by tooling and inlay of gold and silve among the chief specialties of the Persians (see fig.

A process called by Europeans "damascening" Damascus, the chief seat of the export) was used to very delicate and rich surface ornament. A patte incised with a graver in iron or steel, and then go was beaten into the sunk lines, the whole surface then smoothed and polished. In the time of Cell process was copied in Italy, and largely used, es for the decoration of weapons and armour. The r process both for brass and silver was much used by C workers, and even now fine works of this class a duced in the East, old designs still being adhered t

cent Metal-Work.—In modern Europe generally the of metal-working both as regards design and tech- skill are not in a flourishing condition. The great e lions of the Nelson monument in London are a sad ple of the present low state of the founder's art. e sand-casting in England now takes the place of the te "cire perdue" process.

ne attempts have lately been made in Germany to e the art of good wrought iron work. The Prussian bought at a high price for the South Kensington um, are large and pretentious, but unfortunately are of value as a warning to show what wrought iron not to be. Some English recent specimens of ham- l work are more hopeful, and show that one or two s are working in the right direction.

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METAMORPHOSIS. This term has been em in several distinct senses in biology. During th part of the century it was constantly used to incl current morphological conceptions, as, for instance, parts of a flower as modified or "metamorphosed" or of the segments of a skull as modified ve It is still frequently employed to denote that prog change from the general to the special undergone developing tissues and organs (see BIOLOGY, EMBRY but in this sense is conveniently superseded by th "differentiation." In the process of animal develo two types are broadly distinguishable,—a foetal t which development takes place wholly or in great either within the egg or within the body of the and a larval type, in which the young are born condition more or less differing from that of the while the adult stage again is reached in one of two either by a process of gradual change, or by a suc of more or less rapid and striking transformatio which the term metamorphosis is now usually res Metamorphosis is generally regarded as havin brought about by the action of natural selection, pa curtailing and reducing the phases of developme obvious advantage in economy of both structur functional change), and partly also in favouri acquirement of such secondary characters as are tageous in the struggle for existence. Freshwa terrestrial animals develop without metamorphosis more frequently than marine members of the same a circumstance which has been variously explained details of metamorphoses see the articles on the groups of animals; see also Balfour's *Comparati bryology*, 1880–81.

M E T A P H Y S I C

E term metaphysic, originally intended to mark the place of a particular treatise in the collection of otle's works, has, mainly owing to a misunderstanding, ved several other titles, such as "First Philosophy," ology," and "Theology," which Aristotle himself or suggested. Neo-Platonic mystics interpreted it gnifying that which is not merely "after" but ond" physics, and found in it a fit designation science which, as they held, could not be attained t by one who had turned his back upon the natural . And writers of a different tendency in a later gladly accepted it as a convenient nickname for ies which they regarded as having no basis in ience, in the same spirit in which the great German ter Stein used the analogous title of "metapolitics" ry and unpractical schemes of social reform. A brief ation of the contents of Aristotle's treatise may enable give a general definition of the science which was first ctly constituted by it, and to determine in what sense bjects which that science has to consider are beyond e and experience.

r Aristotle, metaphysic is the science which has to do Being as such, Being in general, as distinguished from special sciences which deal with special forms of . There are certain questions which, in Aristotle's we have a right to ask in regard to everything that presents itself as real. We may ask what is it nature or definition, and what are the conditions realization; we may ask by what or whom it was pr and for what end; we may ask, in other words, formal and the material, for the efficient and th causes of everything that is. These different qu point to different elements in our notion of Being, e which may be considered in their general relation from any particular case of their union. These, th the first philosophy must investigate. But, furth science of being cannot be entirely separated fr science of knowing, but must determine at least i general principles. For the science that deals wit is most universal in being is, for that very reason, with the objects which are most nearly akin intelligence. These, indeed, are not the objects wh first presented to our minds; we begin with the par not the universal, with a *πρῶτον ἡμῖν* which is not *φύσει*; but science reaches its true form only wh order of thought is made one with the order of natu the particular is known through the universal. V conversion or revolution of the intellectual point o is not to be regarded as an absolute change from e truth; for Aristotle holds that *nihil est in intellec non prius in sensu*, in the meaning that in sense per there is already the working of that discriminative

which, beginning in sense perception, with the dis- of particular from particular, can rest only when it prehended things in their universal forms or defini Looking at knowledge *formally*, the highest law of , the law of contradiction (or, as we might call it, to Aristotle's meaning more exactly, the law of de- or distinction), is already implied in the first act of ion by which one thing is distinguished from another. g at it *materially*, the reason of man is to be con- as potentially all that is knowable; *i.e.*, objects are ed to it that for it to know them in their essential ons is only to know itself. The aim of science, in ew, is to break through the husk of matter, and to nd things in their forms, in which they are one with d that knows them. Hence also it follows that in o the most universal science, the science of Being in , the mind is not leaving the region of immediate nce, in which it is at home, for a far-off region of tions. Rather it is returning to itself, apprehend t which is most closely related to itself, and which re, though it is late in being made the direct object stigation, is yet presupposed in all that is, and is ?

aphysic, then, is the science which deals with the les which are presupposed in all being and knowing, they are brought to light only by philosophy. r trait completes the Aristotelian account of it. eology, or the science of God. Now God is *νόησις* s, pure self consciousness, the absolute thought which with its object, and He is therefore the first cause xistence. For, while the world of nature is a world ion and change, in which form is realized in matter, ocess of the finite can be explained only by referring to an unmoved mover, in whom there is no distinc matter and form, and who is, therefore, in Aristotle's to be conceived as pure form, the purely ideal or e activity of a consciousness whose object is itself. conception, however, while it secures the independ d absoluteness of the unmoved mover, by removing m all relation to what is other than himself, seems e his connexion with the world inexplicable. We this theory refer the world to God, but not God to rld. Hence Aristotle seems sometimes to say that the first mover only as He is the last end after which ation strives, and this leads him to attribute to a desire or will which is directed towards the good bject or end.

totle then brings together in his metaphysic three ts which are often separated from each other, and nnexion of which is far from being at once obvious o him the science of the first principles of being. lso the science of the first principles of knowing. , it is the science of God, as the beginning and end things, the absolute unity of being and thought, in all the differences of finite thought and existence her excluded or overcome.

some this description of the contents of Aristotle's e, and especially the last part of it, may seem to be irmation of all the worst charges brought against hysic. For at both extremes this supposed science to deal with that which is beyond experience, and therefore cannot be verified by it. It takes us o a beginning which is prior to the existence as well he consciousness of finite objects in time and space, n to an end to which no scientific prophecy based our consciousness of such objects can reach. In the former aspect of it, it has to do with notions so ab and general that it seems as if they could not be fix tested by reference to any experience, but must neces be the playthings of dialectical sophistry. In the aspect of it, it entangles us in questions as to the cause and ultimate meaning of things, questions inv so comprehensive a view of the infinite universe in we are insignificant parts that it seems as if any at to answer them must be for us vain and presump On both sides, therefore, metaphysic appears to attempt to occupy regions which are beyond the hal space of the intelligible world to deal with ideas are either so vague and abstract that they cann fastened to any definite meaning, or so complex an reaching that they can never by any possibility be ve For beings like men, fixed within these narrow lim space and time, the true course, it would seem, "cultivate their gardens," asking neither whence come nor whither they go, or asking it only with possible limits of history and scientific prophecy. back to the beginning or on to the end is beyond even in a temporal, still more in a metaphysical, That which is *πρώτον φύσει* escapes us even more abso than the prehistorical and pregeological records o and his world. That which is *ἔσχατον φύσει* esca even more absolutely than the far off future ty civilization, which social science vainly endeavor anticipate. Our state is best pictured by that Anglican philosopher who compared it to a bird through a lighted room "between the night an night." The true aim of philosophy is, therefo would seem, to direct our thoughts to the careful ination and utilization of the narrow space allotted by an inscrutable power, and with scientific self-re to refrain from all speculation either on first or o causes.

The main questions as to the possibility and the na metaphysic, according to Aristotle's conception of i be summed up under two heads. We may ask w we can in any sense reach that which is beyond expe and, if so, whether this "beyond" is a first or principle, a pre-condition or a final cause of natu experience, or both. The former question branch into two, according as we look at metaphysic fr objective or the subjective side, or, to express the more accurately, according as we consider it in rela those natural objects which are *merely* objects of know or in relation to those spiritual objects which a subjects of knowledge. We shall therefore consider physic, first, in relation to science in general, and, se in relation to the special science of psychology. latter question also has two aspects; for, while the a first cause or principle points to the connexion b metaphysic and logic, the idea of a last principle cause connects metaphysic with theology. We shall fore consider in the third place the relation of meta to logic, and in the fourth place its relation to religi the philosophy of religion.

1. *The Relation of Metaphysic to Science.* — The begi of science and metaphysic are identical, though the sense in which it may be admitted that the metap comes before the scientific or positive era. The first of philosophy grasp at once at the prize of a knowledge. No sooner did the Greeks become diss with the pictorial synthesis of mythology by whic thoughts were first lifted above the confusion of par things, than they asked for one universal principle should explain all things. The Ionic school sought some one phenomenon of nature which might be the key to all other phenomena. The Eleatics, see

ναὶ κριτική, Anal. Post., II. 99*b*.

hat is said here as to the intelligence is partly taken from the *ora*. The necessary qualifications of the above general state- Aristotle's views will be given subsequently.

of making one finite thing the explanation of all
nite things, tried to find that explanation in the very
of unity or being itself. We need not underestimate
culative value of such bold attempts to sum up all
iety of the world in one idea, but it is obvious that
ther give a name to the problem than solve it, or
y put the very consciousness of the problem in place
solution of it. Science is possible only if we can
m the particular to the universal, from a subjective
things as they immediately present themselves to
perception to an objective determination of them
laws and principles which have no special relation
particular set of events or to any one individual
But this is only one aspect of the matter. To
from a conception of the world *in ordine ad*
num to one *in ordine ad universum*, and so to
t and eliminate what is merely subjective and
tal in our first consciousness of the world, is the
ng of knowledge. But little is gained until the
al, which we reach through the negation the
lars, is more than their mere negation, unless it
v or principle by means of which we can explain
rticulars. Now the defect of early philosophy
t its universal was "the one beyond the many,"
"one in the many," in other words, that it was
aw or principle by which the particulars subsumed
it could be explained, but simply the abstraction
element common to them. But the process of
dge is a process that involves both analysis and
is, negation and reaffirmation of the particulars
hich we start. If we exaggerate the former aspect
e enter upon the *via negativa* of the mystics, the
pure abstraction and negation, which would open
nd to the ideal reality of things simply by shutting
the perceptions of sensible phenomena. And, if we
out this method to its legitimate result, we must
ne highest abstraction, the abstraction of Being, as if
the sum of all reality, and the Neo-Platonic ecstasy
h all distinction, even the distinction of subject and
is lost as the only attitude of mind in which truth
apprehended.

ne philosophy of the Socratic school we find the first
t at a *systematic* as opposed to an *abstract* theory
t attempt to bring together the one and the many,
to determine the former that it should throw light
ne latter. Yet even in Plato the tendency to oppose
niversal to the particular is stronger than the
gy to relate them to each other, and in some of his
ues, as, *e.g.*, in the *Phædo*, we find a near approach
identification of the process of knowledge with
tion which is the characteristic of mysticism.
le, therefore, had some ground for taking the Platonic
le that "the real is the universal" in a sense which
s the reality of the individual. Yet, though he
d Plato's error in opposing the universal to the
lar, and though, at the same time, he did not
y lose sight of the truth which Plato had exagger
hat the particular is intelligible only *through* the
sal, Aristotle was not able to escape the influence
dualism which had marred the philosophy of his
essor. Hence the effect of his protest against a
phy of abstraction was partly neutralized by his
tion between the divine Being as pure form and
as the unity of form and matter, and again by his
tion of the pure reason which apprehends the
of things from the perceptions of sense which deal
orms realized in matter. And after Aristotle's time
ndency of philosophy was more and more to withdraw
contact with experience. The Neo-Platonic philo-
and the Christian theology which was so strongly
influenced by it, contained, indeed, an idea of the
ciliation of God and nature, and hence of form and
which must ultimately be fatal to dualism, and there
the method of mere abstraction. But the explicit m
of the philosophy of the Middle Ages was still du
and the mode in which the Aristotelian formula
wrought into the substance of Christian doctrine
scholastics tended more and more to conceal that
the unity of opposites which was involved in Christ
Hence mediæval realism presented, in its most ou
form, the doctrine that "the real is the universal," n
by the universal nothing more than the abstract.
a natural consequence, the modern insurrection
scientific spirit against scholasticism took its star
an equally bald and one-sided assertion of the o
principle, that "the real is the individual," mean
that the individual of immediate perception. It Pla
had dwelt too exclusively on one aspect of the pro
knowledge, viz., that it seeks to rise above the particu
sensible, the subjective, to the universal, the intelligi
objective, as if in the latter alone were reality to be
modern men of science learnt from their first nomi
teachers to regard the universal as nothing more t
abbreviated expression for the particulars, and scienc
as a mere generalization of the facts of sensible perc
But this view of scientific knowledge, as a mere re
tion of what is immediately given in sense, is as im
as the opposite theory, which reduces it to the
negation of what is so given. An ideal world
and entirely divorced from the phenomenal, and a
world which is simply a repetition of the phenc
are equally meaningless. The processes of scienc
both a negative and a positive side; they involve
tion of the particular as it is immediately presen
sense, but only with a view to its being reaffirmed
new determination through the universal. The fa
is first presented to us is not the fact as it is; for,
it is from the fact as given that we rise to the kno
of the law, it is the law that first enables us to und
what the fact really means. Our first conscious
things is thus, not an immovable foundation upon
science may build, but rather a hypothetical and s
tradictory starting-point of investigation which
changed and transformed as we advance.

The nominalism of scientific men in modern time
to two special causes, one of which has alread
mentioned. It is partly due to the traditions of
when mediæval realism was the great enemy of
The Baconian protest against the "anticipation of n
was a relative truth when it was urged against a
writers who supposed that true theories could be a
without regard to facts, the Baconian assertion
necessity of attending to *axiomata media* was the ne
correction of the tendencies of mystics, who suppos
philosophy could attain its end by grasping at
absolute unity, and contented themselves, therefo
a unity which did nothing to explain the diff
But, when the former was turned into the d
assertion that the mind is, or ought to be, passive
process of knowledge, as having in itself no principl
explanation of things, and when the latter was turn
the dogmatic assertion that science can only proce
part to part and never from the whole to the part
relative truths became a source of error. And th
was confirmed and increased by the mistaken views
who first tried to correct it. For these, admittin
scientific truth is entirely derived from external exp
only ventured to assert the existence of *a priori* kn
alongside of, and in addition to, that which is *a po*
In other words, they sought in inner experience a b

eliefs which outward experience seemed unable to
. But this basis was soon found to be treacherous.
ection, observation of the inner life as opposed to
stinguished from the outer life, could be only an
tion of the facts of the individual consciousness as
and to base religion and morality on such a founda-
s to treat God and right as subjective phenomena,
do not necessarily correspond to any objective
Nor was this conclusion really evaded by the
n of the self-evidencing necessity of such ideas and
or of the principles upon which they are founded.
is necessity, as a subjective phenomenon, might be
ted for otherwise than by the supposition of their
ve validity. Such scepticism, further, was favoured
progress of science, which, as it advanced from
s to biology and sociology, became more and more in-
ent with the idea of an absolute breach between inner
ter experience, and narrowed the sphere which had
therto reserved for the former. Man, it was urged, is
art in a greater whole, not exempted from the law
on and reaction which connects all parts of that
with each other. His individual life contains only
links in a chain of causation that goes back to a
ing and onward to an end of which he knows
g. And, as Spinoza says, *eis quæ unaquæque res in
lo perseverat a causis æternis infinite superatur.*
to treat ideas which are only states of the individual
ousness as the explanation of the world, instead of
g them as phenomena to be explained by its relation
world, seemed to be an absurdity. The particular
and tendencies of the mind were to be regarded,
ultimate facts in reference to which everything
be interpreted, but rather as facts which are
lves to be referred to more general causes and
It thus appeared that the attempt to divide truth
a posteriori and an *a priori* part, the latter of
should find its evidence in an inner experience
former in an outer experience, is an illusive pro
If the *a priori* is reduced to the level of the *a
ori*, it becomes impossible to base on the *a priori*
eliefs that go beyond the range of subjective
ence. If the self and the not self are taken simply
erent finite things, which we can observe in turn,
elations must be brought under the general laws of
nnexion of finite things with each other; and the
nena of mind must be treated, like the phenomena
ter, as facts to be accounted for according to these

this of itself indicates a way of escape both from
rospective theory and from the empiricism to which
posed. For it suggests the question What is the
of those very laws which guide the procedure of
in accounting for facts, psychological facts among
! When a scientific psychologist of the modern
attempts to show how by habituation of the
dual and the race the necessity of thought expressed
law of causation was produced in the minds of the
t generation of men, it is obvious that his whole
gation and argument presuppose the law whose
s he is accounting for. A glaring instance of such
r reasoning is found in the writings of the most
nent representative of the school in the present day.
encer begins by laying down as a first postulate of
that necessity of thought must be taken as a
m of truth. It is by the continual aid of this
te that he constructs his system of nature, and
his psychological theory of the development of
ousness in man. Yet the main object of this
logical theory seems to be to account for the very
ities with which the author starts. Obviously such a

philosophy contains elements of which the aut
imperfectly conscious; for it involves that mind
only the last product but the first presupposit
nature, or, in other words, that in mind nature
upon its first principle. But to admit this is at o
lift the conscious being as such above the position
he would hold as merely a finite part of a finite worl
is to assert that nature has an essential relation to
sciousness which is developed in man, and that
growth of this consciousness we have, not an evo
which is the result of the action of nature as a sys
external causes *upon him*, but an evolution in which
is really "coming to itself," *i.e.*, coming to self-con
ness, *in him*.

Now it was Kant who first—though with a
limitation of aim—brought this idea of the rel
of thought and being to the consciousness of the
world. In the *Critique of Pure Reason*, thought, i
is not set up as an absolute *prius*, in relation to wl
existence must be conceived, but it is set up as th
of experience, and so of all existences which are obj
our knowledge. Experience is for Kant essentially
to the conscious self; it exists through the ne
subsumption of the forms and matter of sense und
categories, as, on the other hand, the consciousness
is recognized as essentially dependent on this proces
this view, the *a priori* and *a posteriori* factors of exp
do not really exist apart as two separate porti
knowledge. If they are severed, each loses all its
ing. Perceptions in themselves are void; catego
themselves are empty. We do not look outwards f
kind of truth and inwards for another, nor do we
by an external process, bring facts given as con
under principles recognized as necessary; but the
is the condition under which alone the *a posterior*
for us. Even if it is allowed that the facts of in
outer experience contain a contingent element or
given under the conditions of time and space, yet
time nor space nor the facts of experience conditio
them exist for us except as elements of an exp
which is organized according to the categories.

This is the essential truth which Kant had to e
It is marred in his statement of it by the pe
influence of the abstract division between con
matter given from without and necessary pr
supplied from within, a division essentially incon
with the attempt to show that the contingent m
necessarily subsumed under these principles, and
exists for us only as it is so subsumed. But Kant
puts into our hands the means of correcting h
inadequacy, when he reduces the inaccessible thing i
which he at first speaks of as affecting our sensibil
so giving rise to the contingent matter of experien
noumenon (*νοούμενον*) which is projected by reaso
The *Dialectic* exhibits the idea of thought as no
constituting finite experience but also reaching bey
though as yet only in a negative way. The min
this view, so far unlimited that it knows its own lir
is conscious of the defects of its experience, of t
tingency of its sensible matter, and the emptine
finitude of its categories; and by reason of this co
ness it is always seeking in experience an ideal whi
impossible to realize there. Thought measures exp
by its own nature, and finds it wanting. It d
a kind of unity or identity in its objects which it is
to find in the actual objects of experience. It
demand of reason which lifts man above a mere
existence, and forces him by aid of the categ
determine the matter of sense as a world of objects;
this finite world of experience can never satisfy the

son, the consciousness of it is immediately com-
with the consciousness of its limited and phenomenal
er. The student of the *Critique of Pure Reason*
but recognize the strange balance between the real
e phenomenal in which it ends, allowing to man the
usness of each so far as to enable him to see the
of the other,—so that by aid of the pure identity of
he can criticize and condemn the "blindness" or
lved difference of experience, and by means of the
eness and complexity of experience he can condemn
mpty" identity of reason.

order, however, to understand the full bearing of
criticism of knowledge, and at the same time to find
cting-point of the opposite currents of thought which
tely prevail in it, it will be necessary to consider
ject a little more closely. The lesson of the *Critique*
e gathered up into two points. In the first place,
refutation of the ordinary view of experience as
ing immediately given for thought and not con
d by it. In the second place, it is a demonstration
merely phenomenal character of the objects of
ence, *i.e.*, the demonstration that the objects of
ence, even as determined by science, are not things
nselves. Both these results require to be kept
in view if we would understand the movement of
t excited by Kant. On the one hand Kant had to
hat what is ordinarily regarded as real, the world
erience, is transcendently ideal, *i.e.*, is determined as
a priori forms of thought. On the other hand he
teach that the world so determined is empirically
ot transcendentally real, *i.e.*, its reality is merely
nenal. With the former lesson he met the man of
, and compelled him to renounce his materialistic
ation of the world as a thing which exists in
ndence of the mind that knows it. The world we
s a world which exists only as it exists *for us*, for
nking subject; hence the thinking subject, the ego,
be taken as an object like other objects, an object
enomena of which are to be explained like other
nena by their place in the connexion of experience.
g, however, thus repelled scientific materialism by
oof that the reality of experience is ideal, Kant
to proceed to the complete identification of reality
leality, and meets the claims of the metaphysician
he assertion that the reality of experience is merely
nenal. Hence he rejects any idealism that would
the negation of things in themselves beyond
nena, or the identification of the objects of experience
hese things. The reality we know is a reality which
only for us as conscious subjects, but this, though
he only reality we can know, is not the absolute
.

s, however, to be observed that the nature of this
tion between phenomena and things in themselves
to change as we advance from the *Analytic*, where
istence of such things is presupposed, to the *Dialectic*,
the grounds of that presupposition are examined.
t the opposition seems to be between what is present
sciousness and what is absolutely beyond conscious-
The matter of experience is regarded as given exter-
in the affections of the sensible subject,-- affections
by an unknown thing in itself, of which, however,
an tell us nothing. On the other hand the form of
ence, the categories and principles of judgment which
hese affections into objects of knowledge, are not pure
ssions of the real nature, the pure identity, of the
t in itself, but only products of the identity of the
relation to the sensibility and its forms of time
pace. Hence, on both sides we must regard expe-
as merely phenomenal, alike in relation to the noumenal object and in relation to the noumenal sub
which lurk behind the veil and send forth into
rience on the one side affections which become ob
through their determination by the unity of thought
on the other side an identity of thought which bec
self-conscious in relation to the objects so determin
itself.

Kant, however, having thus answered the questi
the possibility of experience by reference to two thin
themselves which are out of experience, is obliged t
himself how the *consciousness* of these two thing
themselves, and the criticism of experience in relati
them, is possible. And here, obviously, the oppo
can no longer be conceived as an opposition betwee
which is and that which is not in consciousness. Fo
things in themselves must be present to consciousn
some fashion in order that they may be contrasted wi
phenomena. If, therefore, phenomena are now reg
as unreal, it must be because we have an *idea of real*
which the reality of experience does not fully corres
In the *Analytic* Kant had been speaking as if the rea
sisted in something which is not present to the cons
subject at all, though we, by analysis of his experi
can refer to it as the cause of that which is so pr
Now in the *Dialectic* he has to account for the fact
the conscious subject himself is able to transcend
experience, and to contrast the objects of it as phenom
with things in themselves.

Now it is obvious that such an opposition is possibl
so far as the thought, which constitutes experience,
the same time conscious of itself in opposition t
experience it constitutes. The reason why experie
condemned as phenomenal is, therefore, not becaus
that which exists for thought as opposed to that
does not exist for thought, but because it imper
corresponds to the determination of thought in itself
other words, it is condemned as unreal, not becaus
ideal, but because it is *imperfectly* ideal. And the ab
reality is represented, not as that which exists w
relation to thought, but as that which is identical wi
thought for which it is. In the *Dialectic*, the
the noumenon is substituted for the thing in itsel
the noumenon is, as Kant tells us, the object as it
for an intuitive or perceptive understanding, *i.e.*, an
standing which does not synthetically combine the
matter of sense into objects by means of categorie
whose thought is one with the existence of the obj
knows. It is the idea of such a pure identity of kn
and being, as suggested by thought itself, which le
to regard our actual empirical knowledge as imperfe
its objects as not, in an absolute sense, *real* objects.
noumena are not, therefore, the unknown causes by
action and reaction conscious experience is produced
represent a unity of thought with itself to which i
experience inadequate. This higher unity of though
itself is what Kant calls reason, and he identifies i
the faculty of syllogizing. Further, he finds in the
forms of syllogism a guiding thread which brings
the recognition of three forms in which the pure u
reason presents itself to us in opposition to the
synthetic unity of experience, a psychological, a
logical, and a theological form. In each of these
the empirical process of knowledge is accompanied, g
and stimulated by an idea which nevertheless it is
to realize or verify. In psychology we have ever p
to us an idea of the identity of the self, which is
realized in our actual self-consciousness, because th
of which we are conscious is manifold in its state
because it stands in relation to an external world,
idea of simple identity is, therefore something we n

is as the goal of an ideal psychology, to which we proximate in so far as we can trace unity of faculty all the differences of mental phenomena, but to ve can never attain owing to the nature of the matter hich we deal. Again, in our scientific attempts to our external experience, the unity of reason takes n of an idea of the world as a completed infinite which contains all the object known to us and all possible objects; but this cannot be realized in perience which is conditioned by space and time, therefore, ever incomplete. The idea of totality efore, an *ideal*, which guides and stimulates our e progress, without which such a thing as science ot exist, but which at the same time can never be i by science. Lastly, the unity of reason takes a rm in which identity and totality are combined, dea of a unity in which all differences, even the ce of subject and object, are transcended, the idea ty of all things with each other and with the mind ws them. This idea also is one which science can surrender nor realize. It cannot surrender it f giving up that striving after unity without which would not exist, and it cannot realize it, for the e between the world, as it is presented to us in experience, and the subjective determination of nking consciousness cannot be overcome. We can, use the idea that the world is an organic whole, ined in relation to an end which consciousness sets lf, as an *heuristic* principle to guide us in following nnexion of things with each other; but, as we cannot n of any such idea anticipate what the facts of l experience will be, so we cannot prove that for a other than ours the unity of things which we repre- this way might not take a quite different aspect, we have reason to think it would; for, while we think of a designing mind as using material which existence and nature independent of the purposes h they are put, the absolute mind must be conceived ature the materials themselves by the same act y they are determined to an end. We must con- , in short, as an intuitive understanding for which d means, objective and subjective, are one, or, in words, as an intelligence whose consciousness of s or contains the existence of all that is object

new view of the things in themselves as *noumena* als of reason involves a new attitude of thought s them different from that dogmatic attitude which sciously adopted in the *Analytic*. Accordingly, we d Kant speaking of them, not as things which exist dently of their being conceived, but as "problal conceptions" of which we cannot even determine r they correspond to any objects at all. They are ative notions which have a negative value, in so far keep open a vacant space beyond experience, but enable us to fill that space with any positive realities. are like dark lanterns which cast light upon the cal world, and show what are its boundaries, but heir own nature in obscurity. All that we can say noumenal self or subject is that it corresponds to the implied in all knowledge, but whether there is such independent of the process of empirical synthesis e self consciousness which accompanies that process, not tell. All that we can say of the noumenal reality objective world is that it corresponds to the idea objects of experience as a completed whole in them apart from the process whereby we know them, but r there is any such real world independent of the s of experience it is impossible to say. Lastly, all e can say of God is that He corresponds to the idea of the unity of all things with the mind that knows th an ideal which is involved in all knowledge,- but w the realization of this idea in an intuitive underst is even possible we have no means of determining ever we may suspect that understanding and sensibi "branches springing from the same unknown root." *Criticism of Pure Reason* ends, therefore, in a k seesaw between two forms of consciousness - a th consciousness, which transcends experience and sets us an idea of absolute reality, but which cannot to any knowledge or even certitude of any corresponding to this idea, and an empirical con ness, which gives us true knowledge of its objec whose objects are determined as merely phenomen not absolutely real.

The equipoise thus maintained between the em and the intelligible world is, however, in the *Cri Practical Reason*, overbalanced in favour of the What the theoretical reason could not do "in that weak through the flesh," through its dependence very empirical consciousness which it sought to tra is possible to the practical reason, because it is pr determined by itself. In our moral consciousness ourselves under a law which calls upon us to *act* as who are absolutely self-determined or free, and therefore, as it tells us that our intelligible self is our re and conclusive, determines our empirical self in c with it as phenomenal. Thus the moral law gives to the intelligible world; or, as Kant expresses i idea of an intelligible world is a point of view beyo phenomenal which the reason sees itself compelled up, in order to think of itself as practical." I words, the moral law presupposes freedom or determ in the rational being as such, and makes him rega self, not merely as a link in the chain of cond existence, in time and space, but as the original of his own life. The blank space beyond the phen thus begins to be filled up by the idea of a free ca which again postulates a world adequate and co able to itself. And the man who, as an empiric in ality, is obliged to regard himself merely as an ind being determined by other individual beings and is authorized as a moral being to treat this a necessity as having its reality in freedom, and to loc himself as the denizen of a spiritual world where is determined for him from without which is not the expression of his own self determination from "Thus we have found, what Aristotle could not fixed point on which reason can set its lever, not present or future world, but in its own inner freedom,- a point fixed for it by the immovable law, as a secure basis from which it can move the will, even against the opposition of all the po nature. [1] Starting from this idea of freedom, th Kant proceeds to reconstruct for *faith* the unseen which in the *Critique of Pure Reason* he had denie object of *knowledge*. Nor is he content to lea two worlds in sharp antithesis to each other, but the *Critique of Practical Reason*, and still more *Critique of Judgment*, he brings them into relation other, and so gives to theoretical reason a l authority to use for the explanation of the phen world those ideas which of itself it might be inc regard as illusive.

In all this, however, it is difficult to avoid s partial retractation of Kant's first view as to the irreco opposition of the phenomenal and the noumenal. the first place, the moral imperative is addressed t

[1] Kant, i. 638 (Rosenkranz's edition).

is at one and the same time regarded in both
ters, and which is called upon to subsume under the
law acts which otherwise derive their character and
g from the relations of the phenomenal world. That
rticular nature of men as phenomenal individuals
the means of realizing the universal law of reason is
l in all Kant's statements of the latter, and particu
his conception of men as constituting together a
dom of ends"; for it is difficult to conceive this
m otherwise than as an organic unity of society, in
each individual, by reason of his special tendencies
pacities, has a definite office to fulfil in realizing
iversal principle that binds all the members of the
m to each other. The *summum bonum*, again, is
consist in the union of happiness with goodness,
the empirical conditions of man's individual life as
ble subject with the pure self-determination of the
ible self; and God is postulated as a *Deus ex*
a to bind together these two unrelated elements,
ption which shows the difficulty into which Kant
ought himself by defining them as unrelated. Still
bvious is the effort of Kant to get beyond the
n of his first view of things in the *Critique of*
ent. For in that work he maintains that the con-
ess of the beautiful and the sublime is or involves
ony of the understanding or the reason with sense;
hat is still more important, he points out that the
organic unity, without which we cannot explain the
nena of life, contains in it a possibility of the recon
n of freedom and necessity, of the intelligible and the
nenal. This idea, he argues, we are authorized by
ral consciousness to apply to the whole course of the
in the phenomenal world, and so to regard it as a
to realize the moral ideal. No doubt he again
y retracts this view when he declares that we must
he idea of final causality as merely a *subjective*
le of judgment, which, even in the case of living
is to be regarded only as necessary for us as finite
ences. But such saving clauses, in which Kant
to the dualism with which he started, cannot hide
s how near he has come to the renunciation of it.

n we regard Kant in this way as asserting from one
f view an absolute limit which from another point
v he permits us to transcend, it becomes obvious
s philosophy is in an unstable equilibrium, which
but be disturbed by any one who attempts to
or even to restate his ideas. Hence we need not
that those who take in earnest his denunciations
attempt to transcend experience generally, like
or Huxley,- reject as worthless all Kant's later work;
at, on the other side, those who take in earnest his
t freedom, of organic unity, of an intuitive under
g, and of a *summum bonum* in which freedom and
ty meet together, are compelled to break through
bitrary line which he drew between knowledge
lief. In favour of the former course it is easy in
places to appeal to the letter of Kant. In favour of
ter it need only be pointed out that, in Kant's view,
erience rests upon, or is in its development guided
se ideas which yet he will not permit us to treat as
of knowledge. Hence the principles of the *Critique*
legitimately be used against metaphysic, except
se who are prepared to admit the ideas of reason, up
point to which he admits them, as ideas that limit
rect our experience,—while rejecting all use of them
light upon that which is beyond experience. "In
words, they must maintain the possibility of a purely
ve knowledge, of the knowledge of a limit by one
et cannot go beyond it. They must show how we
ve an ideal of knowledge which enables us to criticize
experience without enabling us to transform it, they
show how ideas of the supersensible can so far be
to our thought as to make visible the boundaries
prison of sense in which we are confined, without
way enabling us to escape from it.

Is this possible? We may gather up the K
antithesis in the assertion that experience is the im
realization of an ideal of knowledge, derived from
with materials, derived from sense and understandi
nature of which is such that they can never be b
into correspondence with the ideal. But this ideal, i
three forms, as we have seen, is simply the idea of
unity or identity in which all differences are
dissolved whether they be the differences of the
of the outer life, or finally the difference of inn
outer, subjective and objective, from each other.
view therefore is, in effect, this, that thought
with it the consciousness of an identity or unity, to
our actual experience in none of its forms fully corres
On the other hand, Kant does not hesitate equally
demn the identity of thought as "empty" and subj
because it does not contain in itself nor can evol
itself the complex matter of experience. Bu
alternate condemnation of experience as unreal fr
point of view of the ideas, and of the ideas as unrea
the point of view of experience, seems to show that
unreal, as being abstract elements, which have no val
in their relation to each other, and which lose all thei
ng when separated from the unity to which they
According to this view, ideas and experience, n
and phenomena, if they are opposed, are also nec
related to each other. If our empirical consciousn
the world of objects in space and time, as determ
the categories, does not correspond to the unity or i
of thought which is our ideal of knowledge, yet th
of unity or identity is set up by thought in *relat*
experience, and cannot, therefore, be essentially i
cilable with it. The two terms may be opposed, bu
opposition cannot be absolute, seeing that they
essential relation to each other. It is a great logica
not to discern that a negative relation is still a re
i.e., that it has a positive unity beyond it. This
unity may not, indeed, be consciously present to
our immediate apprehension of the relation in qu
but it is necessarily implied in it. Now it is just h
in his separation of noumena and phenomena, Kant
to note their essential relativity that he is forced to
the former as a set of abstract identities, of which n
can be known, and the latter as the imperfect prod
a synthesis which can never be completed or brough
true unity. Yet the value of his whole treatment
ideas of reason in relation to our intellectual and
experience arises from the fact that in practice h
not hold to this abstract separation of the two el
Ideas absolutely incommensurable with experienc
neither stimulate nor guide our empirical synthesis
could not even be brought into any connexion w
When, therefore, Kant brings them into this connex
necessarily alters their meaning. Hence the pure a
identity which excludes all difference is changed,
application, into the idea of an organic unity, of wh
highest type is found in self-consciousness, with its
parent difference of the subjective and objective se
would be absurd and meaningless to say that science s
reduce experience to an abstract identity, in which t
no difference, unless for this were tacitly substitute
is really an entirely different proposition, that scienc
to find in the infinitely diversified world of space an
that unity in difference of which self-consciousness
itself the pattern. It is in reference to the forme

utity—the abstract oneness of formal logic—that proves that it is impossible for experience to be dequate to ideas. But it is only of the latter kind tity—the oneness of self-consciousness—that it can that it furnishes a guiding principle to scientific gation or an ideal of knowledge. The same con is still more evident in Kant's account of our moral nce, in dealing with which he directly attempts to nthetic propositions out of the pure identity of in other words, to draw definite moral laws out logical principle of non-contradiction. Whatever he attains is gained by substituting for the formal le of *self-consistency* the positive idea of *consistency e self*, and again by conceiving this self as a concrete ual, the member of a society, and so standing in al relation to other selves. The pure abstraction ll the external results of action and from all motives re, which at the beginning of the *Metaphysic of* Kant declares to be essential to morality, is modified leed transformed, as we go on, by the admissions her rational beings are *not* external to us in any hat excludes their good from being an end of our our, and that the desires are *not* irrational and al except in so far as they are directed to the es of the sensuous individual (which in a conscious they never entirely are). Both in the speculative the practical sphere, therefore, the absolute opposi- the ideal or noumenal to the empirical disappears, as Kant attempts to apply it. For in both the t identity of formal logic, which is really the g of the noumenon as absolutely opposed to and nensurable with experience, gives way to the unity onsciousness, a unity which is so far from being *ly* opposed to the difference of the empirical usness that it necessarily implies it. For self- usness presupposes the consciousness of objects; it is opposed to that consciousness, it is essentially ed with it, and therefore its opposition cannot be d as absolute, or incapable of being transcended.

e considerations may throw some light on the of the *Analytic* and *Dialectic* of Kant, and on the of the opposition of noumenon and phenomenon presented in the latter. In the deduction of the ies, Kant pointed out the essential relation of the e world of experience to what he called the endental unity of apperception"; *i.e.*, he pointed t the unity of consciousness is implied in all its This unity, he further showed, must be conceived able of self-consciousness"; but it actually becomes us of self only in relation, though also in opposi- the other objects determined by it. Now it is this usness of itself in opposition to other objects which ource of Kant's "ideas of reason," of the dissatisfac- the mind with its empirical knowledge, even in its ic form, and of the demand for a higher kind of know- which experience is not adequate. That a standard p for experience by which it is condemned is simply of the further development of that unity which is in experience—a result of the progress of thought nsciousness to self-consciousness, and of the contrast n the former and the latter. The problem with Kant's *Dialectic* attempts to deal, and which it treats uble, is, therefore, simply the problem of *raising con- ss to the form of self-consciousness*; in other words, of ng to a knowledge of the world of experience as not a "synthetic," and therefore imperfect, unity of things l to each other, but as an organic unity of transparent nces, a self-differentiating, self-integrating unity, such ns to be presented to us in pure self-consciousness. an this problem be regarded as insoluble; for the unity of self-consciousness is identical with the u consciousness; it is only that unity become self-co Hence the point of view at which consciousness a consciousness seem to be absolutely opposed to each o the highest point of view which Kant *distinctly* rea can be regarded only as a stage of transition from th at which their relative difference and opposition is developed to the point at which they are seen to factors or elements of a still higher unity.

The later philosophy of Germany, from Kant to is little more than the development of the idea just in its twofold aspect. In the first place, it is an a to show what is involved in the idea of thought consciousness as in itself an organic whole, a many a unity which expresses itself in difference, yet so t difference remains transparent, and therefore is imme recognized as expression of the unity. In the place, it is an attempt to bridge over the difference b thought or self-consciousness and the external w experience, and to show that this opposition subordinated to a higher unity. Or, to put it more d the idealistic philosophy of Germany seeks, on t hand, to develop a logic or metaphysic which base not, like formal logic, on the idea of bare identity, the idea of self-consciousness; and, on the other h show, in a philosophy of nature and spirit, how, by of this logic, the opposition of thought to its ob of the *a priori* to the *a posteriori* in knowledge, transcended. In the third and fourth sections article something more will be said of the man which this task was fulfilled. Here only a few wo necessary to sum up the results reached, and to giv distinctness to the new ideal of knowledge which results suggest. We have seen that Kant's critical a involved two things, on the one hand, the asserti the existence we know is necessarily existence for th and, on the other hand, the denial that that which for our thought is absolute reality, a denial which involves the presence to our thought of an ideal of ledge, by which our actual knowledge is cond This ideal, however, was falsely conceived by Kan identity without any difference, and, in this sense, h not hesitate to apply it even to self-consciousness For, in a remarkable passage,[1] he attempts to prov the consciousness of self is not a knowledge of the s a simple reference to the duality of the self knowi the self known, arguing that the ego "stands in i way," just because it exists only *for itself*, *i.e.*, bec knowing itself it presupposes itself. Kant evidently that to know the real self it would be necessary to app it in simple identity as purely an object without re to a subject, or purely a subject without reference object. Yet to this it seems sufficient to answer tha an object or subject would lose its character as ob subject and become equivalent to mere being in g and that, as such being is a mere abstraction, to k cannot be the ideal of knowledge. If therefore the unity or identity of thought which is not realized perience, and in reference to which we can regard exp as an imperfect form of knowledge, it cannot be fo this abstract identity of being. In truth, as we have is found in that very idea of self-consciousness whic is criticizing. Just because we are self-conscious, and fore oppose the unity of the conscious self to the ma ness of the world in space and time, do we seek world of space and time for a transparent unity wh cannot at first find there. But, when this is seen, in Kant himself the partial solution of the dif

[1] *Kritik*, p. 279 (Rosenkranz's edition). *cf.* Hegel, v. p.

nsciousness presupposes consciousness; for, while the ension of objects in consciousness is possible only ation to the unity of the self, yet it is only in n to and distinction from these objects that we are us of that unity. Hence the two opposites, self t-self, are bound together, and presuppose a unity reveals itself in their opposition, and which, when explicit, must reconcile them. If, therefore, self usness, in its first opposition to consciousness, gives an ideal of knowledge to which our empirical dge of objects is inadequate, this arises from the at not only empirical knowledge but also the ideal ch it is opposed is imperfect, or that they both to a unity which is manifested in their difference, hich is capable of containing and resolving it. In words, the opposition of science to its ideal, which has stated in his *Antinomies*, is not an absolute ion, but one the origin and end of which can be

opposition reaches its highest point in the con- etween the transparent unity of self consciousness, ch the difference of knower and known is evanescent, e essential manifoldness and self-externality of the n space, in which the differences seem to be insoluble. ust, indeed, think of self-consciousness as having life f and therefore as differentiating itself from itself; s differentiation is held within the limit of its unity, separation of movements which are separated only as re united. On the other hand, the world in space s itself as the sphere of external determination, in things are primarily disunited and act only as they ed on from without, and in which this external ce never goes so far as to destroy their reciprocal lity. In this sense it is that the opposition of mind tter was taken by Descartes, and it is a survival of he mode of thought that leads many even now to bsolute lines of division between *a priori* and *a ri*, between ideas and facts, between spiritual and . Kant and Fichte give a new aspect to the y by showing that the difficulty is one of recon- consciousness and self-consciousness, and that in usness there is already present the unity which is ted in self-consciousness, as, on the other hand, it through consciousness and in opposition to it that sciousness is possible. And Fichte made a further hen he attempted to show that the categories and the f perception, time and space, which Kant had taken plicable facts, are implied in this contrast of con ess and self-consciousness. The error that clings to s speculations is, however, that he treats conscious- erely as a necessary illusion which exists simply view to self-consciousness, and hence is led to regard sciousness itself—because it is essentially related necessary illusion—as a schema or image of an vable absolute. In fact, in the end Fichte falls pon the abstract identity in which Kant had found menon, and so ends his philosophy with mysticism. Schelling, though he saw that the absolute unity e one that transcends the difference of self and not- id not finally escape the tendency to merge all ce in absolute oneness. On the other hand, it was leavour of Hegel to proceed in the opposite way,— lose self-consciousness or subjectivity in a mere of substance, but rather to show that the absolute nce can be truly defined only as a self-conscious . And just because he did this he was prepared a further step, and to regard the external world, Fichte regarded it, as merely the opposite of spirit, Schelling regarded it, as merely the repetition and al of spirit, but rather as its necessary manifestation or as that in and through which alone it can realize His doctrine therefore might be summed up in two p tions,—first, that the absolute substance is spiritual conscious, and, secondly, that the absolute subject o can be conceived as realizing itself only through th world of externality which at first appears as its op In both respects Hegel's philosophy reverses the *ci tion* of mysticism, and teaches that it is only throu exhaustion of difference that the unity of science, of the mind contains in itself the certitude, is to be re For mind or spirit, viewed in itself, is conceived as differentiating unity, a unity which exists only t opposition of itself to itself. And it is but a ne result of such a conception that spirit can fully rea unity only through a world which in the first i must present itself as the extreme opposite of Hence the process of thought in itself, which is ex in the logic, ends in the opposition to thought of a which is its negative counterpart. And the "a spirit" of Hegel is thus, not pure self-consciousne that more concrete unity of self-consciousness wit which it attains through and by means of this worl

The effect of this view upon the relation of metaph science, which we are at present considering, is noti It does not, as is often supposed, supersede science *a priori* construction of the universe, nor does it le results of science unchanged and simply provide deeper foundation. The latter was the point at Kant and Fichte stopped; for, while they showe relativity of experience to the principle of self-consci they conceived that the function of metaphysic is com in showing the phenomenal character of the obj science, and in reserving a free space beyond th nomenal world for "God, freedom, and immort Schelling, on the other hand, as he did not adop merely negative view of the relation of spirit to nat of *a priori* to empirical truth, was obliged to rein the latter by the former. As, however, he did not nize any distinctions which were not merely quanti he was led to apply the same easy key to every loc to think that he had explained all the different fo existence, organic and inorganic, when he had pointed out a certain analogy between them. The physic of Hegel, whatever may be said of the philosophy of nature produced by its author, conta necessity for any such arbitrary procedure. In his indeed, he attempts to give us *in abstracto* the mov of thought in itself, from its simplest determinat being as qualitative or quantitative, through the re categories of substance and cause, up to its full con ness of itself in its organic unity.[1] And in so doing course gives us an account of the various categories science uses in the interpretation of nature. He attempts to show that the highest categories of scie in themselves imperfect and self-contradictory,—in words, that they mark a stage of thought whic short of that unity of being and knowing after science is striving, and which is the presupposit well as the goal of all intelligence. But, while h this, he clearly acknowledges two things,—on t hand that nature is essentially different from pur consciousness, and that therefore logic can ne direct evolution of its categories anticipate the inv tions of science, and, in the second place, that th interpretation of nature through the highest cat presupposes its interpretation by the lower categori cannot be directly achieved without it. In other

[1] This subject—the progress of thought from lower to high gories and methods—will be more fully discussed in the third

must first determine the laws of nature according
principles of causality and reciprocity, etc philosophy
in a position to discover the ultimate meaning of
by the aid of higher principles. "The philosophy
ture," says Hegel, "takes up the material which
al science by direct dealing with experience has
ed for it at the point to which science has brought
l again transforms this formed material without
back to experience to verify it. Science must,
ore, work into the hands of philosophy, in order that
ophy in its turn may translate the lower universality
understanding realized by science into the higher
sality of reason, and may show how in the light of
igher universality the intelligible world takes the
of a whole which has its necessity in itself. The
ophic way of looking at things is not a capricious
t, once in a way for a change, to walk upon one's
after one has got tired of walking upon one's feet, or
nstorm one's work a day face by painting it over;
st because the scientific manner of knowing does not
the whole demand of intelligence, philosophy must
ment it by another manner of knowing."[1]

result then may be briefly expressed thus. Kant
s succeeded in showing the relativity of the object of
edge to the knowing mind. He thus pointed out
the ordinary consciousness, and even science, are
t and imperfect modes of knowing, in so far as in
determination of objects they take no account of a
which is always present, to wit, the knowing subject.
their purposes, indeed, this abstraction is justifiable
ecessary, for by it they are enabled within their pro
l limits to give a more complete view of these objects
ir relation to each other than if the attempt had
made to regard them also in relation to the knowing
t. At the same time the scientific result so arrived
mperfect and incomplete, and it has to be recon
l in the light of a philosophy which retracts this
ional abstraction. For it must be remembered that
t that science looks at things only in their relation
h other, and not to the knowing mind, narrows the
s of view or categories under which it is able to
l them, or, in other words, limits the questions which
nd is able to put to nature. Just because science
not treat its objects as essentially related to the mind,
nable to rise to what Hegel calls the point of view
son, or of the "notion"; *i.e.*, it is obliged to treat
s and their relations merely under a set of categories,
ghest of which are those of causality and reciprocity,
is incapable of attaining to the conception of their
e unity. In other words, it is able to reach only a
etic unity of given differences, and it cannot discover a
pl of unity out of which the differences spring and
ch they return. Now philosophy goes beyond science
ecause, along with the idea of the relativity of things
mind, it brings in the conception of such a unity.
ighest aim is, therefore, not merely, as Kant still
to secure a place for the supersensible beyond the
of experience, but to reinterpret experience, in the
of a unity which is presupposed in it, but which
t be made conscious or explicit until the relation of
ience to the thinking self is seen, the unity of all
s with each other and with the mind that knows them.

Relation of Metaphysic to Psychology. It has already
shown that the doctrine that the thinking subject is
pposed in all objects of knowledge or, in other
, that existence means existence for a conscious self
not to be taken in a psychological sense. The idea
ll science is based on psychology, and that, therefore,

[1] Hegel, vii. p. 18.

metaphysic and psychology are identical, cannot be re
by any one who has entered into the full meaning
Kantian criticism. It is, however, so natural a mi
pretation of it, and it is so much favoured by the le
the very book in which it was first decisively re
that it will be useful to point out more directly the f
involved in it, especially as this will place us in a
position to determine the true relation of the two pa
philosophy thus confounded.

The misunderstanding first took a definite form
introduction to Locke's *Essay*, in which he propo
provide against any undue application of the intel
powers of man to problems which are too high for
by first examining and measuring the powers them
Stated in this way, it is obvious that the pr
involves an absurdity; for we have nothing to m
with, except the very powers that are to be measured
see round our knowledge and find its boundary, we
stand outside of it, and where is such a standing gro
be found? We cannot by knowing prescribe lim
knowledge, or, if we seem to be able to do so, it ca
be because we compare our actual knowledge with
idea of knowledge which we presuppose. In this w
ancient sceptics and modern writers like Sir W. Ha
and Mr Spencer who have followed them turne
duality involved in the idea of knowledge against its
and argued that, because we cannot know the
except as different from and related to the subje
cannot know it as it is in itself. Obviously i
argument it is involved that in true or absolute kno
the object must not be distinguished at all from the s

to which the easy answer is that *without* such
tion knowledge would be impossible. The sceptic
ment, therefore, lands us in the unhappy case pi
in the German proverb: "If water chokes us, wha
we drink?" The object cannot be known if
distinguished from the subject, and it cannot be kn
it is *not* distinguished from the subject. Obvious
one objection is as good as the other, and both co
only show that the idea of knowledge involves dist
as well as unity, and unity as well as distinction.
sceptic insists on one of these characteristics to the ex
of the other, and condemns our actual knowledge b
it contains both. In Kant there is undoubtedly som
of the same fallacy, in so far as the idea by contras
which he condemns the objects of experience as
menal is the idea of an abstract identity witho
difference; but we have seen that with him this a
identity is on the point of passing into an alto
different idea the idea of self-consciousness as the
knowledge.

It appears, then, that the idea of measuring our
before we employ them rests on a paralogism; for w
really meant is that we abstract one of the elements
idea of knowledge, and then condemn knowledge for
other elements in it. It is possible to criticize an
demn special conceptions as not conforming to ou
of knowledge; but it is not possible to criticize th
of knowledge itself; all we can do is to explain it.
possible to see the limited and hypothetical chara
certain of our ideas or explanations of things, beca
are conscious that in developing them we have left
account certain elements necessary to the whole
but this criticism itself implies, as the standard to wh
appeal, a consciousness of truth and reality, a consci
which we cannot further criticize. Here, therefo
come upon what must seem to all who think it adm
to question the very possibility of knowledge an ine
reasoning in a circle. We can answer objections o
means of the very idea which they dispute. I

is nevertheless a good one; for the objector also within the very circle which he seeks to break, and means of breaking it except itself. As soon as he he can be refuted by his own words; for his doubts resuppose that unity of the intelligence and the ible world which he pretends to deny.

error, however, cannot be fully corrected until we r what gives it plausibility. The confusion of the ysical with the psychological problem is due to the at the being who is the subject of knowledge, for all exists that does exist, appears to be one, and only the many objects of knowledge. When we say istence means only an existence for a thinking self, n to be identifying the whole world with the feelings eas of men, *i.e.*, with certain phenomena that belong life of a class of beings which only forms a part of orld,—phenomena, moreover, that are not exactly ne in any two of that class of beings. If we are to this difficulty it is obvious that we must be able to e the conscious self or subject, as it is implied in owledge, from the nature of man as a being who gh formally self conscious" is yet "part of this par-

rld," *i.e.*, one of the objects which we know along with distinction from other objects, and in whom "the sciousness which is in itself complete, and which ompleteness includes the world as its object," is only ssively realized.[1] Metaphysic has to deal with con- of the knowable, and hence with self consciousness unity which is implied in all that is and is known. logy has to inquire how this self-consciousness is l or developed in man, in whom the consciousness grows with the consciousness of a world in space ne, of which he individually is only a part, and to parts ch only he stands in immediate relation. In con- g the former question we are considering the sphere which all knowledge and all objects of knowledge are ed. In considering the latter we are selecting one lar object or class of objects within this sphere,— gh no doubt it must make a great difference in our ent of this object that we have to consider it as g not only for us but for itself. If nature "becomes scious in man," it is impossible to treat man as one among the other objects of nature. But it less true that he *is* one of those objects, and, in this of view, the department of science and philosophy eals with his life is as distinct from metaphysic- deals with the conditions of all knowing and bein, s astronomy or physics. In both cases we have us objects which we may consider in themselves from their relations to the conscious subject, and n cases we must take cognizance of these relations if uld have a complete and final view of those objects. ossible to have a purely objective anthropology or logy—which abstracts from the relation of man to nd that knows him—just as it is possible to have a objective science of nature. Such a natural science , however, will necessarily abstract at the same time he fact that in man is manifested that universal le in relation to which all things are and are known. er words, it will omit that distinctive characteristic of being in virtue of which he is a subject of knowledge moral agent. Hence the abstraction in this case is likely to lead to positive error, more likely to produce ly an imperfect but a distorted view of the object. anic nature, if we take it *in itself*, is not untruly d, under the categories of causality and reciprocity, collection of objects externally determined by each ; the error lies only in taking it as if it could exist

[1] Hume, vol. i. p. 131 (Green's edition).

in itself. Even organic beings do not suffer much injus in being brought under such categories; for, though living and still more as sensitive beings, they involv themselves and in their relation to the world a kin unity of differences to which the categories of exte relation imperfectly correspond, yet they are not unities *for themselves*, but only *for us*. In other words, principle through which they are and are known is external to them. Hence also they are determined outward influences, though these influences act rathe stimuli to what we may call the self-determined move of their own life than as mechanical or chemical fo which change it. But in man, in so far as he is self- scious, and it is self consciousness that makes him - the unity through which all things are and are kn is manifested; and therefore he is emancipated, o least is continually emancipating himself, from the of external influence. Nature and necessity exist him as that from which his life starts, in relation to w he becomes conscious of himself, against which he to assert himself, and in the complete overcoming which lies the end of all his endeavour. Nature is negative rather than the positive starting point of existence, the presupposition against which he reacts ra than that on which he proceeds; and, therefore, to treat simply as a natural being is even more inaccurate misleading than to forget or deny his relation to na altogether. A true psychology must, however, avoid errors: it must conceive man as at once spiritual and natu it must find a reconciliation of freedom and necessity. must face all the difficulties involved in the concep of the absolute principle of self consciousness, thro which all things are and are known,—as manifesting i in the life of a being like man, who "comes to himse only by a long process of development out of the un sciousness of a merely animal existence.

This problem first presented itself in a distinct for the discussions of the Socratic school as to the natu knowledge, discussions which turn mainly upon the rela of the conscious to the unconscious element in thou Socrates, by his method more than by any direct s ment, drew attention to the fact that all particular j ments in morals involve or presuppose a universal princ At the same time he pointed out that, so far from universal principle being known to those who are ntinually making such judgments, they are not conscious of its existence. They constantly use ge terms whose meaning they have never even thought defining. Th beginning of a rational life for them therefore lie in t heir becoming conscious of their ignor *i.e.*, conscious that they have been all along judging, therefore acting on untested and even unknown ass tions. They must bring the unconscious universal t light of day and define it, for until that is don impossible to live a moral, that is, a rational life. 'V is knowledge," *i.e.*, it is acting, not according to opin or particular judgments, whose universal is unknown which therefore may be regarded as expressing merel impulses or habits of the individual,—but in view universal principle determined by reason.

The onesidedness of this view—which absolutely demns as vice all virtue that is not based on cons principle—was partly corrected by another part o doctrine of Socrates, who taught that knowledge is thing that must be evolved from within the mind, an merely communicated to it from without. For this in that the moral principle may be present in men's m and may rule their thoughts and actions, long b they become directly conscious of it. They are rat although they have never thought about reason, and

wait for scientific ethics to judge and act morally, re than they wait for logic to reason correctly. It ine of thought which is universalized and mythically ed by Plato in his doctrine of "reminiscence." ing to this myth, we were conscious of ideas or als in our pre-natal state, we forgot them in the of birth into this mortal life, but in feeling or the rapture of the poet or the lover we recall them ntified or confused with individual objects which ke them, or partake in them." The same explana given of the practical skill of the general and the an, and even of the "right opinion" which guides inary good man. Such opinion is neither knowledge norance, not knowledge, for general principles or e not in it present to the mind *as* ideas, and there e particular cannot be distinctly subsumed under yet not ignorance, for the ideas are after all present, wrapped up in the particulars or confused with . Nay, in the *Theætetus*, Plato endeavours to show pure particular without the universal, sensations ideas, cannot enter into our consciousness at all, t therefore the lowest point to which a conscious an descend is "opinion," in which particular and l, sensible and intelligible, are mingled together. words, no conscious being can apprehend the ar except through the universal, though that uni- may be present only *in* consciousness and not *to* e task of philosophy is therefore only to make men et themselves," *i.e.*, to make *self-conscious* that ulty of thought in which all rational beings se," or which, in the language of later philosophy, utes reason. The imperfection of Plato's view lay, , in this, that, while he clearly recognized that the n of all consciousness of the particular is the l, he did not see with equal clearness that the l has a meaning only in relation to the particular. s tendency to separate universal from particular is ly accompanied by a tendency to set the subjective the objective, and to regard the world, not as the tation of reason, but as a dualistic world, in which is chained to a lower principle a world which e t only give a hint or suggestion to the mind to t to recollect itself and recover for itself its own . Thus the false method of introspection, the *ward* road' of mysticism, was at least opened up o, if he did not altogether forsake the narrower der way to the spiritual world through nature and nce.

great step in advance taken by Aristotle was due to ng the danger of this tendency. Those, however, ve maintained that Aristotle is the great *a posteriori* pher, as Plato is the great *a priori* philosopher, tirely mistaken the bearing of Aristotle's criticism Platonic theory. As strongly as Plato does Aristotle n that reason is ὅσαρχα τὰ νοητά, and that, re, the apprehension of truth *by* the mind is not a eternal communication *of* it *to* the mind, but rather mind coming to a consciousness of itself. As firmly does he declare that truth in its highest form is dencing, *i.e.*, that the principles of science, the laws re, when once they have been discovered, are seen true by their own light. His statements to this have been neglected or explained away, because ere supposed to be inconsistent with his still more tly reiterated assertions that it is only from nce and by induction that the truth of things can covered. Writers of a later day, who came to le with an idea of a fixed opposition between *a* and *a posteriori*, and who held that the only possible tives were *either* to divide knowledge between the two *or* to explain away one of them,—could not comp that Aristotle might be in earnest *both* in asserti knowledge is derived from experience *and* in asserti it is an apprehension by reason of that which is id with itself and needs no extraneous evidence Aristotle started with no such fixed opposition. contrary, any one who reads the last chapter *Posterior Analytics* will see that he had no diffic maintaining that knowledge begins in the apprehen τὸ καθ' ἕκαστον in sense perception, and that it p from many perceptions to experience, and from experiences to science; while at the same time he d that the principles of science have their evidence i selves. And the meaning of this declaration is sh the *De Anima*, where we find him speaking of knowl the realization in the "passive reason" of man of an reason" which is eternal and unchangeable, and w the consciousness of itself includes the knowledg things. Of this realization, indeed, there is in ma the potentiality or capacity, but just because this is or universal capacity, because, as Aristotle puts it, it quality or determination of its own to stand between its objects, it is a capacity in which the absolute rea realize itself, a capacity of knowing all things. H have Plato's myth of reminiscence freed from the m of memory, and reduced to scientific terms; for tha simply meant that the evolution of knowledge development of the mind to the consciousness of its of all that is potentially in it. Only, by the combi of this doctrine with the idea of the necessity of ind Aristotle at the same time guards against the subjective interpretation to which in Plato it was For the process by which the mind "comes to its conceived as a process by which at the same time from the particular to the universal, from the ἡμῖν to the γνώριμα ἁπλῶς, from the bare apprehen the facts of experience to the knowledge of them t their principles or laws.

Yet Aristotle was as little able as Plato to work ou a theory of the relation between the universal a individual reason; and the cause of this failure both cases substantially the same. In Plato's phil the ideal tended to divorce itself from the phen world in such wise that the latter was regarded suggesting or partaking in the former, but not as explicable by it. It was not merely that, to the mind individual in its progress, the veil was only graduall from the rationality of the world, but that in the there was an irrational element from which the could save itself only by flight into the region of a tion. And, though Aristotle by his doctrine of the e relation of ideas to experience, or of the develop the mind to the acquisition of knowledge of the seemed to be on the way to correct this error, yet shrinks from regarding the phenomenal world as i intelligible. To him also an irrational matter mingl things, and is in them a source of contingency and fection. Chance is not merely the reflexion upon th of our imperfect knowledge, but a fact of experien there is therefore a region in which our best science rise above generality to universality. In this wa remains for Aristotle an absolute *a posteriori*, a reality cannot be understood, and which we can scarcely c as existing at all for the divine intelligence. At th the Aristotelian philosophy appears to stand betwe alternatives, either that, in the sense of pantheism, th world and its contingency is an illusion, or that it tingent only for the growing intelligence of man fully understands neither itself nor the world whic object. Aristotle, however, does not choose either

emma, and leaves us therefore with an unresolved
between thought and its object; and this again
rily involves a dualism between the active reason,
as he asserts, realizes itself in man, and the passive
which constitutes his nature as a finite being.

he Middle Ages the Platonic and Aristotelian idea
e apprehension of objective truth is one with the
on of the mind to self-consciousness seemed to be
lost. Knowledge of the finite world was regarded
fferent, and knowledge of the infinite was conceived
omething given on authority, and in reference to
the mind was confined to an attitude of pas-ive
on or implicit faith. No greater slavery of the
an be conceived than that in which even the
of religion and morality the truths that regard the
life of the spirit itself were taken as a lesson
learned by rote from the lips of a teacher. Yet
sciousness that such truth, if it was to be received
mind, still more if it was to transform the mind,
ot be entirely foreign to it, found a voice in the
ic philosophy. And the compromise or truce
faith and reason expressed in the saying of Anselm
intelligam, according to which reason was to
itself to the analysis and demonstration of the data
l in implicit faith from the church, prepared the
the recognition that the two are not essentially
ance. The mind that proceeds from *credatio* to
o, from awe and submission to the doctrine to
ent and appreciation of it, must already in its awe
bmission have the beginnings of an intelligent
ation. Anselm's saying might be understood simply
ning that we must have spiritual experience ere
understand the things of the spirit. And in this
was adopted by the Reformers to express an idea
the opposite of that with which the scholastics
ociated it, the idea that the direct apprehension of
l truth as entering into the inner life of the subject,
tified with his very consciousness of self, is the basis
nowledge of it. In the Protestant church of the
after the Reformation, we find a growing tendency
on the subjectivity of religion, in the same exclusive
e sided way in which the mediæval church had
on its objectivity. In some extreme representa
f Protestantism this went so far as to lead to a
rd, almost to a rejection, of all objective doctrine,
eduction of theology to an account of the religious
nsness. On the other hand, while religion was thus
bjective, science claimed to be purely objective.
followers of Bacon seemed to adopt towards nature
e attitude of passive receptivity which the mediæval
n was taught to hold towards the church. While
s to learn everything from himself in religion, he
learn nothing from himself in science. His aim
e to exclude subjective *idola*, in other words, to
the facts as they were given, and keep himself out of
y. The inevitable result of this difference of view
the nature of knowledge in these two different
was, however, on the one hand a withdrawal of
from all connexion with finite interests, and,
lly from the attempt to connect religious principles
e knowledge of the finite world, and, on the other
an increasing tendency in those who represented
science to regard religion as something merely
ive and even individual, as a feeling which could
translated into thought or made the basis of any
dge of the objective world.

opposite principles of certitude which were thus
for religious truth and truth of science need only
brought together and contrasted to betray that they
on opposite abstractions, neither of which expresses
the complete nature of truth or knowledge. On
hand the truths of religion were maintained just
they were not, or were not merely, objective, but
capable of being tested by inner experience, and ide
with the self-consciousness of the individual. On th
hand the truths of science were maintained becaus
were not, or were not merely, subjective, but were
of being verified in objective experience. It was
on the one side that mere subjective feeli
opinions have no validity for any one but the sub
them, and on the other side that what is merely ob
or externally given can have permanent value and
for the intelligence only as it ceases to be mere i
and unrelated fact nay, that, even when scien
discovered law and order in nature, it still wan
highest value and interest so long as that law and or
not seen as standing in essential relation to the intel
itself. The idea of truth or knowledge as that whic
once objective and subjective, as the unity of things w
mind that knows them, enables us to understand th
demnation which the religious mind passed upon a
external dogma, and even its lack of interest in a
which presented itself as an account of merely objec
external facts. And it enables us also to understa
way in which scientific men insisted upon objecti
as the basis of all knowledge, and the disrespect
they felt for a religion which seemed to admit that
no such support. What is wanted to clear up the co
on both sides is the growth of the perception
scientific men that the objectivity which they are s
cannot be mere objectivity (which would be unme
but an objectivity that stands in essential relation
intelligence, and, on the other hand, the growth
perception among religious men that the bjecti
religion only means that God, who is the objective p
by whom things are, and are known, is spiritual, a
therefore be revealed to the spirit. When these t
rections have been made, it must become obvious t
religious consciousness is not the consciousness of a
object than that which is present in finite experien
science, but simply a higher way of knowing th
object. And in this it is also involved that the tw
of *a priori* and *a posteriori*, of that which is evolv
within and that which is given from without, a
essentially opposed to each other, but that the *a pr*
is simply the first form of a consciousness which
ultimate development must become *a priori*.

In that philosophy of compromise which was i
by Descartes, one part of knowledge was regarded as
or developed from within, and another part as em
or imparted from without. In the second period
history of modern philosophy this compromise was
and the names of Locke and Leibnitz – though wit
hesitation on both sides – represent respectively the
that all knowledge is *a posteriori* and that all kn
is *a priori*. The compromise seemed to be renew
Kant, but the form in which it was renewed p
has been already shown, to something more than
promise, for his doctrine was that the *a posteriori*
the facts, exist for us only under *a priori* conditi
in other words, that what is usually called *a po*
is in part *a priori*. The criticism of this view ne
be repeated. It is sufficient here to say that it, a
shows, the elements are inseparable or organically
it is impossible to allege that so much belongs to
and so much to the other. Furthermore, the consci
of an essential difference in the elements of know
possible only so far as that difference is transcended
unity of knowledge. We can distinguish the *a pri*
the *a posteriori* only on condition that we can tra

inction, and this means that the distinction itself absolute, but that there is a point of view from he *a posteriori* may be regarded as *a priori*, and hich is given from without to the spirit may be l to its own self-determined development.

it is just here that we come upon the turning-point philosophical controversy, in the form which it has n modern times. The problem may be expressed In what sense can we apply the idea of development human spirit? Are we to treat that development ly a determination from without, or as an evolution ithin, or as partly the one and partly the other? nse all writers of the present day would admit that st is the case. For, on the one hand, even the ian theory accounts for development by aid of e may call the *a priori* tendency of the individual ntain itself in the struggle for existence, though it es that the condition medium in which the indi- is placed determines the direction in which that ment proceeds. And, on the other hand, no one ould adopt the Leibnitzian theory that the indi- is a monad, whose self development is entirely con- d by itself in such a sense that all the relations it has to other existences are merely apparent, and e coincidence of its life with the life of the world is ult of a pre-established harmony. On both sides, re, the idea of self-determination would be admitted, the tendency of the Darwinians would be to regard lf-determination as something merely formal; and h sides it would also be admitted that the self- ination does not exclude a determination from with- ough extreme opponents of Darwin might be inclined ce this determination to a mere stimulus or external on of the development of the nature of the subject ch the stimulus is applied. The question, however, s whether, after all, this opposition of without and is an absolute one, or whether there is any point of rom which it may be transcended. To Aristotle it l possible to answer this question in the affirmative, e conceived that the reason of man is a pure or ὄϑραυς, the evolution of which to complete self- ness is one with the process whereby the objective comes to be known. Yet, as Aristotle admitted the ce in the world of a material principle which was ially different from the ideal principle of reason, he bliged to limit his statement as to the possible unity subjective and the objective consciousness, and to rely that "in things *without matter* the knower is al with the known." But this would immediately e conclusion that the pure development of reason be secured by abstraction from all finite and material s, rather than by a thorough comprehension of them. reedom of the spirit, on this theory, must be a negative ot a positive freedom, a freedom won, not by over g the world, but by withdrawing ourselves from its nce. It remained, therefore, for modern philosophy rk out the Aristotelian idea that the rational being h, in spite of its necessary relation to and depend on an external world, is never in an absolute sense nally determined. And, as we have already seen, the an philosophy brought this problem within the reach lution, in so far as it showed, first, that objective nce can have no meaning except existence for a ng self, and, secondly, that existence for a thinking eans existence the consciousness of which is "capable ng combined with the consciousness of se Add r to these propositions what was shown by Kant's ssors, that that only can be combined with the con- ness of self which is essentially related to it, and we at an idealistic theory of the world, which enables us at once to understand the relative value of the di tion between self-determination and determination without, and at the same time to see that its value is relative. If it be true that nothing exists which is possible object of consciousness, and again that there possible object of consciousness which is not essen related to self consciousness, then the phenomena external world, which at first present themselves und aspect of contingent facts, must be capable of being mately recognized as the manifestation of reason; an history of the conscious being in his relations with world is not a struggle between two independen unrelated forces, but the evolution by antagonism spiritual principle. It is, on this view, the same life within us is striving for development, and which w ns conditions that development. And the reason wh two terms, the self and the not self, thus appear independent of each other, or to be brought togethe as they externally act or react upon each other, lies i that the object is imperfectly known, and the sub imperfectly self-conscious. This, however, does not m less true that in self-consciousness is to be found th ciple in reference to which the whole process m explained, and therefore that the self conscious subj such, lives a life which belongs to him, not merely object among others, but as having in himself the pr from which the life and being of all proceeds.

From this point of view, as has been already ind the relative value of a theory of human developmen as that which might be based on the ideas of D would not be denied. The conscious being may be re simply as an externally determined object, and the inc ness of this assumption will not entirely destroy the of the results attained, especially if, as is often th with those who seek to construct a natural science o the assumption itself is not very strictly adhered corrected by the tacit admission of other conceptions what inconsistent with it. But, at the same time, it require to be pointed out that such a science is nece abstract and imperfect, as it omits from its vie central fact in the life of the object of which it trea can do nothing to account for man's consciousness, capacity of becoming conscious, of the influences by he is supposed to be determined; or, to put it fr other side, it takes for granted that the objec influence man are intelligible objects, "capable of combined with the consciousness of self," without how much is involved in this assumption. Nov evident that the consciousness of an influence can explained by the influence itself, nor even by that together with the nature of the sensitive beings su to it. It is evident also that an influence media consciousness is not, strictly speaking, an external in but that it is already transformed, and in process of further transformed, by the development of the which it is present. For the dawn of consciousn which the external object first comes into existence as opposed to the self, is at the same time the beg of the process by which its externality is negated come. Self-consciousness is that which makes viduals in a sense in which individuality can be pre of none but a self conscious being. For, in deter himself as a self, the individual at the same time e from himself every other thing and being, and dete them as external objects. He emancipates himse the world at the same time that he repels the worl himself. Yet this movement of thought, by wh individuality is constituted, is also that by which he above mere individuality, for, in becoming conscious and not-self in their opposition and relation, he ce

ly identified with the one to the exclusion of the His finite individuality is regarded by him from a al point of view, in which it has no less and no more ance than any other individuality, or in which its or less importance is determined only by its place whole. On this universality of consciousness rests sibility of science and of morality. For all science a contemplation of the world *in ordine ad universum* *in ordine ad individuum*; and all morality is just with a view to an interest which belongs to the not as this individual, but as a member of a greater and ultimately of the absolute, whole in which all d all things are included.

his nature of the conscious subject lies also the lity of metaphysic in the sense of Aristotle, as that which goes back to a *πρῶτον φύσει*, a beginning is prior to the existence in consciousness of the nal self, and onward to an end in which the divisions finite consciousness are transcended, as including, t, ontology, or metaphysic in the narrower sense, on e side, and theology, or the philosophy of religion, other. In truth, these two extremes of science are rily bound together: we can only go back to the ing if we can go on to the end; we can only recover t unity if we can anticipate the last. Or, to free ject more definitely from the associations of time, not apprehend the unity which is involved or pre- d in all the differences of our conscious life except ar as we can look at our individual existence from nt of view of the whole to which it belongs. This come evident if we consider the nature of the limits have to be transcended by such a science. The ual conscious subject, as he finds himself at first, one being in a world that stretches out, apparently t limits, on every side of him. Of the things by he is immediately surrounded he sees but a small ad the influences which he receives from them are, nows, like the wave that breaks upon a shore from known ocean, only the last partial expression of es that come from regions beyond his ken. Again, s himself as one in a changing series of beings, of he knows only the last preceding terms, and he is hat in a few years he, as one of this series, will o be. He is thus to himself a definitely limited and though his knowledge of himself and his world gradually widened so as to reach some little way nto the past, and anticipate a little of the future, or o outwards in space to embrace a widening circle of ces around him, yet he always stops at a limit, of he is conscious that it is no absolute limit, but an arbitrary halting-place where vision grows ct and imperfect. When he reflects upon himself his point of view, he is forced to regard himself as ragment, and a fragment of an unknown whole, by his whole being is determined to be what it is. ghest knowledge seems to be but a consciousness ignorance, his highest freedom a determination by s the ultimate meaning of which is hid from him.

ar there seems to be no room for any metaphysical dge, any knowledge of ourselves and our world is other than relative and *in ordine ad individuum*. rther reflexion shows that in this very consciousness t there is implied a consciousness of that which is l limit. While we proceed from part to part, beginning urselves and our immediate surroundings, and follow- t lines of connexion that lose themselves in the dis- we are guided by a consciousness of the whole as a through which the parts are determined. Nay, it is e presence of this consciousness that makes us capable at seems the piecework of our knowledge, in which, by the aid of the principle of causality, we connect cular with particular, and so gradually extend the of light into the encompassing darkness. For principle simply means that the limited external does not sufficiently explain to us its own existen that therefore we are forced to explain it by a refer something beyond it. It means, in other words, t cannot rest in that which is not a self-bounde determined whole. The application of the categ external determination has therefore an essential re to the higher category of self-determination. The endlessness of space and time has no meaning ex opposition, yet in relation, to the true infinity of we find the type in self-conscious thought. Or, to in the Kantian form in which it is already familia the consciousness of the objective world in space an stands in essential relation to the unity of self-con ness. And if when we regard the former exclusiv are forced to view ourselves as insignificant and sighted finite beings in an infinite universe, wh regard the latter we are enabled to see that in universe there is revealed only that spiritual pr which we find also in ourselves. In this way a ne is thrown on our first consciousness of ignorance strivings of our reason after knowledge can no lo regarded as strivings after an unknown goal, but after a goal which it has prescribed for itself. The limits of our individual life are not removed, bu cease to be for us the limits of a narrow circle of de within a formless infinite. They become the limi sphere within a sphere, a sphere which is defined idea of knowledge or self consciousness itself, and i therefore, however we may wander, we are everyw home. In religious language, the sphere is not universe, but God, who is without us only as He is us, so that "by the God within we can understa God without."

Again, as this consciousness takes man beyo immediate existence, and enables him to determin relation to an absolute unity of all things in Go enables him to go back to a unity which is bel prior to that existence. For, if the individual can himself as he looks at others, and at others as he himself, *i.e.*, from a point of view which is unaffe his individuality, and in which that individuality is only what it is for impartial reason, he can have not him which binds his consciousness to his individu mere individuality; as therefore he can go beyond to apprehend the whole in which his individuality place, there is nothing to prevent him from going upon himself, and upon the conditions which are his own individual being. He is not tied to his im life, and can go below it just as he can rise above i

"O God, I think Thy thoughts after Thee," said In reading the "thoughts" written in the pl system, Kepler was discovering the meaning which is simpler and more elementary than the of man, as a cycle of mechanical relations are simp more elementary than self consciousness. Yet it true feeling that led him to connect this descent i mechanical world with God. For it is only in the same faculty which enables us to rise to the life which includes and subordinates our own that so free us from the image of our own conscious li apprehend and fix in thought the simpler relat purely physical existence. But the same faculty back upon ourselves has a still deeper manife Not only can we abstract from ourselves so as to stand the inorganic world, we can also abstract fr selves so as to understand the conditions which a

thought, and therefore to the existence, of any
e external world at all, the universal conditions of
wable and therefore also of reality. In doing so,
Hegel's metaphor, which is but an extension of
s, we are "thinking what God thought and was
the creation of the world," *i.e.*, we are thinking the
l unity presupposed in all knowledge, and therefore
bjects of knowledge the consciousness in relation
h everything is, and is known.

The Relation of Logic to Metaphysic - The ordinary
logic is based on two presuppositions which tend to
t it almost entirely from metaphysic: it is based on
supposition of an opposition, or at least a merely
l relation, between thought and its object, and again
pposition, or merely external relation, between the
method and the content or matter of thought. The
ence is regarded as dealing with an object which is
o it externally, and to which, therefore, it can be
ly if it leaves it unchanged and introduces into it
of its own. Truth, to use a well-known definition,
greement of our conceptions with their objects, and
ging about this agreement all the concessions must
he side of thought. Conformably to this view, the
es of thought must be purely analytic; *i.e.*, thought
eak up the given idea of the object into its con-
t elements, and again out of these elements it may
ose the idea in its unity, but it can add nothing and
othing away. It is like an instrument which
tely dissects a solid mass into smaller parts and
mechanically presses them together, but which
penetrates and dissolves the hard matter, still less
into a new form by bringing it into contact with
emical elements.

conception, like much of the philosophy of which
specimen, is a kind of exaggerated caricature of one
of the philosophy of Aristotle. Aristotle is the
nalytic philosopher He first laid down boundaries
continuous domain of science which Plato had first
d. Not that he ever completely lost sight of the
r continuity of the different sciences which he thus
nished His unrivalled speculative genius is shown
e more clearly than in those not unfrequent utterances
ulative insight into the unity of things different, by
as at a stroke, he makes his own landmarks and all
rks to disappear. Yet such utterances generally
y themselves, and do not alter the general analytic
f his philosophy. They are not so developed as to
stinctly the merely relative character of the divisions
stinctions which are set up, or the limits of the sphere
which they hold good. Hence it was easy for
which possessed something of Aristotle's keenness
erstanding without his speculative depth to neglect
xpressions, or to explain them away. And this
of degradation was the more rapid as the philosophy
totle soon ceased to be studied in his own writings,
came a traditionary possession of the schools. In
ay we may partly explain how logic came to be
ed by mediæval philosophy as a form of thought
could be altogether separated from the matter, and
application of which that matter could be in no way
l or changed But for such a view, indeed, it is
t to conceive how the schoolmen could have ventured
y any logical processes at all to the sacred matter of
The idea of externally adding anything to the
nce delivered to the saints was excluded by the
le of authority; and the idea of developing out of
ith anything that was not immediately contained in
not yet presented itself to any one. Hence the
s of thought seemed to be purely formal and
, and it was only on the plea of its being such that
its activity could be tolerated at all. Nor was thi
of logic at once changed by the revolt against scholas
The first philosophical exponents of the modern sc
movement, while they rejected the matter of dog
fictitious, or at least as transcending the sphere of p
knowledge, and while they substituted in its place,
object of investigation, the facts of experience, d
realize any more than the schoolmen that the for
method of knowledge could be other than analytic o
matter. Bacon, their protagonist, was above all sol
to guard against any subjective *anticipatio naturæ*;
he see that the questions which, in his theory of
he proposed that science should ask of nature ther
involved any preconceived theory regarding it. Cor
as every true scientific man must be, that the st
nature involves a constant self abnegation, a patien
distrustful course of experiment and observation,
his followers did not realize the presuppositions tha
the inquiry possible, and by which it must be guided.
less did they recognize that the separation betwe
mind and its object which they took for granted e
be a relative division, *i.e.*, a division on the bas
unity, and that therefore the self abnegation of th
in its investigation of facts cannot be an absolu
abnegation, but is only the first step on the way
discovery that the facts are intelligible, and so esse
related to the intelligence. Hence to them log
seemed a mere analytic process, the end and aim of
was understood to be that a world, existing in its
of relation to thought, should be reproduced in a r
less imperfect image *in* thought. And, when it can
suspected by a less naive philosophy of experienc
after all, certain presuppositions, not given in exp
itself, were involved in the scientific interpretatio
various expedients were devised to reduce these pres
tions in an indirect way to empirical truths,- exp
of which Mill's attempt to base the law of causalit
an *inductio per enumerationem simplicem* may be t
the type.

When we go back to Aristotle, who was the "
of logic" in the sense that he was the first who
logical method as a separate branch of science,
that his division of logic from metaphysic is by no
so definite and complete as it was made by some
successors. The verification of the highest princ
thought, the law of contradiction, is treated by him
business of metaphysic. And, though he separates t
of truth from the idea of reality, and regards the
as involving a relation of thought to a reality w
determined in itself independent of that relation,
does not regard this independence as by any means a
Truth is defined by him as a connexion or distinc
ideas which *corresponds* to a union or separation of
but does not necessarily so correspond. This de
however, holds good only in so far as things a
scientifically known, or in so far as things not ess
related are brought together κατὰ συμβεβηκός.
necessity comes in, and is apprehended by reas
case is different. For in that case we have not
an external synthesis, but an essential identity, *i.e.*,
of elements which can neither be, nor be known
from each other. In relation to the principles of
therefore, Aristotle holds that error, *i.e.*, a conne
ideas not corresponding to a connexion of things, is
sible, and that the only alternatives are knowledge
norance. Either we possess the idea or we do not po
as Aristotle otherwise expresses it, in thought we ar
in contact with the things or not in contact with
there is no third possibility. The meaning of A
becomes clearer when we remember that, according

ne intelligence, in apprehending the indivisible unity
ents in the object, is at the same time apprehending
ty of the object with itself. The mind cannot be
l in regard to that which forms a part of its con-
ess of itself. In freeing the essential conception of
ject from the contingency of matter, science has
he object from that which made it foreign to
ence, and the relation of thought to things ceases
ne of correspondence, and becomes one of identity.
legitimate inference from this view of the relation
intelligence to the intelligible world would seem
at the partial separation of thought from its object
imperfect correspondence with it is characteristic
first empirical consciousness of things, and of the
s from that consciousness to science, but that in
ted science the division ceases. The *res* of things
their *percipi*, but their *intelligi*. But, if this be
s the truth, then it can no longer be supposed that
ocess by which scientific knowledge is attained con-
mply in an analysis of the object as it is given in
iate perception. On the contrary, it must be held
our thought has to submit itself to the object, and
brought into conformity with , by a process of
on, it is equally true that in process the object
ust be changed, that it may be brought into con-
y with the principle of thought. The genesis of
, according to this view, is not merely an analysis
n facts, but a process of vital transformation by
consciousness on the one side and the object on
her are brought into unity with each other. The
ndeed, of an empty process, a process in which the
y of the mind is merely formal, is one which will
and the slightest examination. A mind without
ries, if such a thing were conceivable, would have
stions to ask in relation to the object presented to
could therefore get no answers. Those who make
ence of approaching a subject in an absolutely
ve attitude, and without any presuppositions, only
hat they are unconscious of the categories by
their thought is ruled; and they will be most
ly guided by these categories just because they
nconscious of them. The schoolmen, when
pplied their logical principles to the matter of
an dogma, did not recognize that they were doing
han analysing and bringing out early the meaning
dogma. But the effect of their work was to turn
stem of divinity into a collection of insoluble puzzles;
doctrine was a doctrine of reconciliation between
and human, infinite and finite, universal and
lar, and the principle of their method was to treat
se oppositions as absolute. In like manner it might
wn that the analysis of social phenomena which was
n the last century was inadequate and superficial,
cause of the latent assumption of individualism on
it proceeded, and that the greater success of writers
omte and Spencer does not arise merely or mainly
heir being more careful observers of the phenomena
al life, but in great part from the fact that, rather by
conscious movement of opinion than by any distinct
ysic, their minds have become possessed by more
te categories.

idea that the process of thought is merely formal,
lytic of given matter, is, however, an error that has
h underlying it. This is the truth expressed by
tle in his much misunderstood comparison of the
gence of man to a *tabula rasa*, upon which nothing
t is written, and again in his assertion—already
—that the mind is a pure δύναμις, without any
guishing quality of its own which could prevent it
apprehending the real nature of other things. In
other words, self-conscious reason is not a special th
the world, but the principle through which all thing
and are understood; and hence, as regards the distinct
things from each other, it is in the first instance u
mined and indifferent, and therefore open to be deter
in one way or another, according to the object to w
is directed. But this simply means that the con
subject, as such, is not bound to his own individualit
can regard things, nay, in a sense, must regard them
a point of view which is independent of it. This is
makes possible the self restraint and self-abnegatio
scribed to the scientific man, whose whole duty, as it i
said, is to keep himself out of the way and let the
speak, to lay aside all subjective *idola* and pre
that stand between him and the reality of things.
first sight may seem to be equivalent to the assertio
the mind ought to be in a state of simple passiv
receptivity towards objects. What is really meant
ever, is not that the intelligence should go out of it
cease to be itself, that it may know its object, but
that it should show itself in its universality, or fr
from the limits of the individual nature. The self-a
tion of science is an endeavour, so to speak, to s
object with its own eyes, but this it can do only in
as the consciousness for which the object is is the
sciousness in relation to which alone all objects a
are understood. Or, to put it in another form, th
scious self in its scientific self abnegation does no
itself up to another, and become purely passive;
gives up all activity which is not the activity
universal thought for which and through which all
are. Hence, when it has so abnegated itself, its most
constructive activity is just beginning, though, just
as the self abnegation has been real, that const
activity has become one with the self revelation
object. As, however, it is only through the const
activity of thought that there exists for us any ob
all, so it is only through its continued activity th
conception of the object is changed, till it is com
revealed and known. And this activity involves
tinuous synthesis, by which an ever wider range
is brought together in an ever more definite unity
the mind has, if we may use the expression, exhau
store of categories upon the world, and until the wo
completely revealed itself in its unity with itself an
the mind.

To combine these two ideas on the one hand that
begins in a self abnegation by which the mind re
all subjective prejudices, and thereby attains a
objective attitude, and on the other hand that this
objective attitude is not a mere attitude of recepti
one in which the mind is continually transform
object by its own categories, to see that the univ
of the mind in knowing is not mere emptiness, and
activity is synthetic just when it is most free from
suppositions extraneous to the nature of its object,
of the greatest difficulties of the student of meta
Universality at first looks so like emptiness, and a n
activity so like a merely formal activity, that i
wonder that the one should be mistaken for the
But if we make such a confusion, we may soon be
to choose between a sensationalism that makes kno
impossible and a mysticism which makes it empty
pure identity of thought with itself which is inv
the process of analysis is put on the one side, a
manifold matter of experience which is the ob
thought on the other, and between these oppos
mediation is possible. If we take our stand up
latter, we are forced to reject all mental synth
invalid, because it involves a subjective addition

if we take our stand on the former, we are com- to regard all objective experience as irrational, e it does not correspond to the pure identity of t.

Aristotle's view of logic it cannot be said that this ty is clearly solved, though he seems to have seen ror of both extremes. On the one hand he often izes the synthetic character of the process of induc- s when he speaks of the universal idea or law as a principle, in which we must find the key to all the ties suggested by different aspects of a given subject. other places we trace the influence of a merely ana nception of that process as a process in which the sal is to be reached by abstracting from the peculi of individuals. And this conception of it is favoured stotle's metaphysical theory, according to which the of things in the finite world are manifested in a g matter, a matter which prevents them from being ly or universally realized. For, in so far as this is e, the facts will not be entirely explained by the dge of the form, and the knowledge of the form e obtained, not by combining all the facts, but rather racting from them. Again, in Aristotle's account process of thought in the *Prior Analytics*, he it as a formal deductive process, and, though *Posterior Analytics* he attempts to give a synthetic g to the syllogism by treating it as the method in the properties of a thing may be proved of it, or ed with it, through its essential definition, yet this tions meaning bestowed upon the syllogistic process t alter its essential nature. The ultimate source of adequate view of the process of thought seems to lie totle's imperfect conception of the unity or identity s for him the type of knowledge. For, though, both *Metaphysic* and the *De Anima*, he defines that identity consciousness or as a consciousness of objects which tical with self-consciousness, yet he does not seem to distinguish between a unity in which there is no ce and a unity in which difference is transcended and ed. This seems to be shown by his description of the es which reason apprehends as *individua* or indi unities, rather than unities which imply, while they nd, difference. Yet, in this definition of the unity wledge as self-consciousness, Aristotle has implicitly ed that there is a duality or difference in the unity and this might have been expected to modify his ion of the relation of consciousness to its objects. self-consciousness is not simple like a chemical , but only in the sense that it is an indissoluble of opposites, it might have been anticipated that o had realized self consciousness as the principle owledge would be able to regard the opposition n the consciousness of self and the consciousness of rld as itself also capable of being conceived as a

misconception of Aristotle may be shown in way. In the *Metaphysic* we find him laying down s called the logical law of contradiction as the e principle of knowledge. The meaning of this le, however, as Aristotle states it, is simply that t in its essence is definition or distinction. If, as tus says, everything at once is and is not, if we attach any definite predicates to things by which ay be distinguished from each other, then, as le argues, thought is chaos, and knowledge is ble. If determination be not negation, if the n of A be not the negation of not-A, then there is ning in words. The criticism to be made on this obviously, not that it is a false statement of the law ght, but that it is an imperfect statement of it. Thought is undoubtedly distinction; and, if all dist be confounded, no meaning can be apprehended pressed. But thought is also relation and conne the things distinguished, and this aspect of it is important with the other. Aristotle shows his on ness—a one-sidedness which throws him into opp to Plato, but which enables him to correct Plato falling into the opposite error- when he exclusive his attention on the "differentiating" aspect of kno and takes no notice of the "integrating" aspect of is easy to see that this exclusive attention to one the truth may lead in many ways to a distorted vie of the world and of the intelligence that apprehends Heraclitus be interpreted as simply denying the thought to introduce its definiteness into the flux o nothing but absolute scepticism can come out philosophy; and Aristotle was right in maintaining t only as the flux is brought to a stand, and the univ fixed as a permanent and definite object of though knowledge becomes possible. But, on the other h distinction be taken as absolute, if the definite a of a thing be taken as a negation of all relation to is not, if the fixity of thought be taken as an abstra identity which excludes all the movement of finite wherein they show their finitude and pass beyon selves into other things, then knowledge will be impossible. Our consciousness, on such a theory, be disintegrated into parts which would own no co with each other; nor would it be possible for us t of things as, in spite of their differences, bound toget the unity of one world. The law of contradic distinction, therefore, is likely to lead to serious ceptions, unless it be complemented by a law of rel a law expressing the truth that there is a unity transcends all distinction. For all intelligible dis all distinction of things in the intelligible world be subordinate to their unity as belonging to that and therefore essentially connected with each oth with the intelligence. In such a world, in other there can be no absolute distinctions or differenc even between being and not-being); for distinction relation is impossible, and a conception held in a isolation from all correlated conceptions ceases t any meaning. This does not, of course, imply a n of the law of contradiction within its own sphere, does imply that that sphere is limited, and that the absolute contradiction. All opposition is within supposed unity, and therefore points to a higher rec tion, a reconciliation which is reached when we sh the opposition is one of correlative elements.

The great step in logical theory which was taken idealistic philosophy of the post-Kantian period was to dissipate the confusion which had prevailed between that bare or formal identity, which is beginning of thought and knowledge, and that unity of difference, which is its highest idea and e was, in other words, to correct and complete the tions of thought as analytical, and as externally sy cal, by the conception of it as self-determining, that it is a unity which manifests itself in differen opposition, yet in all this, even when it seems dealing with an object which is altogether exte it, is really developing and revealing itself. Th movement of thought might, in one point of v described as the addition of another logic to th of analysis and the logic of inductive synthesis were already in existence. But it was really mo this; for the new logic was not merely an external a

[1] ἠρεμήσαντος τοῦ καθόλου ἐν τῇ ψυχῇ, *An. Post.*, ii.

old logics, it also put a new meaning into these y bringing to light the principles that were involved . At the same time it broke down the division d been supposed to exist between logic and meta- between the form or method of thought and its It showed that thought itself contains a matter hich it cannot be separated, and that it is only by of this matter that it is able to ask intelligent ns of nature, and to get from nature intelligible . A short space must be devoted to explain this of the three logics to each other.

analytic logic fairly represents our first scientific e to the world, in which we concentrate our attention he facts as they are given in experience, with no t of any mental synthesis through which they are To ourselves we seem to have to do with an object s altogether independent of our thought, and what d in order to know it is to keep ourselves in a purely ve attitude. All we can do is to analyse what is without adding anything of our own to it. It has, r, already been pointed out that this apparent self- tion is possible only because, in abnegating our indi- point of view, we do not abnegate the point of view longs to us as universal or thinking subjects. In words, the objectivity of knowledge thus attained is ceasing of the activity of our thought, but rather of interferes with that activity. We seem to abstract urselves, but what we do abstract from is only the uality that stands between us and the world. The ic observer who has thus denied himself, however, necessarily conscious of the meaning of what he has The immediate expression of his consciousness is think the object," but "it, the object, is"; and the tensely active he is the more his activity is lost for the object of it. His whole work is, for himself, e analysis of given facts, and for the rest he seems nothing to do but to take the world as he finds he voice of nature to which he listens is for him own voice but the voice of a stranger, and it does ur to him to reflect that nature could not speak to but a conscious self. His business is to determine as they present themselves, to enumerate their es, to measure their quantities; and his logic accord- a logic governed by the idea of the relative com- sion and extension of the things which he thus and classifies. Such an analytic logic seems to be is necessary, because the only predicates by which are as yet determined are those which are involved r presence to us in perception, and as perceived they be at once given in all their reality to the mind prehends them.

ep is taken beyond this first naive consciousness of whenever a distinction is made between appearance ality, or whenever it is seen that the things perceived entially related to each other, and that therefore they be known by their immediate presence to sense, but a mind which relates that which is, to that which immediately perceived. If "the shows of things are hemselves," we must go beyond the shows in order to them; we must seek out the permanent for that is given as transient, the law for the phenomenon, se for the effect. The process of thought in know- herefore is no longer lost in its immediate object, partly at least, distinguished from it. For just in tion as the reality is separated from the appearance e knower become conscious of an activity of his own t in determining things. From this point of view is no longer an object which spontaneously reveals o us, but rather one which hides its meaning from l out of which we must wring its secret by persistent questioning. And, as this questioning process ob has not its direction determined purely by the object it becomes manifest that the mind must bring with categories by which it seeks to make nature intel To ask for the causes of things, or the laws of thing supposes that the immediate appearance of them d correspond to an idea of reality which the mind with it, and by which it judges the appearance. is supposed to be given to or perceived by us as a tude of objects in space passing through successive in time; and what science seeks is to discover a n of connexion running through all this apparently cont coexistence and succession and binding it into a s Science, therefore, seems to question nature by m an idea of the necessary interdependence and conne all things, as parts of one systematic whole gover general laws- an idea which it does not get from but which it brings to nature. Hence the logic in this process of investigation expresses its conscious itself will be a synthetic logic, a logic built on certai ciples which are conceived to be independent of expe and by the aid of which we may so transform that ence, so penetrate into it or get beyond it, as to find a better explanation than that which it immediately g itself. The *Posterior Analytic*, in which Aristotle br the idea of cause to vivify the syllogistic process, or s real meaning to it, may already be regarded as a firs in this direction. And the theory of inductive l explained by Bacon and his successors down to M continuous attempt to determine what are the princip methods on which experience must be questioned, i to extract from it a knowledge which is not given mediate perception.

It was, however, Hume who first brought into light the subjectivity of the principles postulated logic, and especially of the principle of causality, w the most important of them. In thus contrasting t jectivity of the principles of science with the obj of the facts to which they are applied, it was his in to cast doubt on the science which is based on the tion of the former to the latter. The principles, h tains, are not legitimately derived from the facts, th they cannot legitimately be used to interpret them. are due to the influence of habit, which by an illeg process raises frequency of occurrence into the univ and necessity of law, and so changes a mere sub association of ideas into an assured belief and expe of objective facts. The answer given by Kant sceptical criticism of science involved a rejection very opposition of subjective and objective upon w was based. Without necessary and universal pri the experience of things as qualitatively and quanti determined objects, coexisting in space and through changes in time (or even the determinatio successive states of the subject as successive), wou have been impossible. Hence necessity of thought be derived from a frequent experience of such obje is true that the determination of things as permane stances reciprocally acting on each other, according versal laws, goes beyond the determination of t qualified and quantified phenomena in space an But both determinations are possible only throu same *a priori* principle, and we cannot admit the determination without implicitly admitting the latte therefore, it is through the necessity and univers thought that objects exist for us, even before the app to them of the principles of scientific induction, an application of those principles is only a further that *a priori* synthesis which is already involved perception of these objects, we have no reason for

mer kind of synthesis as objectively valid which
t equally apply to the latter.
vindication of the principles of induction has, how-
further consequence, which was not clearly seen by
It is fatal to the antithesis of the "given" and
nown," of what is perceived and what is conceived,
ura materialiter spectata and *natura formaliter*
, which he still admitted. For that antithesis
rested on the idea that there is no universal and
ry principle of determination of things involved in
prehension of them as qualified and quantified
nena in space and time. So soon, therefore, as it is
at there is such a principle, and that the first deter
n of things as objects of perception is due to the
priori synthesis which determines them in the
place as objects of experience, the ground for that
t between reality and appearance on which the
of induction rested is taken away. Kant, indeed,
new meaning for that contrast by interpreting it as
g, not to the opposition between things as they are
nd things as they are known, but to a supposed
ion between things as they are given and known in
nce and things as they are in themselves out of
nce. This new antithesis of reality and appearance,
r, only means that the former antithesis has broken
and that therefore the ideal of knowledge based
has yielded to a new ideal. The so-called things
selves are noumena, the objects of an intuitive or
ive understanding, *i.e.*, objects in which the contrast
ption and conception, of given and known, is tran
l. We can make Kant's theory consistent only by
ng him to mean that the conception of the world as
n of substances determining each other according
ersal laws does not yet satisfy the idea of know-
hich reason brings with it. In other words, just
nce from the point of view of necessary law found
ng wanting in the conception of the world as a
omplex of quantified and qualified phenomena in
nd time, so philosophy, in view of a still higher ideal
wledge, may condemn the conception of the world
stem of objects determined by necessary laws of
as itself inadequate and imperfect. And we have
at this higher ideal is that which is involved in
ity of self consciousness. Unfortunately Kant was
as Aristotle had been unable, to distinguish this
m the idea of an abstract identity in which there
om for even a relative difference of perception and
ion, and therefore the perceptive understanding was
by him only to be rejected.
owever, we correct this inadequacy of Kant's state-
as his later works enable us partly to correct it,
that it involves a new idea of knowledge and a new
-a logic governed by the idea of organic unity and
ment, just as the analytic logic had been governed
idea of identity, and as the inductive logic had been
ed by the idea of necessary law. For, if the unity
consciousness be our type of knowledge, truth must
o us, not the apprehension of objects as self identical
distinguished from each other in quantity and
, nor even the determination of such things as
g in necessary relations to each other. It must
he determination of the world (and of whatever in
any sense an independent reality, so far as it is so
ndent) as a unity which realizes itself in and through
nce, a unity which is indeed determined, but deter-
by itself In a view of the world which is governed
s category, correlation must be reinterpreted as
unity, and causation as development. Its logical
must be neither analytical nor synthetical, or
t must be both at once, *i.e.*, it must endeavour to
exhibit the process of things as the evolution of a
which is at once self-differentiating and self-integ
which manifests itself in difference, that through dif
it may return upon itself. Further, as this logic
simply out of a deeper consciousness of that whic
contained in the two previous logics, so it first ena
to explain them. In other words, the advance fr
analytic to the inductive logic, and again from the ind
to what may be called the genetic logic, may it
shown to be a self-determined development of thou
which the first two steps are the imperfect manife
of a principle fully revealed only in the last step.
consciousness of self-identical objects, independent
other and of thought, is thus only the beginning of
cess of knowledge which reaches its second stage
determination of these objects as essentially related
other, and which finds its ultimate end in the kno
of the correlated objects as essentially related to th
that knows them. Or if, in this last point of view,
are still conceived as having a certain relative indepe
of the mind, it can only be in so far as they are
Leibnitzian sense monads, or microcosms, - *i.e.*, in se
they are self determined, and so have, in the narrowe
of their individual life, something analogous to th
completed nature of the world, when it is contempl
its unity with its spiritual principle.

Such a genetic logic is inconsistent with any al
distinction between the *a priori* and *a posteriori* e
in knowledge. For here the *a priori* is not simply
of necessary connexion to be applied to an external
but a principle of organic development, a principle
from the very nature of it, cannot be applied to a
matter. To treat the world as organic is to apply
category which is inconsistent with its being som
merely given or externally presented to thought.
relation of things to thought must itself be brought
the same category of organic unity which is applied
relation of things to each other in the world, otherw
externality of the world to the thought for which it
contradict the conception of the world as itself o
Hence the distinction of *a priori* and *a posteriori*, so
it is maintained at all, must shrink to something sec
and relative. It can be maintained only as a dist
of thought from its object, which presupposes their u
unity. From this point of view logic may be said
with the *a priori*, in so far as it treats the general con
and methods of knowledge without reference to any
cular object. Logic must exhibit abstractly the pro
which the intelligence establishes its unity with the
gible world; or, to put it in another way, it must
strate that the being of things can be truly conceive
as their being for thought. It is limited to the *a pr*
the sense that it ends with the idea that the *esse* of
is their *intelligi*, and does not consider how th
intelligence or intelligible reality manifests itself
concrete world of nature and spirit.

In this sense logic cannot be separated from meta
if metaphysic be confined to ontology. They are
two aspects of one science, which we may regard ei
determining the idea of being or the idea of kn
The process of knowing is never really a formal pr
always involves the application of certain categori
these categories are simply successive definitions o
or reality. We cannot separate the category fr
movement of thought by which it is evolved and a
nor the transition from lower to higher categorie
changes of logical method. Hence a logic divorce
metaphysic inevitably becomes empty and unreal
metaphysic divorced from logic reduces itself to a
dictionary of abstract terms, which are put in no

to each other. For such a logic and such a meta- must rest on the assumption of an absolute division n being and thought, the very two terms the unity ch it must be the utmost object of both logic and ysic to prove and to produce.

The Relation of Metaphysic to Philosophy of Religion.

possibility of a "first philosophy," as we have seen, is essentially bound up with the possibility t we may call a last philosophy. It is only in so we can rise above the point of view of the individual dualism of the ordinary consciousness in so far, er words, as we can have at least an anticipative usness of that last unity in which all the differences gs from each other and from the mind that knows re explained and transcended that we are able to to that first unity which all these differences pre- The life of man begins with a divided consciousith a consciousness of self which is opposed to the usness of what is not self, with a consciousness of a icity of particulars which do not seem to be bound er by any one universal principle. Such division parent independence of what are really parts of one is characteristic of nature, and in spirit it is at first far transcended that it has become conscious of A conscious difference, however, as it is a difference sciousness, is no longer an unmediated difference. difference through which the unity has begun to self, and which therefore the unity is on the way to nate. And all the development of consciousness lf-consciousness is just the process through which bordination is carried out, up to the point at which ference is seen to be nothing but the manifestation unity. Just so far, therefore, as this end is present —so far as we are able to look forward to the solution nciliation of all the divisions and oppositions of we are conscious and to see that there is an all- ing unity which they cannot destroy, is it possible e should look back to the beginning or first unity, cognize that these divisions and oppositions are but nifestations of it. Thus the extremes of abstractness concreteness of thought are bound up together. The n of intelligence by which we get rid of the complexity actual life, and direct our thoughts to the simplest ost elementary conditions of being and knowing, is e only to those who are not limited to that life, but gard it and all its finite concerns from the point of f the infinite and the universal. In this sense it is hat religion and metaphysic spring from the same and that it is possible to vindicate the rationality of only on metaphysical principles. The philosophy gion is, in fact, only the last application or final sion of metaphysic; and, conversely, a metaphysic is not capable of furnishing an explanation of religion dicts itself.

last remark affords us a kind of criterion of a true ysic. Can it or can it not explain religion? If it , it must be equally unable to explain its own possi- and therefore implicitly it condemns itself. Thus a istic system, which loses the subject in the absolute nce, cannot explain how that subject should appre- he substance of which it is but a transitory mode, nor, other hand, can it explain why the substance should st itself in and to a subject. And the same criticism made on all theories in which the first or metaphysical s abstractly opposed to the manifoldness and con- cy of things. Not only of Spinoza, but also of Kant, nte, and even of Schelling, it might with some truth d that their absolute is like the lion's den, towards all the tracks are directed, while none come from it. essential that the first unity should be such as to explain the possibility of difference and division, fo is not, then the return to unity out of difference is n accidental as the difference itself. When Aristotle sented the Divine Being as pure self-consciousness form without matter, he found himself unable to a for the existence of any world in which form was r in matter. When therefore he speaks of the proc the finite world by which it returns to God, and att to nature a will, which is directed to the good as i cause, his theory seems to be little more than a me in which the analogy of consciousness is applied unconscious. For, if the Divine Being is not man in the world, any tendency of the world to realize th becomes an inexplicable fact. A similar difficulty we saw, involved in Kant's confusion of the bare id of understanding with the absolute unity of know Reducing the unity of self-consciousness to such identity, Kant could not be expected to see, what Ar had not seen, that pure self-consciousness is esse related to anything but itself. Hence the various at which he made in his ethical works and in his *Critic Judgment* to find a link of connexion between the not and the empirical were necessarily condemned even l self as the expressions of a merely regulative and sub principle of knowledge. Even Fichte, who found thought, which is for him the *prius* of all existe principle of differentiation and integration which exp how self-consciousness in us should be necessarily corr with the consciousness of a world, was unable to fre self from the Kantian opposition of a noumenal id in which there is no difference to a phenomenal which is realized in difference. Hence by him a return out of difference is regarded as an impossibi as a *processus in infinitum*, and the absolute unity which is beyond all knowledge and only apprehen faith.

If we look to completely elaborated theories, a regard all tentative and imperfect sketches, it may be said that all that has as yet been done in the re pure metaphysic is contained in two works, in the *physic* of Aristotle and the *Logic* of Hegel. And certain point the lesson which they teach is one a same, viz., that the ultimate unity which is presu in all differences is the unity of thought with its unity of self consciousness, and that in this unity tained the type of all science, and the form of all exi in other words, I = I is the formula of the universe difference between these two works has, however, been indicated. With Aristotle, because he negle essential relation of self consciousness to conscious of the conscious self to the world of objects in sp time, the unity of self consciousness tends to pass, a pass with the Neo Platonists, into a pure identity difference. In the Hegelian logic, on the other ha consciousness is interpreted as a unity which realiz through difference and the reconciliation of differen in fact, an organic unity of elements, which exist they pass into each other. In other words, it is that the differentiating movement by which the su and the objective self are opposed and the inte movement by which they are reunited are both es Hence we cannot think of the conscious self as a resting identity, but only as an active self-deter principle; nor can we think of its self-determinati pure affirmation of itself, without any negation, b as an affirmation which involves a double negati opposition of two elements which yet are essentially Each factor in this unity, in fact, is necessarily co as passing beyond itself into the other: the sub subject only as it relates itself to the object, the o

only as it relates itself to the subject. It is this against each other of elements which yet are correand indissolubly united, this self-surrender to each of elements which yet are maintained in their distinewhich constitutes the organic unity of thought in and separates it from the mere abstract unity of ism. When, however, the concrete or self-differencharacter of the unity of self consciousness is appre in this way, so that it is impossible to confuse its ible unity with the simplicity of that which is one because it has no differences in it, the problem of ation of pure self-consciousness to the world in space ne ceases to be insoluble. Thought, as it is seen to difference in itself, is no longer irreconcilable with rld of difference; nor is it necessary to introduce a ὕλη to make their connexion intelligible. For, as t is a principle of difference as well as of unity, of is as well as of synthesis, and as it cannot realize its unity except through the utmost development rence, abstract self consciousness, with its transparent rely ideal difference, cannot be its ultimate form. contrary, the consciousness of self is possible only netion from, and in relation to, a world of objects. er words, the unity of the thinking subject pres, not merely the opposition of the subjective and ective self, but also the opposition of the self in its lf-identity to a world of externality and difference. re intelligence, which is the *prius* of all things, must nerefore, be regarded—as Aristotle regarded it—as theoretical, but also as practical. It must be con as a living principle, a principle which only in self- station can be conscious of itself, and to the very of which, therefore, self-manifestation is essential. way Hegel—just because he grasped the concrete er of the unity of thought in itself—was enabled to tand the necessary unity of thought or self-consciousith the world, and to heal the division of physics netaphysic, which Aristotle had admitted.

elling and others who have raised objections to the an method have specially directed their criticisms this transition from logic to the philosophy of from pure self-consciousness to the external world ce and time. In doing so, they have practically back upon the Aristotelian theory, with its opposition , as pure form, to the finite world. But this in effect eny that "the real is the rational" or intelligible, introduce into the world, as the ground of its tion from reason, a purely irrational or contingent t. A modern follower of Schelling's later positive phy only draws the necessary consequence from this hen he teaches the pessimist creed that the highest s the negation or extinction of the finite. Nor can nder that the same writer who denies that the te self consciousness is essentially related to or sted in the world should proceed to reduce this sciousness to a mystic identity which comes out of and becomes self-conscious only by an inscrutable will. The fact, indeed, that those who deny the lity of a rational transition from self-consciousness world are forced by the logic of their position to self-consciousness to an abstract identity may be ed as a kind of indirect proof that the principle of sciousness, truly conceived, does involve that transi- Another step in the same direction may be made if sider how the Cartesian philosophy treated the same tion, which it also regarded as absolute. By tes mind and matter, thought and extension, are as abstract opposites, every quality of each finding ntradictory counterpart in a quality of the other. s a pure self-determined unity, which is as it knows itself and knows itself as it is, which has no discre parts or capacity of division or determination from w Matter is essentially discrete or infinitely divided; pure passivity; and all its determination comes to without. The world is therefore, as it were, "cut with a hatchet," divided into two unrelated exis which are held together only by the will of God. S cuts the knot, and avoids the arbitrariness of this so by treating extension and thought as two att separated only in respect of our intelligence, bu expressing fully the absolute substance. And som like the same view has been revived in recent tir writers like Lewes and Mr Spencer, who speak of f and motions as two opposite "aspects" of the sam When we ask, however, *for whom* these attribu aspects are a unity, it becomes clear that the intel which is regarded as standing on one side of the d must also be taken as transcending it, and relating t sides to each other. Moreover, the correspondence two attributes upon which Spinoza insists and their riety upon which Descartes insists, when taken to give us the idea of a correlative opposition, *i.e.*, of an tion of elements which yet are necessary to each If, therefore, they cannot be simply identified as S identifies them, yet they need no external bond s Descartes introduces to combine them; for they exist apart from each other. Their opposition i within the limits of their unity, and is no absolu tradiction, but rather an opposition which exists on is transcended. In other words, it is an abstract tion, *i.e.*, it is an opposition of elements which seen irreconcilable till it is observed that they are corr that each exists or has a meaning only as it relate to, or passes out of itself into, the other, and tha held in its abstraction and separation from the othe all the meaning that it seemed to have. For, as organic body each member or organ lives only in against the others, yet only as continually relating i the others, so the utmost opposition of mind to ma the intelligence to the intelligible world, presuppos unity, and is only the realization of it.

There is here, however, something more than an o case of correlation, for in this unity of opposite appears twice, once as one of the opposites, and as the unity which transcends the opposition. ambiguity becomes most obvious in theories like tha Spencer, who speaks of "two consciousnesses," which be resolved into each other, but yet which strange inseparable parts of one and the same consciousness. however, is really involved in such a statement is t external world, which in the first instance presen as absolutely opposed in nature to the subject whose it is, is yet one with that subject, and that theref antagonism of mind to its object is only the last diff tion through which it realizes its unity with itse Hegel's language, that which presents itself as oth mind is *its* other—"an other which is not another," difference and opposition to itself it overreaches an comes. We must, therefore, regard the independe externality of nature, its indifference, and even, as it opposition, to the development of the moral and inte life of man, as merely apparent. For man, in th of view, is not merely one natural being among oth the being in whom nature is at once complet transcended. If, therefore, at first he appears t in merely accidental and external relations to th existences among which he finds himself, yet the process of his life—the process by which he comes t the external world, and by which, reacting upon makes it the means to the realization of an individ

life of his own—is the negation of this contingency
xternality. In all this process he is showing himself
a being who can only know himself as he knows the
ive world, and who can only realize himself as he
himself the agent of a Divine purpose, to which all
are contributing.

h an idea of man's relation to the world is necessarily
od in any theory that goes beyond that subjective
m, or sensationalism which denies to him every
of knowledge except his own states of feeling, and
end of action except his own pleasures and pains.
t speculation, indeed, has suggested a compromise by
this dilemma is supposed to be evaded, and mankind
presented as forming an organic unity in themselves,
h they are still conceived as standing in an external
ccidental relation to nature, the forces of which by
knowledge and skill they have subdued and are more
ore subduing to their service. Such a compromise
d in the philosophy of Comte, the first writer who,
g from an apparently empirical basis, was able to
through the individualistic prejudices of the school of
. In the latter volumes of his *Positive Philosophy*,
ore in his *Positive Politics*, Comte so far transcends
dualism as to deny the externality of men to each
and to declare that "the individual, as such, is an
ction," and that in reality he cannot be separated
the social organism, which is thus not merely an
eous condition of his development, but essential to
ry existence as man. Thus individual men exist
hrough the universal—through the spirit of the
, of the nation, of humanity, which manifests itself
m as a principle of life and development. Yet this
e unity, according to Comte, is in contact with a
which in relation to it is external and contingent.
e has not its final cause in man, but on the contrary is,
, rather his enemy; and it is to humanity itself that
aise is due if to a certain extent the enemy has been
into a servant. The unity of life which manifests
in humanity cannot therefore be considered as a
sal principle, as the principle of the whole universe,
nply as the principle of the limited existence of man,
is hemmed in on every side by external and, in the
unknown conditions. If humanity therefore is an
sm, it is an organism existing in a medium which in
ce to it is inorganic, *i.e.*, in a medium which has no
al relation to the life which animates man.

s obvious, however, that this theory is an illogical
t to find a standing ground between two opposite
phies,—between the philosophy which treats man
as a natural individual, placed among other individual
and things, and which therefore regards his relation
n as something accidental and external, and the philo-
which treats him as a spiritual subject, a conscious
f-conscious being, and regards him therefore as having
ely external relations either to other men or to nature.
shrinks from regarding the world without us as the
station of that spiritual principle which is also within
ich constitutes our very nature as individual men,
erefore connects us with the world at the same time
t separates us from it. Yet he recognizes the
ce in us of a principle which is so far universal that
titutes a community between all men. He thinks
e individual can transcend himself, so far as to see
ngs, not indeed from a Divine point of view, *sub
eternitatis*, but from the point of view of universal
ity, and that in conformity with this theoretical
ousness, he can live a practical life of altruism, *i.e.*,
n which he identifies his own good with the good of
ity. But the philosophy that has gone so far must
ly go further. It is impossible to treat humanity as
an organism without extending the organic idea to t
ditions under which the social life of humanity is dev
The medium by aid of which, or in reacting
which, the organized being maintains itself is an e
part of its life; it remains organic only in so far a
mould itself to its conditions, and its conditions t
This is true even of the animal organism in relatio
small circle of conditions, which, however, is pa
larger circle to which the animal has no relation.
conscious being is a *universal* centre of relations;
nothing which it, as conscious, cannot make part of
life. Hence the application of the organic idea t
volves its application to the whole world. And,
recognition of a universal principle manifested in hu
naturally led Comte to the idea of the worship of hu
the recognition of a universal principle manifested
and nature alike must lead to the idea of the wo
God.

The rationality of religion, then, rests on the pos
of an ultimate synthesis in which man and natu
regarded as the manifestation of one spiritual pr
For religion involves a faith that, in our efforts to
the good of humanity, we are not merely straining
an ideal beyond us, which may or may not be realiz
are animated by a principle which within us and w
us is necessarily realizing itself, because it is the n
principle by which all things are, and are known.
absolute certitude that we work effectually because
universe is working with us, or, in other words, t
God is working in us, can find its explanation and
only in a philosophy for which "the real is the ra
and the rational is the real." And such a philo
beginning with the Kantian doctrine that existence
existence for a spiritual or thinking subject, must
to prove that that only can exist for such a subject
is the manifestation of thought or spirit; and, conv
that spirit or intelligence is essentially self-manifesti
in other words, that it cannot be conceived exc
standing in essential relation to an external and n
world. Finally, if nature be thus regarded as a ne
manifestation of spirit, it can be opposed to spirit
so far as spirit in its realization becomes opposed t
In other words, nature must be regarded as, from a
point of view, included in spirit. Nature exists
may show itself to be spiritual in and to man
transcends it yet implies it, who finds in it the ne
basis of his thought and action, but only that he ma
upon it a higher spiritual life.

> Nature is made better by no mean
> But nature makes that mean: so over the art
> Which, you say, adds to nature is an art
> Which nature makes."

Only the order of precedence suggested by these
must be inverted. For, as nature only is for sp
the spiritual energy which reacts upon nature
which manifests for the first time what nature in
is. It is the consciousness of this—*i.e.*, of the iden
that which is realizing itself within and without u
consciousness that the necessity which is the preco
of our freedom is the manifestation of the same
which makes us free—which turns morality into r
For it is this alone which enables us to regard the real
of the highest ends of human life as no mere happy ac
or as a conquest to be won by the cunning of man f
unfriendly or indifferent destiny, but as the result t
which all things are working.

In this philosophy, which finds its most ad
expression in the works of Hegel, there are two
which may be distinguished the general idealistic
the world, and the dialectical movement of thou

Hegel develops and expresses it. And there are
s many at the present time who are prepared to
the former, but who yet suspect, or even reject, the
And no doubt there is much in Hegel's *Logic* and
ophy of Spirit, and still more in his *Philosophy of*
r, which there is reason to regard with distrust.
ver hands that are not checked by a sufficient con-
ness of the whole, the Hegelian dialectic may be
into the means of producing a seeming proof of any-
Nor is it always easy to determine how far Hegel
f was tempted by an impatient consciousness of the
sality of his method to employ it in cases where the
ions of its successful application were wanting.
imes he seems to forget, what he himself teaches, that
must first have generalized experience and deter-
it by its finite categories, ere it is possible for
ophy to give its final interpretation. Yet, when we
the nature of that interpretation, and of the trans-
ion of science which philosophy by means of it
es to effect, it becomes clear that the dialectic of
is no extraneous addition to his idealism, but is part
arcel of the same movement of thought. For this
ic rests on the idea that thought or self-conscious
nds in its own organic unity the ultimate key to all
lties in regard to the objects of thought and their
ns to each other and to the mind. Self-consciousness,
been already shown, is implicitly the whole web
gories which it throws over the world, and by aid
ich it makes the world intelligible. All these it
ns in itself; and, as it proceeds to determine the
ng of things, it simply produces its store, and
sts itself on the object. Now, if it be idealism, in the
sense of the word, to make thought or self conscious-
the principle and ultimate explanation of all that
it is obvious that we cannot separate idealism from
dialectic as this, which is nothing more than the
consciousness of its own movement or process of
firmation. If to find thought in things be more than
npty word, then the movement or process which
ht is must explain at once the transition from
ht to what in opposition to it we call "things," and
give us the means of reconciling that opposition. In
words, the same movement by which thought deter-
itself as self conscious, *i.e.*, as a unity realized through
nce, must also be conceived as the explanation of the
nce between pure thought and the world, and as the
n of that difference in the idea of absolute spirit.
h idealism has a close relation to Christianity; it may
n said to be but Christianity theorized. It has often
sserted that Hegel's philosophy of religion is but an
ial accommodation to Christian doctrine of a philo-
which has no inherent relation to Christianity. If,
e, we regard the actual development of that philo-
it would be truer to say that it was the study of
tian ideas which first produced it. What delivered
from the mysticism in which the later philosophies
hte and Schelling tended to lose themselves, and led
in his own language, to regard the absolute "not
y as substance but as subject,"—what made him
nize with Fichte that the absolute principle is spiritual,
et enabled him with Schelling to see in nature, as
posite of spirit, the very means of its realization,—
is thorough appreciation of the ethical and religious
ng of Christianity. In the great Christian aphorism
"he who loseth his life alone can save it" he found
to the difficulties of ethics, a reconciliation of
ism and asceticism. For what this saying implies
a spiritual or self-conscious being is one who is in
diction with himself when he makes his individual
is end. In opposing his own interest to that of
others, he is preventing their interests from becomin
all things are his, and his only, who has died to h
But if this be the truth of morality, it is something
for "morality is the nature of things." We cannot se
the law of the life of man from the law of the w
which he lives. And, if it is the nature of things,
the nature of spirit, that he who loseth his life shal
it, the world must be referred to a spiritual princip
the Christian doctrine of the nature of God is on
converse of the Christian law of ethics. To Hegel, st
from this point, a new light was thrown on the Fi
treatment of the idea of self, and the Fichtean proof t
consciousness of self implies a relation to an object
is opposed to the self, and which yet from another
of view —since an object exists only for a subject—
be anything but an element of its own life. It wa
that this movement of thought is no mere fluct
between contradictory positions, to be terminated fin
an *ipse dixit* of faith, but that the unity of the o
elements is apprehensible by the intelligence, an
indeed it is *its* presence to the intelligence which
the consciousness of opposition possible. It was
sense that Hegel could say that that unity of op
which had been called unintelligible by previous
was just the very nature of the intelligence, and tha
a view of the world guided by this idea could be pr
intelligible, while every other view must contain
an unsolved contradiction, an element that remain
manently impervious to thought.

The great objection to a metaphysic like this, a
an objection which weighs much in the minds of
is that which springs from the contrast between th
of absolute knowledge which it seems to involve a
actual limitations which our intelligence encount
every direction. If the theory were true, it is
ought to be nearer the solution of the problems
life, practical and speculative, than we are; the ri
the painful earth ought to vex us less; we ou
find our way more easily through the entanglem
facts, and to be able to deal with practical difficulti
less tentative manner. Yet there is really no anta
between such a doctrine and a consciousness of the
tion of our faculties; nay rather, it is only on
theory that a rational distrust of ourselves can be
When Aristotle meets the warning that we should
finite and human things since we are finite and
with the answer that we ought rather, so far as in
to rise to what is immortal and divine, he is not d
the limits of man's knowledge and power; on the co
he is rather pointing to the very principle which m
conscious of those limits; for it is just because the
man a principle of infinity that he knows his finitud
conversely, it is just in the consciousness of this finitu
he rises above it. A rational humility is possible
one who has in himself the measure of his own we
and who, if he "trembles like a guilty thing surpri
yet conscious that he is trembling before himself.
truth is often expressed by Kant with special rela
the moral consciousness, as where he contrasts the lim
of man, as a sensible being, occupying an infinitesime
in the boundless world of sense, with his freedom f
limitation as a personal self, a member of the truly
world of intelligence. But it is not necessary to
Kant's abstract division of the sensible from the inte
world to see that the consciousness of the greatness
problem which has to be solved in human life and t
is deepened and widened by that very idea of phil
which yet gives us the assurance that the prob
not insoluble, and even that, in principle, it is
solved.

TAPONTUM, or METAPONTIUM (the first form is that
y found in Latin writers, but Thucydides, Strabo,
er Greek authors employ the latter form), was a
Magna Græcia situated on the Gulf of Tarentum,
e mouth of the river Bradanus, and distant about
s from Tarentum and 14 from Heraclea. It was
l by an Achæan colony about 700 B.C., though
traditions existed which assigned it an earlier
But according to the only historical account it
joint foundation from Sybaris and Crotona, to
as usual in similar cases, was joined a body of fresh
from the mother country, under the command of a
named Leucippus. The object of its establishment
hout doubt to strengthen the Achæan element in
Græcia, as opposed to the increasing power of the
nes, but at the same time to occupy a territory
was remarkable for its fertility. It was to this
hat Metapontum owed the great prosperity to which
ed at an early period, and appears to have continued
for several centuries, though it never assumed a
ent place in history. It was, however, one of the
at played a conspicuous part in the political troubles
from the introduction of the Pythagorean principles
cities of Magna Græcia, and it was there that the
her himself ended his days. His tomb was still
there in the time of Cicero.

the time of the Athenian expedition to Sicily
c.) Metapontum appears to have been an opulent
werful city, whose alliance was courted by the
ns; but they contented themselves with a very
support. In 332 B.C., at the time of the expedition
ander, king of Epirus, into Italy, it was one of the
ies to espouse his cause, and enter into an alliance
m; and they appear to have in like manner lent an
upport to Pyrrhus at a later period. Down to this
herefore, Metapontum seems to have retained its
as one of the principal cities of Magna Græcia,
re is no evidence of its having suffered materially
e establishment of the Lucanians in its immediate
ourhood. Nor have we any account of the precise
at which it passed under the dominion of Rome, or
ditions under which it became subject to the great
c. But it was the Second Punic War which gave
l blow to its prosperity. After the battle of Cannæ
B.C. it was among the first cities in the south of
declare in favour of Hannibal, and after the fall of
um in 212 B.C. it not only received a Carthaginian
n, but became for some years the headquarters of
al. Hence, when the defeat of Hasdrubal at the
us (207 B.C.) compelled him to abandon this part
, and withdraw into the fastnesses of Bruttium, the
nass of the inhabitants of Metapontum abandoned
ty, and followed him in his retreat.

this time Metapontum sunk into a poor and incon-
le town; though it was still existing as such in
s of Cicero, it soon fell into complete decay, and
ias tells us that in his time nothing remained of it
heatre and the circuit of the walls. All remains of
ave since disappeared, but the site is still marked
ruins of a temple, which occupy a slight elevation
right bank of the river Bradanus, about 2 miles
s mouth. The surrounding plain, so celebrated in
times for its fertility, is now desolated by malaria,
nost uninhabited; and the remains of the city itself,
n the site of the temple and the sea, are in great part
in the alluvial deposits of the neighbouring rivers.
e excavations were carried on upon the spot by the
Luynes in 1828, and the results of his researches
ublished by him in a special work (*Métaponte*, fol.,
1833).

METASTASIO (1698–1782). Pietro Trapassi,
Italian poet who is better known by his assumed nam
Metastasio, was born in Rome, January 6, 1698.
father, Felice Trapassi, a native of Assisi, came to
and took service in what was termed the Corsican regi
of the papal forces. He subsequently married a Bolog
woman, called Francesca Galasti, and established hi
in business as a sort of grocer in the Via dei Cappe
Two sons and two daughters were the fruit of this marr
The eldest son, Leopoldo, must be mentioned, sinc
played a part of some importance in the poet's
Pietro, while quite a child, showed an extraordinary t
for improvisation, and often held a crowd attentive i
streets while he recited impromptu verses on a given sub
It so happened that, while he was thus engaged one eve
in the year 1709, two men of high distinction in Ro
society passed by and stopped to listen to his declama
These were Gian Vincenzo Gravina, famous for legal
literary erudition, famous no less for his dictatorship o
Arcadian Academy, and Lorenzini, a critic of some
Gravina was at once attracted by the boy's poetical t
and by his charm of person; for little Pietro was g
with agreeable manners and considerable beauty.
great man interested himself in the genius he had acci
ally discovered, made Pietro his protegé, and in the co
of a few weeks adopted him. Felice Trapassi was
enough to give his son the chance of a good education
introduction into the world under auspices so favour
Gravina, following a fashion for which we may find
cedents so illustrious as that of Melanchthon, Helle
the boy's name Trapassi into Metastasio; and this
remained with him for life. Gravina intended his ad
son to be a jurist like himself. He therefore made th
learn Latin and begin the study of law. At the same
he cultivated his literary gifts, and displayed the you
prodigy both at his own house and in the Roman cof
Metastasio soon found himself competing with the
celebrated improvisatori of his time in Italy. Days
in severe studies, evenings devoted to the task of impr
ing eighty stanzas at a single session, were fast ru
Pietro's health and overstraining his poetic faculty.
this juncture Gravina had to journey into Calabri
business. He took Metastasio with him, exhibited hi
the literary circles of Naples, and then placed him
the care of his kinsman Gregorio Caroprese at a little
called Scalea. In country air and the quiet of the sou
sea-shore Metastasio's health revived. It was decree
the excellent Gravina that he should never improv
line again. His great facility should be reserve
nobler efforts, when, having completed his educatio
might enter into competition with poets who had
queathed masterpieces to the world.

Metastasio responded with the docility of a pliant n
to his patron's wishes. At the age of twelve, while at
ing to classical and legal studies, he translated the *Iliad*
octave stanzas; and two years later he composed a tragc
the manner of Seneca upon a subject chosen from Tris
Italia Liberata—Gravina's favourite epic. It was
Giustino. Gravina had it printed in 1713; but the p
lifeless; and forty-two years afterwards we find Meta
writing to his publisher, Calsabigi, that he would will
suppress it. Caroprese died in 1714, leaving Gravi
heir; and in 1718 Gravina also died. Metastasio inhe
from the good old man a property, consisting of house,
furniture, and money, which amounted to 15,000 scu
about £1000. At a meeting of the Arcadian Acad
amid the tears and plaudits of that learned audienc
recited an elegy on the patron who had been to him s
a foster-father, and then settled down, not it seems wi
real sorrow for his loss, to enjoy what was no inconsid

e at that period. Metastasio was now twenty. g the last four years he had worn the costume of having taken the minor orders without which it was seless to expect advancement in Rome. His romantic y, personal beauty, charming manners, and distind talents made him fashionable. That before two were out he had spent his money and increased his tion for wit will surprise no one. He now very ly determined to quit a mode of life for which he ot born, and to apply himself seriously to the work profession. Accordingly he went to Naples, and d the office of an eminent lawyer named Castagnola. ould appear that he articled himself as clerk, for gnola, who was a stern master, averse to literary g, exercised severe control over his time and energies. slaving at the law, Metastasio did not wholly neglect luses. In 1721 he composed an epithalamium, and bly also his first musical serenade, *Endimione*, on the on of the marriage of his patroness the Princess i di Sangro to the Marchese Belmonte Pignatelli. he event which fixed his destiny was the following. 22 the birthday of the empress had to be celebrated more than ordinary honours, and the viceroy applied tastasio to compose a serenata for the occasion. He ed this invitation with mingled delight and trepidafor Castagnola looked with no favour on his clerk's al distractions. It was arranged that his authorship be kept a profound secret. Under these conditions tasio produced *Gli Orti Esperidi*. Set to music by ra, it won the most extraordinary applause. The Roman prima donna, Marianna Bulgarelli, called La nina from her birthplace, who had played the part us in this drama, was so enraptured with the beauties libretto that she spared no pains until she had dis- d its author. Asked point blank whether he had ritten the words of the successful play, Metastasio bliged to answer, Yes! La Romanina forthwith took sion of him, induced him to quit his lawyer's office, romised to secure for him fame and independence, if uld devote his talents to the musical drama. It was hat the opera, already partially developed by the ean poet, Apostolo Zeno, attained perfection. The nan had been found for maturing this form of art the genius of the age demanded, but which was still ncomplete. In La Romanina's house Metastasio e acquainted with the greatest composers of the day,— Porpora, from whom he took lessons in music; with Pergolese, Scarlatti, Vinci, Leo, Durante, Marcello, whom were destined in the future to set his plays to y. Here too he studied the art of singing, and l to appreciate the style of such men as Farinelli. ngularly pliant genius discerned the conditions which ama must obey in order to adapt itself to music in age it then had reached. Gifted himself with extraary facility in composition, and with a true poetic g, he found no difficulty in producing plays which, beautiful in themselves, judged merely as works of y art, became masterpieces as soon as their words set to music, and rendered by the singers of the st school of vocal art the world has ever seen. Read etastasio in the study, it is impossible to do him e. Our only chance of rendering him a portion of e is to approach these lyrical scenes so passionate ir emotion, so cunningly devised for musical effect— he phrases of Pergolese or Paesiello ringing in our nd to imagine how a Farinelli or a Caffariello voiced stanzas which demand for their artistic realization inked sweetness long drawn out" of melodies as the school developed them. In short, Metastasio is a whose poetry leapt to its real life in the environment of music. The conventionality of all his plots, absurdities of many of his situations, the violence he d to history in the persons of some leading characters, "damnable iteration" of the theme of love in all phases, are explained and justified by music. He can be studied with pleasure and profit. But our only cha of understanding the cosmopolitan popularity he enjo is by remembering that at least one half of the effect aimed at has been irrecoverably lost.

Metastasio resided with La Romanina and her husb in Rome. The generous woman, moved by an affection maternal half romantic, and by a true artist's admirat for so rare a talent, adopted him more passionately e than Gravina had done. She took the whole Trap family—father, mother, brother, sisters—into her own ho She fostered the poet's genius and pampered his capri Under her influence he wrote in rapid succession *Didone Abbandonata*, *Catone in Utica*, *Ezio*, *Alessan nell' Indie*, *Semiramide Riconosciuta*, *Siroe*, and *Artase* These dramas were set to music by the chief composer the day, and performed in the chief towns of Italy. Ev month added to Metastasio's renown. But meanwhile Romanina was growing older; she had ceased to sing public; and the poet felt himself more and more depend in an irksome sense upon her kindness. He gained scudi (about £60) for each opera; this pay, though g was precarious, and he longed for some fixed engagem Abandoning himself gradually to despondent whims fancies, it became clear that some change in his condi was desirable. And the opportunity for a great cha soon presented itself. In September 1729 he recei the offer of the post of court poet to the theatre at Vie with a stipend of 3000 florins. This he at once accep La Romanina unselfishly sped him on his way to gl She took the charge of his family in Rome, and he set for Austria.

In the early summer of 1730 Metastasio settled Vienna in the house of a Spanish Neapolitan, Nic Martinez, where he resided until his death. This marks a new period in his artistic activity. Between years 1730 and 1740 his finest dramas, *Adriano*, *Deme Issipile*, *Demofoonte*, *Olimpiade*, *Clemenza di Tito*, *Ac in Sciro*, *Temistocle*, and *Attilio Regolo*, were produced the imperial theatre. Some of them had to be compo for special occasions, with almost incredible rapidity— *Achille* in eighteen days, the *Ipermnestra* in nine. F composer, musical copyist, and singer did their w together in frantic haste. The impress of the pec circumstances under which they were created is still upon them, not only in negligence of style, but also in undefinable quality which marks them out as produc collaboration. But what must always surprise us is they should be as good as they are. Metastasio unders the technique of his peculiar art in its minutest det The experience gained at Naples and Rome, quickened the excitement of his new career at Vienna, enabled almost instinctively, and as it were by inspiration, to hit exact mark aimed at in the opera.

At Vienna Metastasio met with no marked s success. His plebeian birth excluded him from aristoc circles. But, to make up in some measure for this parative failure, he enjoyed the intimacy of a great l the Countess Althann, sister-in-law of his old patroness Princess Belmonte Pignatelli. She had lost her husb and had some while occupied the post of chief favourit the emperor. Metastasio's liaison with her became so that it was even believed they had been privately mar From his letters to his friend La Romanina, and to great singer Farinelli, who reigned supreme at the o of Madrid, we learn the little details of the poet's li

risome monotony, and come to comprehend his
er, at once generous and timid, selfish and amiable,
almost to excess of caution, and personally cold in
iction with the fervour of his sentimental muse.
en tenor of this dull existence was broken in the
734 by the one dark and tragic incident of his
hy. It appears that La Romanina had at last got
his absence. Little satisfied with his friendly but
at reticent communications, impatient to see him
ain, inquisitive perhaps about the terms on which
l with his new mistress, she resolved to journey to
Could not Metastasio get her an engagement at
rt theatre? The poet at this juncture revealed his
sential feebleness of character. To La Romanina he
lmost everything as a man and as an artist. But
ashamed of her and tired of her. He vowed she
not come to Vienna, and wrote dissuading her from
jected visit. The tone of his letters alarmed and
d her. It is probable that she set out from Rome,
d suddenly upon the road. Nothing can be said for
about her end, or about the part which Metastasio
ave played in hastening the catastrophe. All we
that she left him her fortune after her husband's
erest in it had expired, and that Metastasio, over-
d with grief and remorse, immediately renounced
acy. This disinterested act plunged the Bulgarelli-
asio household at Rome into confusion. La
ina's widower married again. Leopoldo Trapassi,
father and sister, were thrown upon their own
es. The poet in Vienna had to bear their angry
lations upon his ill-timed generosity, and to augment
wances he made them.

time advanced the life which Metastasio led at
, together with the climate, told upon his health
rits. From about the year 1745 onward he writes
ningly of a mysterious nervous illness, which
d him into the abyss of melancholy, interfered with
tive energy, and constantly distressed him with the
ension of a general breakdown. He wrote but
ow, though the cantatas which belong to this
and the canzonet *Ecco quel fiero istante*, which he
his friend Farinelli, rank among the most popular
productions. It was clear, as his latest and most
biographer, Vernon Lee, has phrased it, that "what
im was mental and moral ennui." In 1755 the
ss Althann died, and Metastasio was more than ever
d to the society which gathered round him in the
is house of the Martinez. He sank rapidly into
its of old age; and, though his life was prolonged
year 1782, very little can be said about it. On
h of April he died, bequeathing his whole fortune
130,000 florins to the five children of his friend
ez. He had survived all his Italian relatives.

g the long period of forty years in which Metastasio may be
said to have overlived his originality and creative powers
went on increasing. In his library he counted as many as
itions of his own works. They had been translated into
English, German, Spanish, even into Modern Greek. They
n set to music over and over again by every composer of
on, each opera receiving this honour in turn from several
ost illustrious men of Europe. They had been sung by the
tuosi in every capital, from Madrid to St Petersburg, from
to Constantinople. The critics of all nations vied in
Metastasio's credit to the skies. There was not a literary
of note which had not conferred on him the honour of
ship. Strangers of distinction passing through Vienna
point of paying their respects to the old poet at his lodgings
Kohlmarkt Gasse. Letters of congratulation, adulation,
y, respect, condolence, poured in upon him. And yet,
the whole of this long period, he was gradually outliving the
conditions upon which that fame was really founded. It
already pointed out that Metastasio cannot rank as a poet
unqualified sense of that word, but as a poet collaborating
musical composer and performer. His poetry, further-
more, was intended for a certain style of music—for the mus
omnipotent vocalists, of thaumaturgical sopran. With the cha
effected in the musical drama by Gluck and Mozart, with
development of orchestration and the rapid growth of the Ge
manner, a new type of libretto came into request. Metasta
plays fell into undeserved neglect, together with the music to w
he had linked them. Farinelli, whom he styled "twin broth
was the true exponent of his poetry; and, with the abolition o
class of singers to which Farinelli belonged, Metastasio's n
suffered eclipse. It was indeed a just symbolic instinct which
the poet dub this unique soprano his twin-brother.

The musical drama for which Metastasio composed, and in w
ing for which his genius found its proper sphere, has so wh
passed away that it is now difficult to assign his true place to
poet in Italian literary history. Compared with Shakespeare, or
with Racine, he hardly merits the title of a dramatist. His ins
tion was essentially emotional and lyrical. Instead of cre
characters, he created situations for the display of very varied
ings, for all the feelings in fact to which melody allies itself.
In doing this he showed a capable playwright's faculty. His
sonages act and react upon each other. Their characters, thoug
in harmony with history or fact, are clearly traced and cleverly
tained. Each of the dramatis personæ is an emotion incarnate
consistent, admirably fitted for musical effect and contrast.
clash and combat of passions are vividly presented, with the sm
possible expenditure of rhetoric, in the dialogues intended
recitative. The climax of emotion is cadenced in appro
stanzas, with ample but effective imagery, at the close of
important scene. The chief dramatic situations are expresse
lyrics for two or three voices, embodying the several conten
passions of the agents brought into conflict by the circumstan
the plot. The total result is not pure literature, but litera
supremely fit for musical effect. Language in Metastasio's han
exquisitely pure and limpid. Of the Italian poets, he profes
special admiration for Tasso and for Marmi. But he avoided the
ceits of the latter, and was no master over the refined richness
former's diction. His own style reveals the improvisatore's fac
Of the Latin poets he studied Ovid with the greatest pleasure
from this predilection some of his own literary qualities may b
rived. The pedantic rules of Aristotelian poetics never touch
artist who felt his real vocation to be the interpretation of n
For historical propriety, for the psychology of character, for un
plot, for probability of incident, he had a supreme disregard. I
indeed his merit to have discarded all these considerations.
poetry was the twin-sister of Italian melody, and he was rig
trusting entirely to music and action on the stage to render his
ceptions vital. What, therefore, he gained during his own life
while the musical system to which he subordinated his genius
yet living, he has since lost when, as now, he must be studie
readers who have only a faint and dim conception of that pe
art. For sweetness of versification, for limpidity of diction
delicacy of sentiment, for romantic situations exquisitely ren
in the simplest style, and for a certain delicate beauty of im
sometimes soaring to ideal sublimity, he deserves to be appre
so long as the Italian language lasts.

There are numerous editions of Metastasio's works. That by Calsabigi,
1755, 9 vols. 8vo, published under his own superintendence, was the
favourite. Another of Turin, 1757, and a third of Paris, 1780, deserve me
The posthumous works were printed at Vienna 1795. The collected editi
Genoa, 1802 and Padua, 1811, will probably be found most useful by the g
student. Metastasio's life was written by Alunni, Assisi, 1783; by Charles B
London, 1796; and by others; but by far the most vivid sketch of his biog
will be found in Vernon Lee's *Studies of the 18th Century in Italy*, London
a work which throws a flood of light upon the development of Italian dr
music, and upon the place occupied by Metastasio in the artistic movement
last century. (J. A

METCALFE, Charles Theophilus Metcalfe, B
(1785–1846), a distinguished administrator, was
at Calcutta on January 30, 1785; he was the second
of Thomas Theophilus Metcalfe, then a major in
Bengal army, who afterwards became a director of
East India Company, and was created a baronet in
Having been educated at Eton, where he read extensi
he in 1800 sailed for India as a writer in the service o
Company. After studying Oriental languages with su
at Lord Wellesley's college of Fort William, he, at the
of sixteen, received an appointment as assistant to
Cowley, then resident at the court of Sindhia; in
he became assistant in the office of the chief secretary
1803 he was transferred to that of the governor-gen
and in 1806 to that of the commander in-chief. On Au
15, 1806, he became first assistant to the resident at D
and in 1808 he was selected by Lord Minto for the diff
post of envoy to the court of Ranjít Sinh at Lahore;

l 25, 1809, he successfully concluded the important
ecuring the independence of the Sikh states between
lej and the Jumna. Four years afterwards he was
rincipal resident at Delhi, and in 1819 he received
ointments of secretary in the secret and political de-
nt, and of private secretary to the governor-general
lastings). From 1820 to 1823 Sir Charles (who
ed his brother in the baronetcy in 1822) was resident
ourt of the nizam, but in the latter year he was com-
y the state of his health to retire from active service;
, however, he was so far restored as to undertake
idency of the Delhi territories. Two years after-
e obtained a seat in the supreme council, and in
ry 1835, after he had for some time been governor
a, he, as senior member of council, provisionally
led Lord William Bentinck in the governor-general-
During his brief tenure of office (it lasted only till
28, 1836) he originated or carried out several
nt measures, including that for the liberation of the
which, while almost universally popular, complicated
tion with the directors at home to such an extent
withdrew from the service of the Company in 1838.
following year he was appointed by the Melbourne
stration to the governorship of Jamaica, where the
ies created by the recent passing of the Negro
ipation Act had called for a high degree of tact and
Sir Charles Metcalfe's success in this delicate
was very marked (see vol. XIII. p. 551), but unfor
y his health compelled his resignation and return to
d in 1842. Six months afterwards he was appointed
Peel ministry to the governor-generalship of Canada,
s success in carrying out the policy of the home
ment was rewarded with a peerage shortly after his
in 1845. He died at Malshanger, near Basingstoke,
ber 5, 1846. See J. W. Kaye's *Life and Corre
ce of Charles Lord Metcalfe*, London, 1854.

FELLUS, the name of the most important family of
man plebeian gens Caecilia. They rose to distinction
the Second Punic War, and Naevius satirized them.
NTUS CAECILIUS METELLUS MACEDONICUS, praetor
. in Macedonia, defeated Andriscus in two battles,
ced him to surrender. He then superintended the
sion of Macedonia into a Roman province. He tried
essfully to mediate between the Achaean league and
, but, when the Achaeans advanced, he defeated
easily near Scarpheia; Mummius soon after super
him, and returning to Italy he triumphed in 146.
in 143, he reduced northern Spain to obedience.
censor with Q. Pompeius (the first two plebeian
s), he proposed that all citizens should be compelled
ry. He was a moderate reformer, and was con-
d the model of a fortunate man; before his death
three of his sons had been consuls, one censor, and
urth was a candidate for the consulship.

NTUS CAECILIUS METELLUS NUMIDICUS, whose repu-
for integrity was such that when he was accused of ex-
the jury refused to examine his accounts, was selected
mand against Jugurtha in 109 B.C. He subjected
ny to rigid discipline, and aimed solely at seizing
ha himself; he defeated the king by the river
l, and next year, after a difficult march through the
took his stronghold Thala. Marius, however,
d Metellus of protracting the war, and received the
ate for 107. Metellus returned to Rome and
phed. Saturninus, whom as censor he tried to
from the senate, passed in 100 an agrarian law,
ng a provision that all senators should swear to it
five days. All complied but Metellus, who retired
a. After Saturninus was killed, he returned, but
hortly after under suspicion of poison.

QUINTUS CAECILIUS METELLUS PIUS, so called fr
efforts to restore his father Numidicus, commanded
Social War, defeating Q. Pompaedius (88 B.C.). Su
departing gave him proconsular command over
Italy. When Marius returned, the soldiers, who h
confidence in Octavius, wished Metellus to comman
he refused. Metellus retired to Africa and afterwa
Liguria, resuming his former command on Sulla's r
In 86 he gained a decisive victory over Norba
Faventia. In Sulla's proscriptions he pleaded in fav
moderation. Consul in 80 with Sulla, he went to
next year against Sertorius, who pressed him hard
arrival of Pompeius in 76. Next year Metellus de
Sertorius's lieutenant Hirtuleius at Italica and Se
and joining Pompeius rescued him from the conseq
of a check at Sucro. From this time Sertorius
weaker till his murder in 72. Metellus had prev
set a price on his head. In 71 he returned to Ro
triumphed. He was an upright man, of moderate
QUINTUS CAECILIUS METELLUS PIUS SCIPIO,
Scipio Nasica, was adopted by the preceding. H
accused of bribery in 60 B.C., and defended by Cice
August 52 Pompeius procured him the consulate,
in return supported Pompeius, now his son-in-law
war being resolved on, Scipio was sent to Syria. His
tions were excessive, and he was about to plund
temple of Artemis at Ephesus when he was recal
Pompeius. He commanded the centre at Pharsal
afterwards went to Africa, where by Cato's influe
received the command. In 46 he was defeat
Thapsus; in his flight to Spain he was stopped by
sair, and stabbed himself. His connexion with two
families gave him importance; but he was selfis
licentious, and his violence drove many from his pa
QUINTUS CAECILIUS METELLUS CELER, praetor 63 B.
sent to cut off Catiline's retreat northward. Consul
his personal influence prevented the holding of th
pitalia, which the senate had forbidden and the t
permitted. He opposed the agrarian law of the
L. Flavius, and stood firm even though imprisone
law had to be given up. He also tried, though frui
to obstruct Caesar's agrarian law in 59. He die
year under suspicion of poison given by his wife Cl

METEMPSYCHOSIS, the transmigration of th
as an immortal essence, into successive bodily forms
human or animal. This doctrine, famous in antiqui
one of the characteristic doctrines of Pythagoras,
to have originated in Egypt. This indeed is affir
Herodotus (ii. 123):—"The Egyptians are, moreov
first who propounded the theory that the human sou
mortal, and that when the body of any one peri
enters into some other creature that may be born r
receive it, and that, when it has gone the round
created forms on land, in water, and in air, then
more enters a human body born for it; and this
existence for the soul takes place in three thousand

Plato, in a well-known passage of the *Phædrus*,
as was his wont, the Pythagorean doctrine to his r
allegory about the soul of the philosopher. That s
says, though it may have suffered a fall in its atte
contemplate celestial things, still is not condemned
first entrance into another form, to any bestial ex
but, according to its attainments, *i.e.*, to the progress
it has made in its aspiration for celestial verities, it
in nine distinct grades, into the body of some one d
to become a philosopher, a poet, a king, a general,
&c.; or, if very inferior, it will animate a sophist
autocrat (*τύραννος*). Plato extends the cycle of ex
to ten thousand years, which is subdivided into per
a thousand years, after the lapse of which the souls u

nt, and are admitted to everlasting happiness or ned to punishment.[1] It is after the period of a d years, he adds, that the human soul comes into and from a beast again into a man, if the soul ly was human.

agoras, who was said to have travelled in Egypt,[2] this fantastic doctrine into Magna Græcia, and a prominent part of his teaching. He declared had himself been Euphorbus, the son of Panthus, time of the Trojan War, and had successively ed other human bodies, the actions of all which he bered.[3] Closely connected with his theory of metem sis was his strict precept to abstain from animal ven from eggs, from some kinds of fish, and (for nknown, probably symbolical, reason) from beans.[4] an be no doubt that the Egyptian custom of pre the mummies of cats, crocodiles, and some other es had its origin in the notion that they had been ed by souls which might some day claim these for their own. We cannot suppose that Plato or er Greeks really believed in the transmigration of hough there are many allusions to it, generally of a

nat playful character. Thus Menander, in the play *The Inspired Woman*[5] (Θεοφορουμένη), supposes od to say to an old man, Crato, "When you die, ill have a second existence; choose what creature uld like to be, dog, sheep, goat, horse, or man." ch he replies, "Make me anything rather than a or he is the only creature that prospers by injustice." rd and fantastic as such a doctrine as metem sis appears at first sight to be, it was in reality a deduction from primitive ideas about the nature of l. It is necessary to explain these ideas (which nportant bearings on other questions) in order to hat metempsychosis was almost a necessary corollary belief that the soul was the vital or animating prin that the one distinction between organic and inor was the existence in the former of a ψυχή.

difference between a dead body and a living body ather, one principal difference—was that the living breathed; and it was observed that, as soon as the left the body, not only did warmth and motion but the body began to decay. Life, therefore, was an opinion tacitly expressed by the Greek and vocabulary, *animus*, *anima* (ἄνεμος), ψυχή, πνεῦμα, s. But breath is air, and air is eternal and imperish its very nature. Therefore the "soul," or portion which gave animation to the body, did not perish at solution of the body, but it was returned to the t of which it was composed, and out of which it It followed that, from the countless millions of " emancipated from bodies in all time, and still about invisibly in space, the air must literally with souls,—a doctrine taught by Pythagoras.[6] any creature, human or bestial, that first drew the of life, might, so to say, swallow a soul, *i.e.*, take in he act of respiration the very same particles of air had animated some former body. For, although as air, and returned to its kindred element, it was ed to retain a peculiar character in intelligence (φρόνησις), remembrance of the past, and knowledge experience gained in some former existence. Any crea which first breathed might or might not inhale this or soul, just as a net thrown into the water may catch th that fish, or no fish at all. But if no "soul" was inh the creature was believed for that reason to die, and different degrees of intelligence observed in different and animals led to the notion that there must have a difference in the souls that first animated them. the belief that the soul, especially near the time of dis tion from the body, could foretell future events was b on the notion of intelligence and consciousness resul from experiences of the past.[7]

As all the science of modern times cannot say prec what life is, nor how it first came upon this earth, it is wonderful that so obvious, though wholly erroneous explanation should have presented itself to primitive when first he began to inquire into the causes of thi The extension of life, by the same term ψυχή, to plants apparently non-breathing things, which, however, had b growth, and death, was a development of a philosophic and we are not surprised to find Aristotle recognizing form of life as *vegetable*, φυτικόν.[8] The irrational confu of "soul" with sentient bodily functions, the attributio spirits (εἴδωλα) of motion, speech, or other muscular material action, though still common, while metempsych is derided or forgotten, is in reality, perhaps, a less ev able superstition.

The Romans inherited the doctrine of metempsych from Ennius, the poet of Calabria, who must have familiar with the Greek teachings which had descende his times from the cities of Magna Græcia. In his *An* or Roman history in verse, Ennius told how he had Homer in a dream, who had assured him that the soul which had animated both the poets had once belo to a peacock, a story that might seem to indicate In traditions. The *Pavo Pythagoreus* and the *Somnia Py gorea* are referred to by Persius and Horace, as well a Lucretius.[9]

Theories suggesting element-worship naturally led t notion that air and ether (upper air) were divine.[10] H every soul, as being but a portion of it, was in itself di and therefore immortal. We thus see that the doctri the immortality of the soul, whether attained by a s or a vicious course of reasoning, was an inevitable co sion for early thinkers. Pantheism taught that all universe was pervaded by a divine mind, and Virgil the opinion of some, that the intelligence of bees wa to a portion of this universal mind residing in them, a closely allied to the doctrine of metempsychosis.[11] A d thing might be polluted, but not destroyed; hence notion of purifying souls by airing them or burning a material defilement is enlarged upon by Virgil i sixth book of the *Æneid* (724 *sq.*). (F. A.

METEOR, METEORITE. The term meteor, i cordance with its etymology (μετέωρος), meant origi something high in the air. It has been applied to a variety of phenomena, most of them of brief dura which have place in the atmosphere. Disturbances i air are aerial meteors, viz., winds, tornadoes, whirlw typhoons, hurricanes, &c. The vapour of water i atmosphere creates by its forms and precipitations aqueous meteors, viz., clouds, fogs, mists, snow, rain,

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[1] 249 A. Comp. Rev. xx. 2, 13; Virg., *Æn.* vi. 745, "Donec ies, perfecto temporis orbe, concretam exemit labem," &c.

[2] gen. Laert., viii. 1, 3; Lucian, *Gallus*, § 18 *sq.*, where the of metempsychosis and the stories about the pre-existence of oras are wittily satirized.

[3] cian, *Gallus*, §§ 4, 5; Diodor. Sic., x. §§ 9, 10; Hor., *Od.* i. "habentque Tartara Panthoiden iterum Orco demissum."

[4] *llus*, 19, 33. For fanciful reasons for the prohibition of beans, ian, *Vitarum Auctio*, § 5.

[5] Frag. 222, Meineke.

[6] gen. Laert., viii. 1, § 32, εἶναι πάντα τὸν ἀέρα ψυχῶν v.

[7] Diodor. Sic., xviii., § 1.

[8] *Ethics*, lib. i. 13.

[9] Pers., *Sat.* vi. 9; Hor., *Epist.* ii. 1, 52; Lucret., i. 124

[10] ὦ δῖος αἰθήρ, Prometheus exclaims, Æsch. *Prom.*, 88.

[11] *Georg.* iv. 219

His quidam signis, atque hæc exempla secuti,
Esse apibus partem divinæ mentis et haustus
Æthereos dixere; deum namque ire per omnes
Terrasque tractusque maris cœlumque profundum.

The effect of light upon the atmosphere and it con
causes certain luminous meteors, viz., rainbows, halos,
ha, twilight, mirage, &c. Discussion of all these, and
e phenomena, belongs to METEOROLOGY (q. v.)
other class of luminous meteors, known a shooting
lling stars, fireballs, bolides, &c., have their place in
upper parts of the atmosphere But by reason of
origin from without they, and the aerolites or meteor-
hich sometimes come from them, belong properly to
nomy. The term meteors often used in a restricted
as meaning one of these latter phenomena The
nt article will treat of them alone
e most remarkable of the meteors (and the most
ctive) are those which are followed by the falling of
to the earth The e have since the beginning of
resent century attracted so much attention, and the
omena have been so frequently examined and described
entific men, that they are very well understood The
meteors accompanying the fall of stones are tolerably
n. A ball of fire crosses the sky so bright as to be
appears in the daytime, sometimes even at
ed or miles from the meteor, and if it appear in the
at is bright enough to light up the whole landscape,
ver the sky, generally finishing its course in a few
d. It suddenly goes out, either with or without an
ent bursting in pieces, and after a short period a loud
ation is heard in all the region near the place where
eteor has disappeared Sometimes only a single stone,
mes several are found For some falls they are
ered by thousands About three thousand were
ted from the fall of L'Aigle in 1803, scattered over a
n about 7 miles long and of less breadth. A like
er was obtained from the fall of Knyahinya on June
66 At Pultusk a still larger number were collected,
red over a larger space, by a fall in January 1868
the Emmet county (Iowa) fall, May 10, 1879, a
rily large number have been secured.
e meteors leave behind them in the air a cloud or
that may disappear in a few seconds, or may remain
our They come at all times of day, at all seasons of
ear, and in all regions of the earth They come
pective of the phases of the weather, except as cloud
al them from view
t us describe one or two of these meteors more in
On the evening of the 2d of December 1876,
ns in or near the State of Kansas saw, about eight
k in the evening, a bright fireball rising from near
the moon then was in the western sky. It increased
illiancy as it proceeded, becoming so bright as to
t the attention of every one who was out of doors.
ersons in the northern part of the State the meteor
d the southern sky going to the east, to those in the
ern part it crossed the northern heavens. To all it
down near to the horizon a little to the north of east,
whole flight as they saw it occupying not over a
te.
e same meteor was seen to pass in nearly the same
across the heavens from west-south-west to east north
by inhabitants of the States of Nebraska, Iowa,
uri, Wisconsin, Illinois, Michigan, Kentucky, Indiana,
Pennsylvania, and West Virginia But besides this
were heard near the meteor's path, four or five
es after its passage, loud explosions like distant
nading, or thunder, or like the rattling of empty
ons over stony roads So loud were these that people
animals were frightened. East of the Mississippi
these explosions were heard everywhere within about
les of the meteor's path, and in Bloomington, Indiana,
s were heard supposed to come from the meteor even
distance of nearly 150 miles from it. Over central Illinois it was seen to break into fragments like a
and over Indiana and Ohio it formed a flock or cl
meteors computed to be 40 miles long and 5 miles
The sky in New York State was wholly overcast.
in Ohio and Pennsylvania, who from their si
could look over the cloud last, saw the meteor pas
eastward over New York From many places
State itself came accounts of rattling of houses, thu
noises, and other like phenomena, which at the ti
attributed to an earthquake.

At one place in northern Indiana a farmer h
heavy thud as of an object striking the ground
house. The next morning he found on the snow a
very peculiar appearance weighing three-quarters of a
which from its character there is every reason to
came from the meteor. By putting together the
accounts of observers, the meteor is shown to have
first visible when it was near the north west corner
Indian Territory, at an elevation of between 60 a
miles above the earth. From here it went nearly
to the earth's surface, and nearly in a right line, to
over central New York. During the latter part
course its height was 30 or 40 miles. It thus tr
the upper regions of the air through 25 of longitu
5° of latitude in a period of time not easily dete
but probably about two minutes. A part of the bo
have passed on out of the atmosphere, but probab
remnants came somewhere to the ground in New
or farther east.

A somewhat similar meteor was seen in the eve
July 20, 1860, by persons in New York, Pennsy
New England, &c., which first appeared over Michi
a height of about 90 miles The light was so bril
to call thousands from their houses. It passed eas
east, and over New York State, at a height of ab
mile, broke into three parts which chased each othe
the sky. At New York city it was seen in the
while at New Haven it was in the south. At both
the apparent altitude was well observed, and its true
proved to be about 12 miles above the earth's
between the two cities. It finally disappeared far o
the Atlantic Ocean. It is doubtful whether any on
any sound of explosion that came from this mete
no part of it is known to have reached the ground
velocity was at least 10 or 12 miles per second,
times the velocity of sound. These two meteor
evidently of the same nature as those which have fu
so many stones for our museums, except that the
so friable that it has given us but one known fra
while the other was only seen to break in two, not
sound of explosion being known to have come fr
meteor.

Next to the stone-producing meteor is the fire
bolide, which gives generally a less brilliant light t
former, but in essential appearances is like it. The m
July 20, 1860, above described, though unusually b
was one of this class, and represents thousands of
which have been seen to break in pieces. The
leave trains of light behind them just as the stone
do; they travel with similar velocities both appare
actual, and in all respects exhibit only such differe
phenomena as would be fully explained by differe
size, cohesion, and chemical constitution of stones
them.

Next to the bolide is a smaller meteor which
as if one of the stars were to leave its place in the h
shoot across the sky, and disappear—all within the
of a second. Some meteors of this class are as b
Venus or Jupiter. Some are so small that though y
directly at the meteor, you doubt whether you see

n the telescope still smaller ones are seen that are
e to the naked eye. Meteors comparable in bright
the planets and the fixed stars are usually called
g stars.

e various kinds of meteors differ from all other
ns phenomena so as to stand in a group entirely
Though they have been sometimes regarded as
ble among themselves into three or four different
and for purposes of description may still be so
, yet they all seem to have a like astronomical
er, and the differences are only those of bigness,
al constitution, velocity, &c. There appears to be
r line of distinction between the stone producing and
onating meteors, nor between those heard to explode
ose seen to break in pieces, nor between these and
mple fireballs, nor between the fireball and the
shooting-star.

ades of Meteors. The first important fact about
eteors is the region in which they become visible to
hundreds of instances observations have been
pon the luminous path of a meteor at two or more
s many miles apart. When such stations and the
e properly situated relatively to each other, observa
arefully made will show a parallax by which the
of the meteor above the earth, the length and di
of the path, and other like quantities may be com
The general result from several hundred instances
the region of meteor paths may be in general
d as between 40 and 80 miles above the earth'
. Some first appear above 80 miles, and some
l below 40 miles. But an altitude greater than
les, or one below 25, except in the case of a stone
ing meteor, must be regarded as very doubtful.
he meteor paths are far above the usual meteoro
phenomena, which (except aurora and twilight)
ot one tenth of the height of the meteors. But
ference to all other astronomical phenomena they
y close to us. The comets, for example, are well
millionfold, and even the moon is a thousandfold,
istant from us.

ities of Meteors. When the length of a luminous
known, and the time of describing it has been
d, it is easy to compute the velocity in miles.
mately the large meteors, describing long paths,
t rare intervals, and unexpectedly, and it is a happy
t when one is observed by a person accustomed to
e correctly short intervals of time. On the other
the total time of visibility of the shooting stars,
come so frequently that they may be watched for,
lly less than a second. It is not easy to estimate
ly such an interval, where the beginning and ending
marked by something like a sharp click. Hence
nates and computations of velocities of meteors are to
ived with due regard to their uncertainty. We may
y in general that the velocities computed from good
ations are rarely if ever under 8 or 10 miles a second,
40 or 50 miles, and that some have far greater
es than others. The average velocity seems to be
30 miles.

t makes the Luminous Meteor. The cause of a
is now universally admitted to be something that
the earth's atmosphere from without, with a
y relative to the earth that is comparable with the
velocity in its orbit, which is 19 miles per second.
resistance it meets in penetrating the air the light
her phenomena of the luminous train are produced.
favourable circumstances, portions of these bodies
he earth's surface as meteorites.

oroids.—A body which is travelling in space, and
on coming into the air would under favourable
circumstances become a meteor, may be called a
oid.

The meteoroids are all solid bodies. It would
be possible for a small quantity of gas out in
retain such a density as would enable it on comi
the air to go 10 or 100 miles through even the ra
atmosphere, and give us the clear line which a
star describes. Even if a liquid or gaseous mass ca
as such in space, it would be instantly scattered on
the air, and would appear very unlike a shooting
bolide.

Numbers of Meteors. Of the larger meteor the
the mean six or eight per annum which in the last fif
have furnished stones for our collections. A much
number have doubtless sent down stones which hav
been found. Thus Daubree estimates for the whol
an annual number of six or seven hundred stone fal

But of the small meteor or shooting star the
very much larger. Any person who should o
moonless night watch carefully a portion of the
would, in the mean, see at least as many as eight
shooting stars per hour. A clear sighted and pr
observer will detect somewhat more than thi
Dr Schmidt of Athens, from observations made
seventeen years, obtained fourteen as the mean hour
ber on a clear moonless night for one observer dur
hour from midnight to 1 A.M. A large group of ob
as has been shown by trial, would see at least six
many as a single person. By a proper consideration
distribution of meteor paths over the sky, and
altitude in miles, so as to allow for mist near the
it appears that the number over the whole globe
more than ten thousand times as many as can be
one place. This implies that there come into the at
than twenty million bodies daily, each of which
very favourable conditions of absence of sunlight,
light, clouds, and mist, would furnish a luminou
visible to the naked eye. Shooting stars may be
naked eye are often seen in the telescope. The n
of meteors, if these are included, would be rec
least twentyfold.

How densely Space is filled with Meteoroids. By as
that the absolute velocity of the meteor in space
to that of comets moving in parabolic orbits (we hav
reason to believe that this is nearly their true velo
may prove from the above numbers that the average
of meteoroids in the part that the earth traverses is
volume equal to that of the earth, about thirty th
In other words, there is on the average to every po
space equal to a cube whose edge is about 210 m
meteoroid large enough to make a shooting star
enough to be visible to the naked eye. Such me
would, upon an equable distribution, be each a
number 250 miles from its nearest neighbours. All the
bers rest upon Dr Schmidt's horary number fourte
for a less practised observer and a less clear sky they
be correspondingly changed. How much they wo
to be altered to represent other parts of space tha
near the earth's orbit is a subject of interest rath
of observation.

Motion in space.—The meteoroids, whatever
size, must by the law of gravitation have motion
the sun in the same way as the planets and comet
is, in conic sections of which the sun is always at on
The apparent motions of the meteors across the sk
that these motions of the meteoroids relative to
cannot as a rule be in or near the plane of the
For if they were there, since the motion of the earth
in the ecliptic, the motion of the meteoroids relativ
earth would be in the same plane. This would

ll the meteor paths as seen on the sky would if pro- backward cross the ecliptic above the horizon. In here is no tendency of this kind. Hence the meteor- o not move in orbits that are near the ecliptic as the s do, but like the comets they may and usually do orbits of considerable inclinations.

mbers through the Night.—There are more meteors in the morning hours than in the evening. If the rs had no motion of their own in space, the earth l by its motion receive the meteors only on the hemi- e that was in front. There would be no meteors seen other hemisphere. On the other hand, if the meteors ach large velocities of their own as that the earth's ty might be neglected in comparison, and if the ions of the meteors' motions were towards all points riminately, then as many would be seen in one part night as another. In fact there are about three as many seen in the morning hours as in the evening. s of chance from evening to morning gives a means ving that the mean velocity of meteors is so great hey must in general be moving in long orbits about n. In this respect also the meteoroids resemble and are unlike planets, in their motions. Of the turning meteors more are seen in the day than in ght, and more in the earlier hours of the night than later. This is probably due to the fact that more are in a position to see the zone fall at the period ater abundance.

Showers.—While the average number of shooting or a single observer at midnight may be regarded as ly constant, there have been special epochs when more have been seen. In certain instances the sky en filled with the luminous trains, just as it is filled scending snowflakes in a snowstorm, making a ible shower of fire. One of the best observed, though not the most brilliant, of these showers occurred evening of the 27th of November 1872. Some of ers of that shower, counting singly, saw at the s eight or ten thousand shooting stars in the course hour. The distances of the meteoroids in the of the warm which the earth then passed through, rom its nearest neighbours, would be 30 or 40 miles. following quotations show the impression made by owers in time past.

On several years after 1833, and before an 1866 68, there were unusual numbers of those mete on the mornings of November 13, 14, and 15, thou haps they would have been unnoticed had there n special watching for them. It will be seen that a showers are at intervals of a third of a century, th are at a fixed day of the year, and that the day has steadily and uniformly along the calendar at the about a month in a thousand years. The change of days in the 17th century is due to the change from new style.

The only explanation of this periodical display now seriously urged, and the one which is uni accepted by astronomers, is that there is a long thin of meteoroids, each of which is travelling about the a conic section. These conic sections are all parallel, and have nearly the same major axis, ex out about as far as to the orbit of Uranus, and each ing the common period of thirty three and a years. The length of the stream is such that th advanced members are six or eight years ahead hindermost, and they all cross the earth's orbit velocity of about 26 miles a second. Since the plunges through the group nearly in the opposite di the velocity with which they enter the air is 44 second. One of the facts which have greatly aide arriving at this explanation is that these meteors the years and through all hours of the night cross as we look at them in lines which diverge from near the centre of the sickle in the constellation Leo the paths in the air are parallel. This implies tha velocities relative to the sun are all parallel and e each other. The radiation from Leo has given to th name *Leonids*.

Orbit of the Leonids.—This orbit, common to Leonid meteors, is inclined to the ecliptic at an angle (or rather 163°, since the motion is retrograde), has axis of 10·34, a periodic time of 33·27 years, and helion distance a little less than unity.

The above orbit, and that alone, explains the appearances of the November meteors, the annual thirty three year periods, the radiation from Leo, change of day of the month in the course of the ce This it does so completely that the result has nev questioned by astronomers. Shortly after the pub by Professor Adams in 1867 of the last link in th of the proof of this orbit, there was also publish definitive orbit of the comet 1866 I. That the com running almost exactly in the orbit of the meteors once recognized. In fact the comet is itself, in a meteoroid, and the principal member, so far as we of the group. Leonids had been seen in 1863, tw and two months in advance of the comet, while t 1866 were ten months behind it. Those of later y few Leonids were seen even in 1870) were extende the line of the comet's path behind it. The leaders long file of meteoroids had passed up beyond the Jupiter long before those which brought up the r crossed that planet's orbit going down toward th The thickness of the stream is less than the ten-thou part of its length. In the densest part that w recently passed through - namely, that traversed in the density of the stream may be expressed by sayi each meteoroid must in the mean have been 10 miles from its nearest neighbours.

What makes this Comet and these Meteors desc same Orbit about the Sun?—Its path might hav inclined to the ecliptic at any angle instead of 163 with this inclination, its plane might have cut the orbit at any other place than where the earth is on t

the year 286 [of the Hegira] there happened in Egypt an ake on Wednesday the 7th of Dhu l-Ka'dah, lasting from the of the night until morning, and so-called flaming stars one giant another violently while being borne eastward uthward and southward, and no one could bear to w it the heaven on account of this phenomenon."

the year 399 [of the Hegira], on the night of Saturday, on th of Muharram, stars shot hither and thither in the s eastward and westward, and flew against one another like r of swarms of locusts, to the right and left, people were n consternation, and cried to God the Most High with d clamour.

hese meteors [November 12, 1799] might be compared to the g sheets shot out from a firework.

e phenomenon was grand and awful: the whole heavens ed as if illuminated with fire rockets."

ember 13, 1833.—"Thick with streams of rolling fire. y a space in the firmament that was not filled at every

most infinite number of meteors. They fell like flakes of

ovember Meteors or Leonids.—These quotations all refer of possibly the first) to a shower which has appeared tober and November of many different years since its known occurrence on the 13th of October 902 A.D. of these showers are given in the following table.

3, 902	Oct. 17, 1101.	Oct. 28, 1602.	Nov. 13, 1833.	
2, 934.	Oct. 19, 1202.	Nov. 9, 1698.	Nov. 14, 1866.	
4, 934.	Oct. 23, 1366.	Nov. 12, 1799.	Nov. 14, 1867.	
5, 1002.	Oct. 25, 1533.	Nov. 13, 1832.	Nov. 14, 1868.	

vember. Or, happening to have these two elements
non, it might have passed the earth's orbit nearer
n or farther away from it than the earth is. Or,
g these three things in common, it might, by a slight
nce in velocity, have had a periodic time much more
ch less than thirty-three years. Or, with all these
mon, it might have crossed the earth's orbit at a far
nt angle than the meteors. These several independ-
ements for the comet and the meteors are substan
identical, and this identity proves almost beyond
that between the two either there is now an actual
there has been in the past a causal connexion.
there is now any physical connexion is thoroughly
ved by the immense magnitude of the stream, and
e isolation and distances from each other of the
dual components. It seems difficult to find any cause
should bring into such a strangely shaped group
that had originally orbits distributed at random.
we are apparently forced to conclude that these
roids have something common in their past history.
t they seem to have been once parts of a single body,
hese common elements are essentially those of the
mass. By some process not yet entirely explained
ave become separated from the comet, thrown out of
ntrol of its attractive power, and so left to travel
ne in its own orbit. If the cause of separation was
o violent, each new orbit would necessarily be but
y different from that of the comet. Very small
ions in velocity, and hence in periodic time, would
course of ages scatter the several individuals along
bit even to the length of many hundreds of millions
es.

Meteor Group is not the Comet's Tail. These
roids must be carefully distinguished from the
's tails. The former follow or precede the comet
y in the comet's path; the particles that compose
tter are driven off by the sun's repulsion directly
from the comet's path. The meteoroids and the
have orbits with nearly common elements; the
of the particles of the tail have elements that are
each other, and unlike those of the comet. The
roids are undoubtedly solid masses; the tails are
nulent or gaseous.

in Comets of 1366. The comet 1866 I. is probably
e only one that has been connected with the November
rs. In 1366, a few days after the earth went through
neteor stream, a comet appeared in the northern
ns, and, passing directly in the line of the stream so
to the earth as to describe an arc of 90° in a single
disappeared in the constellation Aquarius. Immedi-
upon its disappearance a second comet was seen in
orth, which followed nearly in the same path. The
se accounts are not sufficiently exact to furnish
endent orbits for them, but both comets were
ubtedly members of the Leonid stream. The comet
I. may be identical with one of them.

Andromeds and Biela's Comet. Mention has been made of the
ower of November 27, 1872. The periodical comet known
a's, which makes three revolutions in twenty years, passes
near the earth's orbit at a longitude corresponding to
mber 27, but by reason of its direct motion the node has
nsiderable motion in longitude as the result of perturbations.
s having the same orbits as Biela's comet would have a
in the constellation Andromeda, that is, would cross the
lines diverging from a point in that constellation. They
however, be at dates after or even before November 27.
sual numbers of meteors were seen December 7, 1798, by
es. A like abundance was seen December 7, 1838; and, as
ad been expected, and radiation was now looked for, they
ound to diverge from a point in Andromeda. Hence they
een called Andromeds. Since 1852 Biela's comet itself has
entirely lost. The star shower of November 27, 1872,
usly referred to, had a adiant in Andromeda, and in every
way appeared as though its meteors had once been parts of
comet. A sprinkle three days earlier, on the night of Nov
24, had the same radiant, and came from a less dense or
parallel stream. A small comet was seen in the southern
Pogson in the direction opposite to the radiant shortly aft
shower. Biela's comet had been found in 1845 46 to be
parts, which at its next return to perihelion in 1852 had sep
to eight times their former distance. But the meteor sho
1872 could hardly have been separated from the comet so re
and the Pogson comet II of the same origin must also have
parent mass at an earlier date than 1815. No ordinary pe
tions would in a short period have so changed the orbits
parts of the small stream traversed by the earth, December 1
December 1798, were far from the comet, and these fragment
have been thrown off much earlier.

The Perseids and the Comet 1862 III.—There is a third
when meteors appear in unusual numbers, viz., the 9th to
August. This "sprinkle," as it may be called, has been see
stantly at the time named for nearly fifty years, and the
on record accounts of similar appearances in the earlier years
its annual character had been discovered. Some observer
thought that there were evidences of a variation having
period, but the proof seems as yet unsatisfactory, and the
may be regarded as tolerably constant from year to year. On
10th of August we may confidently expect a display of meteo
shall be at least four or five times as numerous as those of o
nights. The radiant is in the constellation Perseus, and her
name Perseids.

The comet 1862 III., which has a period of more than a hu
years, passes close to the earth's orbit, nearly cutting it at th
of this shower, and has a velocity and direction corresponding
this radiant. Hence a connexion of the Perseid meteors wi
comet is presumed like that which the Leonids and Andr
have with the comet 1866 I and Biela. The meteors are
buted along this orbit more regularly than along either of th
two, and at the same time the breadth of this group is a hu
times greater than that of the Leonids. We must for the
regard it rather as a meteor ring, the meteoroids being sc
along the entire conic section which the comet describes. Th
has an inclination of 113° with the ecliptic.

Meteors of April 20–21. *Lyrids.* About the 20th of Apr
have been several quite brilliant star showers, the earli
record having been in the year 687 B.C. On that day meteo
been observed which radiated from Lyra, and to these the
Lyrids has been given. The comet 1861 I passes near the
orbit in that longitude, and any meteors having such a con
with it as is proved for the Leonids with comet 1866 I wou
radiate from Lyra.

Again, at several other periods of the year, meteors hav
seen in unusual numbers which seem to be connected with
comets.

Meteor Radiants. We have thus definite proof th
earth at certain epochs plunges through meteor st
and that these streams travel along the same track
tain comets. The question is at once asked. Do n
sporadic meteors, those which are seen on any a
nights of the year, belong to similar streams? An im
amount of labour has been spent in observing the pa
meteors, and classifying them, so as to detect and pro
existence of radiant points. As many as a thousan
radiants have been suggested by the different investi
Some of these are duplicates, some will prove to b
dental coincidences; but a goodly number may reas
be expected to endure the test of future observ
Such will show the existence of meteor streams, an
haps will be connected with comets that are now k
or that may hereafter be discovered.

The radiants have been spoken of as if they were
in the heavens. This is so nearly true as to justify
conclusions that have been deduced above. But in
radiant, even in the star showers in which it i
sharply defined, must be regarded as a small area.
apparent meteor paths when produced backward
exactly meet in a point. If they be treated as proc
from a small area, it does not appear that this is
narrow one. Hence it may be shown that the pa
the meteors in the air are not exactly parallel eithe
line or to a plane. This can hardly be due to a w
parallelism of the paths before the meteoroids me
earth, but is rather due to their glancing as they str

These facts add not a little to the difficulties to be
ome by the energetic observers and investigators who
rying to deduce order out of an apparent chaos.

eteorites. The fragments which fall immediately after
disappearance of large meteors have been carefully
ted and preserved in mineralogical museums, and have
studied with special interest. The largest collections
urope are in Vienna, Paris, London, and Berlin, some
ese representing over three hundred localities. In the
ed States there are large collections at New Haven,
ord, and Louisville.

several respects these fragments differ at first sight
terrestrial rock.

ey are when found almost always covered in part or
ely with a very thin black crust, generally less than
t an inch in thickness. This crust may have a bright
ous surface, or it may be of a lusterless black. It has
ently been melted, yet so rapidly as not to change in
least the parts of the stone immediately adjacent.
ks showing the flow of the melted matter are often

on the surface. Upon some surfaces are what appear
deposits of the melted matter that has flowed off from
ther. Some surfaces are only browned, showing an
ently recent fracture, and some cracks are found in
s which are not yet completely broken in two.

e surfaces very often have small cup-like cavities,
times several inches in diameter, sometimes like deep
nts in a plastic mass made by the ends of the fingers,
sometimes still smaller. These "cupules" have not
various sizes in different stones, but even in the same
differ considerably from one surface to another. They
r in meteorites that are almost exclusively iron, as
as in those mainly destitute of that metal, and they
be regarded as a characteristic of meteorites.

e meteorites have usually metallic iron as one of their
onent parts. Native iron is very rare indeed among
trial minerals, and its presence in the meteorites is
tore characteristic. Sometimes the iron forms the
ipal part of the body, giving it the appearance of a
of that metal. Sometimes it forms only a connected
work which is filled in with mineral matter. Some
particles of iron are scattered through a stony mass;
few meteorites are said to be destitute of metallic
altogether. The metallic iron is always accompanied
nickel.

e stony meteors when broken or cut through have
ly a greyish interior, and often exhibit a peculiar
lar structure. From the small rounded grains that
t this appearance, the name chondrite (from *χόνδρος*,
) has been applied to this kind of meteorite. Some-
the irregular fragments are compacted into a kind of
ia.

e pieces as we find them are always apparent frag-
of some larger mass, and there is no structural
rance which would indicate that the mass might not
fragment of a still larger one. In some of the falls
ents picked up at a distance of miles from each other
gether in this way browned surfaces, showing that
were true fragments recently separated. In some
surfaces of the stone are partially polished. In some
s section of the stone exhibits thin black lines as
gh the melted matter of the surface had been forced
the crevices of the partially broken stone.

e stones when seen to fall, if at once picked up, are
ly too warm to be taken in the hand. But cases are
ord in which the stones were excessively cold. They
times, on striking the ground, penetrate into it from
feet. In extreme cases large ones have struck much
er into soft earth. Sometimes they are broken to
s by the impact with the hard earth.

The stones are usually not very large. Althou
light of the meteor is such as sometimes to be seen
region 1000 miles in diameter, and the detonatio
phenomena suggestive of an earthquake over many e
yet a stone exceeding 100 lb is quite exceptional in
lections. The total weight secured at any fall has n
ever amounted to a thousand pounds. The average
of nine hundred and fifty perfect specimens of the
fall in the Paris museum is 67 grammes, or less t
oz. One of the Hessle meteorites in the Stockholm m
weighs less than 1 grain. Many of the Emmet count
orites (May 10, 1879) are not much larger, thou
largest specimen of that fall weighs nearly 500 lb.

Meteors traversing the Atmosphere.—We can no
very good idea of the history of that part of a met
life between its entrance into the air and its arrival
earth. It is entirely invisible until it has reached that
at which the density of the air is enough to crea
siderable resistance. Up to that time it moves
exclusively in obedience to the sun's attraction,
earth's attraction may be neglected, especially duri
passage through the air. Since the velocity is a h
times that of sound, the elasticity of the air is impo
remove it from in front of the meteorite, or to pro
high degree of condensation. Perhaps the air is fi
immediately in front of the stone. Heat is develope
enormously, and the stone being pressed closely agai
hot air is melted, with an intense light. The conde
charged with the melted matter is pushed aside, a
behind nearly in the wake of the meteor to form th
The brightness of the train rapidly diminishes beh
meteor, so that the light of the meteor and the train
fied by irradiation, make the whole appear to a dist
of the shape of a pear or candle-flame. The stone
poor conductor of heat, and itself rigid, is not heated
interior either by condensation or conduction, an
reach the ground with its surface only heated, wh
interior is as cold as it had been out in space.

If the stone is a small one it will soon be used
this intense fire. Until its front surface is rounded
flame, the irregular resistances may cause such a s
glance. But if the stone is larger it will lose veloc
rapidly. As it comes down into the region where
is more dense, it will in spite of loss of velocity meet
resistance. The air pressed hard against it burns
equally, forming cupules over its surface. The
of the air cracks the stone,—perhaps scaling off sma
ments, perhaps breaking it into pieces of more
size. In the latter case the condensed air in front
meteor being suddenly relieved will expand, givi
terrific explosion which accompanies such breaking u
either case a fragment may have still velocity eno
burn on for an instant in its new path and the
invisibly to the earth, covered with a coating, the
part obtained after the principal explosion. In th
part of the course the original velocity has almost
appeared, so that the sound travels faster than the
The air's resistance exceeds the earth's attraction, a
stones strike the ground only with the force of a
cannon ball. It is no doubt in violent disruption tha
of the fractures are made in such a way as to g
rubbed and polished surfaces.

Trains of Meteors. The smaller meteors general
no perceptible train. Only in exceptional cases
trains of ordinary shooting stars remain visible long
a fraction of a second. An unusual number of the
have a bluish train. But the brighter shooting st
the larger meteors sometimes have trains that end
minutes, and in extreme cases for an hour. Such
are at first long narrow lines of light, though much

e track of the meteor. They begin at once to
in the middle and to fade away at one or both
Presently they become curved, sometimes with two
convolutions. The white cloud floats slowly away
the stars, coiling up more and more, and finally
t of sight. The cause of all this seems to be as
The heated air charged with the debris of the
is by the meteor's impact driven off horizontally,
the narrow train to spread into a cloud. The
s of air differing in direction at different altitudes
e cloud into its varied fantastic forms. Attempts
in the spectrum of the trains have been made, and
and magnesium lines have been thought to be
d in them. The observation, however, is one that
easy to make or confirm The trains have often
other than white, and in the case of the brighter
different colours are seen in the different parts of
n.

ntude.- Some computations have been made of the
the shooting star meteoroids from the mechanical
ent of the light developed by their disintegration.
e energy of the meteor is changed into light, then
omputations would be conclusive But a part is
n disintegrating and burning the stone, a part
ng the air, and a part in giving direct motion to
s of air. A computation based on the light developed
nly a lower limit to the size.
ems probable that the larger meteors might be safely
d as weighing on entering the air only a few
ds or at most a few thousands of pounds. The
t visible shooting stars may be equal in size to
grains of sand, and still be large enough to furnish
light exhibited by them. The largest shooting
rnish matter enough to fill with thin trains
niles of space, but this need not require a very
ass.

e Irons.- There have been found at various times on the
of the earth masses of metallic iron combined with nickel.
ve been so like the irons which have been known to fall,
their structure and in composition, that they have been
hesitation classed among the meteoric irons. A mass of
acter weighing 1635 lb, found in Texas, is in the Yale
Museum. The Chaco (Mexico) iron in the Paris museum
the same size. A ring-shaped mass somewhat smaller,
uzon, is in the United States National Museum in
gton. A still larger mass is in the British Museum, and
ther large masses are in public collections or private
n.

annstatten Figures If in any of the meteoric irons, whether
fall or found on the earth, a section is cut and polished and
hed with acids, a series of peculiar lines are developed
re known as Widmannstatten figures The lines of iron
ed by the acid consist of an irregular grouping of parallel
often lying along the faces of a regular octahedron. The
n of these figures and the combination of iron with nickel
en usually considered conclusive evidence of the meteoric
f any iron mass.

l Iron of Ovifak.- In 1870 Baron Nordenskiold in his voyage
nland, found on the shore of the island of Disco fifteen iron
the largest of which weighed 20 tons, all in an area of half
In the basaltic rocks not far distant other iron masses
nd embedded in the basalt. The presence of nickel with
, and the development of lines like the Widmannstatten
were at once accepted as proof of their meteoric origin, in
the combination with basalt. A more complete examination,
s, however, established the terrestrial origin of these irons
en reasons to hope for new discoveries of relations existing
the earth and the meteors. The additional discovery
l particles of metallic iron in certain other igneous rocks
that the union of the Ovifak irons with basalt is not excep-

ical Constitution of the Meteorites. - No new element has
nd in the meteorites Three elements most widely distri-
nd most important among the meteorites- iron, silicon, and
—are also most abundant in our earth Daubrée gives the
ng lists of elements, arranged somewhat in the degree of
nportance, in meteorites (Maskelyne adds lithium and
ay):—

Iron.	Titanium.	Arsenic
Magnesium.	Tin.	Phosphorus
Silicon.	Copper.	Nitrogen.
Oxygen.	Aluminium.	Sulphur
Nickel	Potassium	Chlorine
Cobalt.	Sodium.	Carbon
Chromium.	Calcium	Hydrogen
Manganese.		

Minerals in Meteorites. Among the minerals in the meteo
there are several which occur in the rocks on the earth A
these are cited by Daubrée peridote, pyroxene, enstatite, tr
felspar, chromite, magnetic pyrites iron oxide, graphite
probably water Several minerals, however, are found whic
far as now known, are peculiar to the meteorites :- metallic
iron, phosphide of iron and nickel schreibersite), sesquisulph
chromium and iron (daubréelite), sulphide of calcium (oldha
and chloride of iron (lawrencite).

Meteorites of different falls are in general unlike ; but the
many instances in which the stones of two falls are so sim
constituted that it is not easy to distinguish them.

In four falls (Alais, Cold Bokkeveld, Kaba, and Orgeui
tones contain little or no iron. In these carbon appears
graphite but in union with hydrogen and oxygen, and also
soluble and even deliquescent saline matters. The combin
are such as to suggest the existence of hydrous and organic re
But after careful search nothing of this kind has been detect
them In general the meteorites show no resemblance in
mechanical or mineralogical structure to the granitic and s
rock- on the earth One condition was certainly necessary in
formation, viz., the absence of free oxygen and of enough wa
oxidize the iron and other elements Perhaps it is to this fac
are due the resemblances between the minerals and those
deep-seated rocks of the earth in the formation of which
oxygen and water were also not present

Gases in Meteorites. The meteoric irons and stone
reduced to fine particles and placed in the vacuum of a Spreng
pump give off small quantities of gases which may be reasonabl
sumed to have been occluded by the irons at some time in their
history Professor Graham found hydrogen in meteoric
Professor Wright has shown that a mode of heat drives off
the stony meteorites carbonic acid and carbonic oxide w
small amount of hydrogen. As the heat increases the proport
hydrogen (and even some nitrogen) increases still at a full red he
hydrogen given off is by far the largest portion. From the irons
gases are given off, but the carbon compounds are not so
component as hydrogen The spectra of the tails of com
not strikingly like those of any of the gases But it is impo
to reproduce in the laboratory the conditions under whic
matter of comet's tails is giving off its heat We cannot th
say that these gases may not be the important parts of the c
coma and tails

Meteoroid as Part of a Comet A suggestion that the meteor
meteoroid once formed an integral part of a comet, not
information is given us of the nature of the mysterious
There is room also for speculation.

First, the comet may be a single large body which come
the cold of space into the heat of the sun and there ha
ments broken off, just as a stone is broken off in a hot fur
nucleus of some of the comets must be very small because in
in the telescope and an impulse that would drive a stone
earth only a few inches would send it perceptibly away fro
a comet. The exposure of new surfaces to the heat of the sun
give occasion for the development of gas to form the comet's

Or, secondly, the comet may be a tolerably compact aggrega
small bodies not in contact, each one being of the siz
meteoroid, and kept near to the rest, not by cohesion, but b
combined attraction. The total mass being small, some m
of the group near the comet's perihelion passage can be by th
perturbing action thrown out into orbits quite independent
comet itself, and yet such as relative to the sun shall resemb
of the main group Perturbations resembling tidal waves m
preparing other members to be cast off at the next pe
passage of the comet.

In either case, if we suppose, as seems probable, that the
came from outside the solar system, and that a disturbanc
large planet changed the original hyperbolic orbit into an
the comet must have passed that planet as a very compact g
not in a single mass, else the disturbance that changed th
would have scattered the group beyond the power of a future
union of the common origin of the fragment

Meteoroids as Fuel of the Sun.—The idea has been h
distinguished physicists that the meteoroids in falling in
sun furnish by their concussion a supply for the heat wh
sun is constantly sending off into space, - that they are in f
fuel of the sun Such a view, however, receives but little s
from facts which we know about meteor The meteoroids
August and two November periods are evidently per

of the solar system moving in closed orbits. The same is ...ee highly probable for most of the other meteoroids, and ...ne of all of them. Permanent members of the solar ...owever, if they ever fall into the sun, do so only after a long ...perturbation. If any meteoroids come from stellar spaces ...any uniform or random distribution of velocities or direc... ...y a very small portion of these would hit the sun's surface. ...greater portion would go on in hyperbolic orbits. But ...receives the impact of a portion of these foreign ...s, both in their inward and outward course, and in ...encounters a full share of the permanent members of the ...em, of which the sun receives very few or none. It is ...to show that a supply of meteoroids to the sun sufficient ...o offset its daily loss of heat would require that the twenty ...meteoroids which the earth daily encounters, even if all were ...in space, would have an average weight of hundreds of ...; the facts do not warrant the admission of any such magni... ...for the large meteor, much less for the ordinary and ...shooting-star. Whatever be the source of the sun's heat, ...meteoroids of which we know anything are totally inade... ...supply the waste.

...ature of meteors and meteoroids is very much scattered. ...only contained in the scientific journals and in transac... ...the learned societies. The series of valuable *Reports* of the ...Meteor Committee of the British Association contain ...the record of an immense amount of original observations, ...ear by year a digest of most of the important memoirs. ...e science is a structure built stone by stone by many ...In this article no attempt has been made to assign to ...ler the credit for his contribution. (H. A. N.)

METEORA, a remarkable group of rock-built monas... ...The... ...aly, in the northern side of the valley of the ...not quite 20 miles north-east of Trikkala, and in ...mediate vicinity of the village of Kalabaka, Stagus, ...(the ancient Ægminium). From the Cambunian ...vast masses of rock are thrust southward into ...a, surmounted by a number of huge isolated columns from 85 to 300 feet high, "some like gigantic tusks, some like sugar-loaves, and some like vast stalagmites," but all consisting of iron-grey or reddish-brown conglomerate of gneiss, mica-slate, syenite, and greenstone. On the summit of these rocky pinnacles—accessible only by aid of rope and basket let down from the top, or in some cases by a series of almost perpendicular ladders climbing the cliff to the mouth of a tunnel—stand the monasteries of Meteora (*τὰ Μετέωρα*). At one time they were twenty-four in number; but Holland (1812) and Hughes (1814) found them reduced to ten; at Curzon's visit (1834) there were only seven; and in 1853 not more than four of these were inhabited by more than two or three monks. Meteora *par excellence* is the largest and perhaps the most ancient. The present building was erected, according to Leake's reading of the local inscription, in 1388 (Bjornstahl, the Swedish traveller, had given 1371), and the church is one of the largest and handsomest in Greece. St Barlaam's and St. Stephen's (the latter founded by the emperor John Cantacuzene) are next in importance. The decorations of the churches contain a large amount of material for the history of Byzantine art, not much inferior in value to the similar treasures at Athos.

Unless the identification with the Ithome of Homer be a sound one, there is no direct mention of the rocks of Meteora in ancient literature, and Professor Kriegk suggests that this may simply be due to the fact that they had not then taken on their present remarkable form. Ægnium, however, is described by Livy as a strong place, and is frequently mentioned during the Roman wars; and Stagus appears from time to time in Byzantine writers.

See Holland, *Travels in the Ionian Isles, &c.*, 1815; Hughes, *Travels in Greece and Albania*, 1830; Curzon, *Visit to Monasteries in the Levant*, 1849; Leake, *Northern Greece*; Professor Kriegk in *Zeitschr. f. allg. Erdk.*, Berlin, 1858; Tozer, *Researches in the Highlands of Turkey* 1869.

METEOROLOGY

METEOROLOGY, in its original and etymological sense, included within its scope all appearances of ...astronomical as well as atmospherical, but the term ...restricted to the description and explanation of the ...ena of the atmosphere which may be conveniently ...under weather and climate. These phenomena ...the action of the forces on which the variations ...ure, temperature, humidity, and electricity of the ...here depend, but in an especial sense to the aerial ...nts which necessarily result from these variations. ...e more exact development of meteorology, the ...investigation of climate long preceded that of ... Humboldt's work on *Isothermal Lines*, published ..., must be regarded as the first great contribution ...orological science. The importance of this inquiry ...distribution of terrestrial temperature it is ...possible to overestimate, for, though the isothermals ...necessarily to a considerable extent hypothetical, ...cannot be a doubt that they presented a first sketch ...principal climates of the globe. Dove continued ...tended the investigation, and in his great work *On ...tribution of Heat on the Surface of the Globe*, pub... ...in 1852, gave charts showing the mean temperature ...world for each month and for the year, together with ...of abnormal temperature. To this, more than to ...er work, belongs the merit of having popularized ...nce of meteorology in the best sense, by enlisting in ...ce troops of observers in all parts of the civilized ...

...868 another series of important charts were pub... ...representing by isobaric lines the distribution of the ...the earth's atmosphere, and by arrows the prevail... ...ds over the globe for the months and the year. ...charts the movements of the atmosphere and the immediate causes of these movements were for the first time approximately stated, and some knowledge was thereby attained of some of the more difficult problems of meteorology. It was shown that the prevailing winds are the simple result of the relative distribution of the mass of the earth's atmosphere, in other words, of the relative distribution of its pressure, the direction and force of the prevailing winds being simply the flow of the air from a region of higher towards a region of lower pressure, or from where there is a surplus to where there is a deficiency of air. It is on this broad and vital principle that meteorology rests, which is found to be of universal application throughout the science, in explanation, not only of prevailing winds, but of all winds, and of weather and weather changes generally. One of the more important uses of the principle is in its furnishing the key to the climates of the different regions of the earth; for climate is practically determined by the temperature and moisture of the air, and these in their turn are dependent on the prevailing winds, which are charged with the temperature and moisture of the regions they have traversed. The isobaric charts show further that the distribution of the mass of the earth's atmosphere depends on the geographical distribution of land and water in their relations to the sun's heat and to radiation towards the regions of space in different seasons.

In 1882 Loomis published a map showing the mean rainfall of the globe. This map and others that have been constructed for separate countries show conclusively that the rainfall of any region is determined by the prevailing winds considered in relation to regions from which they have come, and the physical configuration and temperature of the part of the earth's surface over which they blow. The maximum rainfall is precipitated by winds which,

traversed a large breadth of ocean, come up against
w over a mountainous ridge lying across their path,
e amount deposited is still further increased if the
pass at the same time through regions the temper-
f which constantly becomes colder. On the other
he rainfall is unusually small, or *nil*, when the pre
winds have not previously traversed some extent
n, but have crossed a mountain ridge and advance
same time into lower latitudes, or regions the
ature of which is markedly higher.

le the observational data for the determination of
ographical distribution of the prime elements of
, viz., the pressure, temperature, moisture, and
ents of the atmosphere and the rainfall were being
but surely collected, the great importance of the
of weather came gradually to be recognized.
onal impetus was given to this branch of study from
mate bearings on the eminently practical question
n warnings. Synchronous weather maps, showing
eather over a considerable portion of the earth's
, were constructed, and some advance was made in
the progress of storms from day to day. Unques-
y one of the first problems of meteorology is to
in the course storms usually follow and the causes
ch that course is determined, so as to deduce from
eteorological phenomena observed, not only the
approach of a storm, but also the particular course
orm will take. The method of practically conduct-
s large inquiry in the most effective manner was
by the genius of Leverrier, and began to be carried
1858 by the daily publication of the *Bulletin Inter-*
l, to which a weather map was added in September
This map showed graphically for the morning
day of publication the atmospheric pressure, and
ection and force of the wind, together with tables
perature, rainfall, cloud, and sea disturbance from a
umber of places in all parts of Europe. From such
r maps forecasts of storms are framed and suitable
gs issued; but above all a body of information in a
ndy form is being collected, the careful study and
ion of which is slowly but gradually leading to the
more exact and satisfactory forecasts of weather,
a juster knowledge of these great atmospheric move
which form the groundwork of the science.

most cursory glance is sufficient to show that the
anging physical phenomena with which it is the
s of meteorology to deal are all referable to the
of the sun, it being evident that if the sun were
out from the sky a cold lifeless uniformity would
take possession of the whole surface of the globe.
ological phenomena naturally group themselves into
eat classes, -those dependent on the revolution of
th on its axis, and those dependent on its revolution
the sun taken in connexion with the inclination of
to the plane of its orbit. The science thus divides
nto two great divisions, the first comprising diurnal
nena and the second annual phenome

Diurnal March of Phenomena.

perature.—Of the daily changes which take place
tmosphere, the first place must be assigned to those
rekate to temperature, seeing that on these all other
s are either directly or indirectly dependent. Obser-
of the temperature of the air are therefore of the
nportance in meteorology. A perfectly accurate
ation of the temperature of the air is unquestionably
the most difficult to make of all physical observations,
ficulty being to eliminate the effects of radiation of
ding objects. The nearest approach yet made to
ation of this important problem of physical inquiry
was made by Dr Joule in a communication
Philosophical Society of Manchester (November '76,
Proc., vol. vii. p. 35). But the manipulative ski
time demanded by the method there detailed render i
unsuitable for general adoption anywhere in collecti
observational data required in the determination
important element of climate. It is therefore neces
fall on some method which, while it gives results th
only be regarded as approximate, secures the es
element of uniformity among the observations.

Fig. 1 represents Stevenson's louvre boarded box for t
nometers, which is now very widely used for temperature
tions. The box is made of wood, and louvred all round
protect the thermometers inside from radiation, and at the sa
seems as free a circulation of air as is consistent with a sati
protection from radiation. The box is painted white, both
and outside, and screwed to four stout wooden posts, also
white, firmly fixed in the ground. The posts are of such
that when the thermometers are hung in position the bulb
minimum thermometer and hygrometer are exactly at t
height of 4 feet above the ground, the maximum thermomet

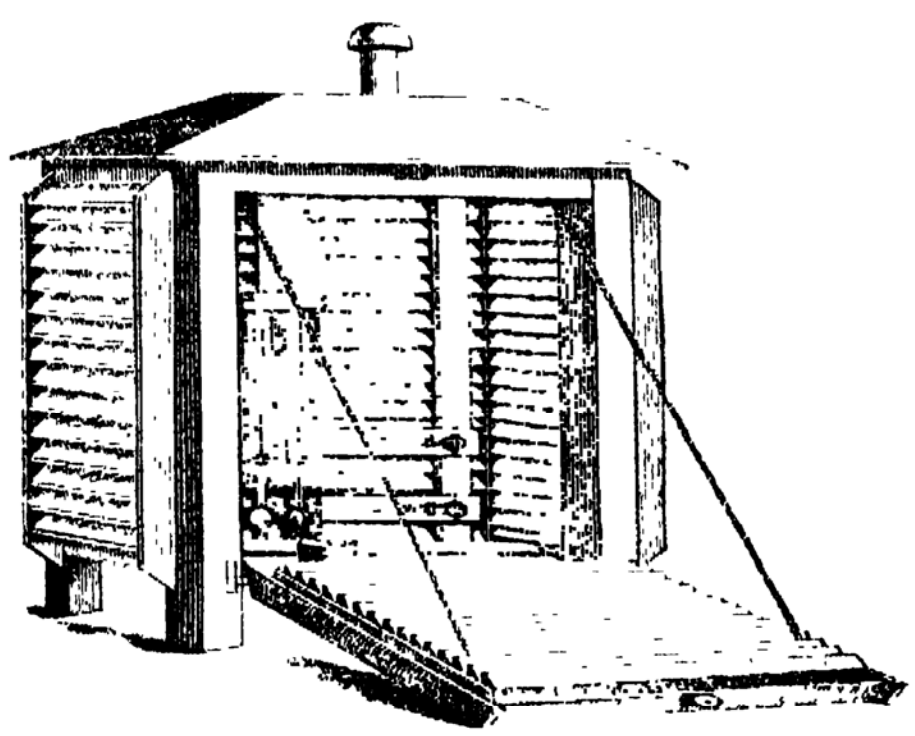


Fig. 1. The ter Bo

hung immediately above the min mum therm meter. Th
mometer box is placed over a plot l grass, and in a free op
to which the s rays have free access during as much of
as surrounding nditions admit. It will observed
thermometers s suspended on cross-laths in the centr f
and face the door, which ld always open to the n h
not possible to overestimate the importance of seeing that un
of height above ground and method of protecting the therm
is secured, since in no other way at possible to obtain rest
different places which shall be comparable with each other a
supply satisfactory materials for the investigation and deve
of comparative climatology.

A desired uniformity is yet far from being a
among the meteorological systems of different co
Thus in Russia the box for the protection of the t
meters is made of zinc, on the supposition that suc
follows more closely the changes of temperature of
than a box of wood. Owing to these international
ties of observation, it is extremely desirable tha
were taken to ascertain, by Joule's method of obs
the approximate errors peculiar to each sort of therm
box, in order that the temperatures of different co
may be compared together in a more satisfactory
than has yet been possible.

Interchanges of temperature among bodies take p
conduction, convection, and radiation. In mete
the most important illustrations of conduction are t
pagation downwards through the earth's strata
changes of the temperature of the surface as it is
during the day and cooled during the night, and t
pagation of the same changes of temperature throu
lowest stratum of the air which rests on the surface.
sand and light loose soils are much worse conduc
heat than clay and dense soils, it follows that loo

ets of sand are subject during the day to higher
ature and during the night to lower temperature near
face than dense soils, and that frosts and extreme
atures do not penetrate so far into loose as into
soils. It is on these differences that some of the
riking features of climates depend. As snow is one
worst conductors of heat, owing to the quantity of air
he interstices among the ice crystals, it protects the
covers by setting a limit to the depth to which the
frosts of the surface penetrate, and by arresting the
of the heat of the soil upwards to the air.

communication of heat from one part of the earth
her by convection is seen on a grand scale in the
and in the current of the ocean. It is seen also in
ending and descending currents of the atmosphere
here, which have their origin in the daily and
l changes of temperature to which the surface of the
subject. The direct and beneficial effect which
from atmospheric and oceanic circulation is a more
distribution of temperature over the globe, thus
ting the regions of the polar regions and the heat
tropics.

interchange of heat is constantly going on among
exposed to each other, whatever be their tempera
This mode by which heat is communicated from
dy to another is called radiation. Radiant heat
ls in straight lines, diverging in all directions from
rce, is only in a limited degree influenced by the
ough which it passes, and is not diverted from the
t course by the wind. The intensity is proportional
temperature of the source, and is greater according
degree of inclination of the surface on which the
ll.

en a body be placed in the presence of other bodies,
older and some warmer than itself, it will from this
interchange of temperature receive more heat from
rmer bodies than it radiates to them, and conse
becomes warmer; but it will receive less heat from
lder bodies than it radiates to them, and its
ature consequently falls. This is precisely the
on in which the earth is placed in space. When a
the surface is turned towards the sun, that part of
face receives more heat than is radiated from it:
temperature consequently rises most in that region
for the time is perpendicular to the sun's rays, and
ound the annulus where the inclination of the surface
atest. On the other hand, since the hemisphere
from the sun radiates more heat than it receives
he cold regions of space, the temperature there falls
to the essentially distinct conditions under which
th is placed with respect to radiation, the subject
erally to be divided into two heads, solar radiation
restrial radiation.

r Radiation.—Of the sun's rays which arrive at the
surface, those which fall on the land and solid
generally are wholly absorbed by the thin surface
exposed to the heating rays, the temperature of
consequently rises. Whilst the temperature of the
increases, a wave of heat is propagated downwards
h the soil. The intensity of the daily wave of
ature rapidly lessens with the depth at a rate
ding on the conductivity of the soil, until at about 1
low the surface it ceases to be measurable. Part of
at of the surface layer is conveyed upwards through
by the convection currents which have their origin
heating of the lowermost stratum of air in direct
with the heated surface of the land.

gether different is the influence of the sun's rays on
In this case the sun's heat is not all, indeed very
n all, arrested at the surface, but penetrates to a
considerable depth. The depth to which the influe
the sun is felt has been shown by the observations
during the cruise of the "Challenger" to be, ro
speaking, about 500 feet below the surface of th
The rate at which, in perfectly clear water, this h
distributed at different depths is a problem that h
yet been worked out. Since water is a bad conducto
heat thus distributed does not, as takes place with
to land, penetrate to still lower depths by conductio
only by different densities prevailing at the same
whether these different densities be due to di
temperatures or different degrees of salinity. Th
of the more important distinctions between lan
water surfaces in their bearings on climate is that
all the sun's heat falling on land is arrested on the s
whereas on water it is at once diffused downward
great depth. In examining temperatures of the sea
at different depths, it is surprising to note the r
with which changes of temperature are felt at consi
depths, especially in cases when the temperature of
rises rapidly, accompanied with strong sunshine.

In shallow water the sun's heat raises the tempe
much higher than that of deep water, this being
from the consideration that nearly the whole of th
heat which falls on the surface is utilized in raisi
temperature of the shallow layer of water; in
words, it is, so to speak, concentrated through a
depth of water instead of being diffused through
depth.

Surface Temperature of the Sea.—The importan
knowledge of this datum of meteorology will be
recognized when it is kept in view that three fou
the earth's surface is water, that the temperature
air resting on this surface is in close relation
temperature of the surface, and that the latter has, t
the intervention of the winds, direct and imp
bearings on the temperature of the air over large p
of the land surfaces of the globe. During the
1859-63 Captain Thomas, while engaged on the su
the islands on the north-west of Scotland, made o
tions of the temperature of the surface of the se
hour of the day at all seasons, and with su
frequency for the determination of the diurnal ra
the temperature of the surface. The daily mi
0°·17 below the mean, occurred near 6 A.M.; the ma
reached about 11 A.M., the maximum, 0°·13 abo
mean, between 3 and 4 P.M., and the mean again
before 2 A.M. Thus the daily oscillation of the temp
of the surface of the sea amounted on the north-
Scotland only to 0°·3. In lower latitudes the am
the daily fluctuation is somewhat larger, but everyw
is comparatively small, if care be taken to ma
observations properly, or at a distance from land,
the influence of the heated or cooled land is not
to vitiate the results.

During the voyage of the "Challenger" a co
system of meteorological observations, including th
perature of the surface of the sea, was made eve
hours as part of the scientific work of the cruise.
are now being discussed, and the writer of this ar
by permission of the Lords Commissioners of
Treasury, allowed to use such of the results as hav
already arrived at.

The diurnal march of the temperature of the su
the North Atlantic has been determined from obser
made on one hundred and twenty-six days from M
August 1873 and in April and May 1876, the
latitude of all the points of observation being nearly
and the longitude 12° W. The following variation
the mean show the phases of this diurnal oscillation

M. −0·24	10 A.M. 0·06	6 P.M.	0·26
„ −0·33	Noon 0·24	8 „	0·02
„ 0·29	2 P.M. 0·47	10 „	0·19
„ −0·12	4 „ 0·47	Midnight	0·35

mid Atlantic, about 30° N. lat., where the sun's strong, and at the time of the year when the sun is f the equator, the diurnal fluctuation of the temperat the surface is only 0°·80. It is highly probable where over the ocean does the mean daily fluctuation emperature of the surface quite amount to a degree. nall daily fluctuation is a prime factor in meteorology, larly in discussions relating to atmospheric pressure nds.

mperature of Air over the Open Sea. The following he daily march of the temperature of the air over rth Atlantic on a mean of the same one hundred enty-six days for which the temperature of the sea n given:—

M. −1·13	10 A.M. 0·75	6 P.M.	0·73
„ −1·40	Noon 1·15	8 „	0·30
„ 1·41	2 P.M. 1·80	10 „	0·80
„ 0·21		Midnight	1·02

mplitude of the daily fluctuation of the air is thus or nearly four times greater than that of the r which it lies. During the same months the enger" was lying near land on seventy-six days servations made on these days show a greater daily of temperature of the air than occurred out in the ea. The minimum, −2°·05, occurred at 1 A.M., and ximum, 2°·33, at noon, thus giving a daily range of The occurrence of the maximum so early as noon is ss occasioned by the greater strength of the sea after this hour, thus maintaining a lower tempera- Part of the increased range of the temperature of as compared with that of the sea was no doubt the higher temperature during the day and the uring the night on the deck of the "Challenger" as ed with that of the air. But, after making allow- r this disturbing influence, it is certain that the ature of the air has a considerably larger daily range nat of the sea on which it rests. The point is one mall interest in atmospheric physics from the im- bearings of the subject on the relations of the air aqueous vapour to solar and terrestrial radiation.

hourly deviations from the mean daily temperature ir at two places, one near the equator and the other north temperate zone, and both near the sea, viz., (6° 8′ S. lat., 106° 48′ E. long., mean temperature and Rothesay (55° 50′ N. lat., 5° 4′ W. long., mean ature 47°·3), are these

A.M. −3·2	1·7	1 P.M.	1·7	+2·4
„ −3·6	−2·0	2 „	1·6	2·7
„ −4·0	−2·1	3 „	+5·2	+2·8
„ −4·3	2·2	4 „	+4·3	+2·6
„ −4·7	2·2	5 „	+3·3	+2·1
„ 4·9	−2·0	6 „	+1·9	+1·5
„ −4·3	−1·5	7 „	−0·6	+0·9
„ −2·2	0·9	8 „	−0·4	+0·2
„ −0·5	−0·2	9 „	1·2	−0·4
„ +2·8	+0·5	10 „	−1·8	0·8
„ +4·4	+1·2	11 „	−2·3	−1·2
on +5·4	+1·9	Midnight	2·8	−1·5

nes of the four phases of the daily temperature at are—minimum about 5.50 A.M., mean 8.45 A.M., um 1.20 P.M., and mean 7.40 P.M.; while for ay the same times are 4.30 A.M., 9.15 A.M., 3 P.M., 20 P.M. At Batavia, where the days and nights are equal during the year, there is little variation in these times through the months; but at Rothesay, the days are much longer in summer than in winter is considerable variation in the times of occurrence o phases. The following table shows the times phases for a number of selected places in the n hemisphere for the two extreme months, Janua July:

	January			July		
	Min.	Mean	Max.	Mean	Mean	Max.
	A.M.		P.M.			
Sitka	6 0	9 40	1 30	6 50	3 10	7 40	0 50
Toronto	6 20	10 0	1 50		3 50	8 15	3 45
Philadelph	6 50	10 0	2 10	8 45	5 0	8 40	3 10
Havana							
Archangel	6 0	10 40	1 30	9 0	2 40	8 36	2 50
Rothesay	5 30	10 10	2 30	8 0	3 30	9 0	3 15
Oxford	7 20	10 10	2 0	7 0	3 10	8 45	3 10
Madrid	6 50	10 5	2 10	8 50	4 10	8 50	2 50
Geneva	6 0	10 0	2 0	8 0	3 45	8 15	2 50
St Bernard	1 30			6 45	3 0	8 10	1 20
Bogoslovsk	5 30		1 30	8 15	3 10	7 35	2 5
Petrodevsnidrovsk	6 50				1 30	8 20	2 10
Tiflis	7 10				5 0	9 5	3 10
Calcutta	6 30				5 30	8 45	0 40
Bombay	6 0				5 30	9 0	1 30
Madras	5 40				5 0	8 45	1 25

During the night in summer the temperature fall tinuously from the effects of terrestrial radiation earliest dawn, when the daily rise in the temperatu in owing to the heat reflected from the upper strata atmosphere, which have begun to be heated and up by the rays of the morning sun. It will be ob that the time of the daily minimum temperature earliest in high latitudes and latest in low lat During winter, on the other hand, the minimum te ture takes place in several regions some time before At this season the two chief causes on which cha temperature depend are the sun and the passage of c and anticyclones; and it is probable that those cases the minimum occurs markedly before the dawn are not occasioned by purely local disturbing causes, the mean diurnal times of occurrence of the char temperature which accompany the great atmospher turbances of cyclones and anticyclones.

In July the daily maximum temperature occurs ge from 2 to 4 P.M. At places, however, near the sea, are within the immediate influence of the sea bree in places at some distance from the sea, such as Ca where the wind, being essentially a sea wind, atta greatest daily velocity and the sky at the same much clouded, the maximum occurs nearly two earlier. In high situations, such as the St Bernard H the highest daily temperature also occurs nearly tw sooner than on the plains below. In the winter the maximum is about an hour earlier than summer.

In investigating the daily curves of temperatu David Brewster drew several interesting conclusio them. By dividing the daily curve of temperature, from the mean of the year, into four portions, at the representing the two daily means and the two ex he showed that the four portions approximate to pa in which the temperatures are the abscissæ and th the ordinates. The correspondence between the o and calculated results is so close that the differe not in any case exceed a quarter of a degree Fah This interesting result is true for places at wh horizon is open all round, so that no shadows o trees, or buildings fall on the places where the meters are kept during the day. If a hill rises

of the place, by which the sun's rays are never ted, it exercises little, if any, influence on the ations; but if one or more hills obstruct the rays un after it has risen above the horizon, such obstruc- ffects the temperature while, and for some time the position in which the thermometer is placed is from the sun.

wster further mad th important remark that the of observations made at any pair of hours of the ame, such as 8 A.M and 8 P.M., 9 A.M. and 9 P.M., es not differ much from the mean temperature of y. The pairs of hours which approximate closest to ie daily mean are 9 A.M. and 9 P.M., 10 A.M. and 10 A.M. and 3 P.M., and 4 A.M and 4 P.M. The mean hours at equal intervals from each other gives a still closer to the true mean temperature.

rganizing any system of meteorological observation, by which tended to develop the climatology of the country, the de- ation of the hours of observation is a question of the first nce. If only two observations be made daily the best hours M and 9 P.M., or 10 A.M. and 10 P.M., and if there be four tions the best hours are 3 and 9 A.M and 3 and 9 P.M., d 10 A.M and 4 and 10 P.M If there be three observa- e best hours are 9 A.M and 3 and 9 P.M., or 10 A.M nd 10 P.M., but in these cases it is essential that the tions of a minimum thermometer be added to the tempera- servations. These hours are further strongly recommended consideration that they are approximately coincident with tual places of atmospheric pressure, an exact knowledge h lies at the root of nearly all climatological inquiries. ree equidistant hours which have been adopted in several s, viz., 6 A.M. and 2 and 10 P.M., are only good as regards perature, not as regards atmospheric pressure. With re- two daily observations, the hours 8 A.M. and 1 P.M., which en adopted in some countries, are singularly unsuitable furnishing of the observational data required in the de- ent of the climatologies of these countries; and, what is re serious in a science where international co-operation is so tively demanded, these observations cannot be used with sfaction in such deeply important inquiries as the com- climatologies of Europe

times of occurrence of the highest, lowest, and daily temperatures and the amount of the daily of temperature, are a great degree influenced by ver t want of covering of the earth's surface on the air rests. When the ground is covered with tion, the wh of the solar heat falls on the ble covering; and, as none falls immediately on the s temperature does not rise so high as happens where s no vegetable covering to shade the surface from n. The temperature of plants exposed to the sun is high a that of exposed soil in the vicinity. As s forests, the four diurnal phases of temperature later than in the open country, and the maximum minimum are less decided; and, since the maximum nature of the air in forests falls short of the maximum open to a considerably greater extent than the um under the above the minimum in the open, ows that the mean temperature of the air in forests s than that the open country adjoining. The of the difference is that the chilling effects of rnal radiation penetrate lower down among the trees lo the heating effect of solar radiation; and as the not heated directly by the sun its temperature is and consequently that of the air over it is also A cleared space in a forest, sheltered by the sur- ng trees, but open to the sun, has a warmer and r atmosphere in spring and summer and very much r in autumn than prevails in the open country ng, and has also the diurnal differences of range ar to a warmer and moister atmosphere.

of the most important elements of climate is dis- by the difference between the hour of lowest and ur of highest mean temperature respectively, or, as it is usually expressed, by the daily range of tempe We have seen that as regards the sea in the north- Scotland the difference is only 0°·3 and in the A about 30° N. lat. 0°·8, and that probably the diurnal of temperature of the surface of the sea nowhere amo a degree. In the same part of the Atlantic the daily of the temperature of the air resting on the ocean and on the sea near land 4°·4. On advancing on th the daily range of temperature rapidly increases, a rate of increase is greatly augmented when an position is arrived at to which any sea breezes th prevail do not extend.

The true daily range of temperature is stated by vations made with maximum and minimum thermo Generally speaking, the amount of the range incre the latitude is diminished, and as the distance from is increased, but above all it increases in proportion dryness of the climate.

The differences of this vital element of climate are strikingl in the meteorology of India In the *Report* for 1880 the fo are the mean daily ranges of March of that year at a few at Goa 5°·4, Bombay 11°·2, Kurrachee 23°·5, Jacobabad 37 Pachbudra (lat 25° 55′ N., long. 72° 18′ E.) 41°·3. In case, undoubtedly one of the greatest mean daily ranges perature meteorology has yet recorded, the mean of the d 103°·4 and of the nights 62°·1. As March is altogether the season of the north-east monsoon, the general drift wind over western India, when these are situated, is f interior towards the sea, subject as regards Bombay and the influences of the land and the sea breeze. On the othe in June, when the south-west monsoon has fairly set following are the mean daily ranges of temperature at t places: at Goa 5°·6, Bombay 8°·2, Kurrachee 10°, Jacobaba and Pachbudra 24°·1. These show in a striking man powerful influence of the moister atmosphere spread over I the south-west monsoon, under which the daily range of t ture falls at Kurrachee from 23°·5 to 10°, and in the exc and climate of Pachbudra from 41°·3 to 24°·1 In th climates of the basin of the Indus, whilst the rainfall both i and in June is practically nil, yet the relative humidity atmosphere is widely different. Thus the humidities for Ma June respectively at 4 P.M., when the temperature is ne maximum for the day, are 48 and 77 for Kurrachee, 18 an Jacobabad, and 11 and 36 for Pachbudra. It is not so m amount of cloud that determines the degree of fierceness of t heat in these climates as the relative humidity, or the dr the air, as pointed out by Strachey in 1866. Thus at Ja less than half the amount of cloud appears in the sky i as compared with March, but the relative humidities and 18, and the daily range of temperature 27°·6 and 37 we except the dry arid wastes of Persia and Arabia, perhaps no other region of the globe where the daily temperature approaches that of the valley of the Indus. in the dry climates of such places as Sacramento (Ca in summer it amounts only to about 30°, at Madrid to 2 Jerusalem 24°. In central districts in the south of it is about 20°; farther north it falls to 15°; and in the in the north, whose climate is strictly insular in its ch the summer daily range is only 10°. In Arctic regio as Spitzbergen and Bootha Felix, the range in winte from 0°·0 to 1°·0; in May, when the sun has reappea continues to rise and set, it rises to 14°; but in July, w sun does not set, the range sinks to 10°.

But maximum and minimum thermometers n show the mean daily range of temperature, they a of great utility in giving observations for the determ of mean temperature. The mean temperature n accepted as the mean of the twenty-four hourly o tions of the day. If with such a system of obse daily readings of the maximum and minimum therm be compared, the value of the latter observati questions of mean temperature may be arrived at. series of observations of this description have bee at many places. The following shows a comparison mean of maximum and minimum daily temperatur means from observations made twenty-four times the former exceeding the latter means in nea cases:—

	Spring.	Summer.	Autumn.	Winter	Year
.....	- 0·3	0·2	- 0·2	0·2	0·2
a	1·0	0·7	0·7	0·9	0·8
....	0·6	0·6	0·6	0·7	0·6
insk...	0·1	0·3	0·6	1·0	0·5
l	0·5	0·5	0·7	0·8	0·6
nburg.	0·5	0·7	0·7	0·6	0·6
... .	0·5	0·5	0·5	0·1	0·5
rsburg.	0·6	0·6	0·3	0·1	0·4
a... ..	0·4	0·5	0·1	- 0·1	0·2
ich. ...	0·7	0·8	0·6	0·0	0·4
ay.. ...	0·4	0·3	0·3	0·3	0·3

e results show remarkable uniformity, and it may rred from them that mean temperatures deduced aximum and minimum observations are about half e above the true mean temperature. In general logical inquiries, observations with these thermo have the strong recommendation of supplying from tions taken once a day the data for the determina- the mean temperature and mean daily range of es; to which falls to be added the further advantage g results more uniformly comparable for different han could be afforded by observations made with a thermometer at any single hour or pair of hours

y Variation of the Humidity of the Air. The envelope surrounding the earth is composed of mospheres, quite distinct from each other,—an here of dry air and an atmosphere of aqueous The dry air, which consists of oxygen and n, is always a gas, and its quantity remains constant; aqueous vapour does not continue permanently in eous state, and the quantity present in the air is, ceaseless processes of evaporation and condensation, tly changing. If the aqueous vapour remained ently and unchanged in the atmosphere, or were le to be condensed into cloud or rain, the mixture become as complete as that of the oxygen and of the air. The equilibrium of the vapour atmo however, is being constantly disturbed by every of temperature, by every instance of condensation, the unceasing process of evaporation. Since dry ther materially obstructs the free diffusion of the s vapour, it follows that the law of the independent e of the vapour and of the dry air of the atmosphere good only approximately. The aqueous vapour, r, constantly tends to approach this state. Since, e independent and equal diffusion of the dry air aqueous vapour is, owing to these disturbing causes, reached, the important conclusion follows that the eter can never indicate more than the local humidity place where it is observed. Hygrometric observa- an therefore be regarded only as approximations to ndication of the quantity of aqueous vapour in the here over the place of observation. It is, however, lded that, while in certain cases the amount of vapour d is far from the truth, yet in averages, particularly erages, a close approximation to the real amount is if the hygrometer be at all tolerably well exposed efully observed.

eous vapour is constantly being added to the air he surfaces of water, snow, and ice, from moist s, and from plants. The rate of evaporation es with an increase of temperature, because the y of the air for vapour is thereby increased. The here can contain only a certain definite amount of according to the temperature; when therefore the its full complement of vapour, or when, in other it is saturated, evaporation ceases. Thus the rate oration is greatest when the air is driest or freest from vapour, and least when the air is nearest the po saturation. Since currents of air remove the moist substitute drier air over the evaporating surfaces, ev tion is much more rapid during wind than in calm we As air expands under a diminished pressure, its tempe consequently falls, and it continues to approach nea the point of saturation, or become moister; and, contracts under an increased pressure, its temperatur and it recedes from the point of saturation or be drier. Hence ascending currents of air become m with every addition to the ascent, and descending cu drier as they continue to descend. Thus as winds a the slopes of hills they become moister, but when have crossed the summit and flow down the othe they become drier in proportion to the descent, and changes may be experienced from extreme dryn saturation in the same mass of air, which all the tim practically had its amount of aqueous vapour neither to nor diminished.

In an atmosphere of air and aqueous vapour per mixed, the elastic force of each at the surface of the is the pressure of each In this case the elastic fo aqueous vapour would be the pressure of the whole v in the atmosphere over the place of observation. pressure is expressed in inches of mercury of the baro If we suppose the total barometric pressure to be 3 inches, and the elastic force of vapour to be 0·745 the pressure or weight of the dry air, or air proper, be 29·255 inches, and of the aqueous vapour 0·745 From this it follows that the elastic force of vapou be regarded as indicating the quantity of aqueous v in the air at the place of observation, or it may be nated the absolute humidity of the air.

The diurnal variation in the elastic force of vap the air is seen in its simplest form on the ope Grouping together all the hygrometric observations on board the "Challenger" on the North Atlantic distance from land, from March to July 1873 (eight days), we have for that time a mean elastic force of inch, and the following diurnal variation:—

	Inch		Inch.		In
2 A.M	015	10 A.M.	+ ·004	6 P.M.	+ ·0
4 ,,	020	Noon	+ ·017	8 ,,	+ ·0
6 ,,	- ·016	2 P.M.	+ ·020	10 ,,	- ·0
8 ,,	·007	4 ,,	- ·017	Midnight	+ ·0

Hence the minimum (- ·020 inch) occurs at the when the temperature of the surface of the sea a resting over it falls to the daily minimum; it the to the mean a little after 9 A.M., and to the daily max (+ ·020 inch) at 2 P.M., when the sea and air are als the daily maximum, and falls to the mean shortly 9 P.M.

Treating the observations made near land b "Challenger" during the same months, the follow the diurnal variation disclosed:—

	Inch		Inch.		In
2 A.M	003	10 A.M.	+ ·014	6 P.M.	·
4 ,,	- ·009	Noon	+ ·011	8 ,,	·
6 ,,	- ·010	2 P.M.	+ ·007	10 ,,	- ·
8 ,,	·003	4 ,,	+ ·015	Midnight	·

The disturbance induced by proximity to land distribution of the aqueous vapour in the lower st the atmosphere is very striking. The maximum minimum no longer follow the corresponding phases temperature of the surface of the sea and of the air. disturbing agents are the sea and land breezes and effects. Under the influence of the land breeze th of the minimum humidity is delayed till about 6 A.M under the influence of the sea breeze and its effe amount of the aqueous vapour shows a secondary min from noon to 2 P.M. It is to be here noted that this m

m occurs at the hours of the day when the surface and is most highly heated, the ascending current ed air rising from it therefore strongest, and the g breeze from the sea toward the land also strongest. does not admit of a doubt that the diminution in ount of the aqueous vapour noted on board the enger" near the shore point to an intermixture e air forming the sea breeze of descending thin ents or currents to supply the place of the masses emoved by the ascending currents which rise from ted surface of the land At Batavia, on the north f Java, and at Bombay, the aqueous vapour is also to a secondary minimum during the warmest hours day.

ing the summer months the secondary minimum is arked at inland places such as Peking, Nertchinsk, l, Tiflis, and Ekaterinburg, but the time of its nce is about two hours later than it is over the Atlantic Over all these places at this season the ng current from the heated land in the interior of very strong On the other hand the lowering of ount of aqueous vapour scarcely if at all appears as re in the summer climate of St Petersburg, and all in that of Sitka, where the sea breeze is equally on that feature of the climate of the district

excessively dry tumble and not climate of Allahabad, in e diurnal minimum of the aqueous vapour occurs from to 6 P.M., the time of absolute minimum being 2 and During all other hours of the day the amount of the above the mean a secondary minimum occurring from A.M. At Allahabad at this time, the absolute maximum apour pressure occurs at 8 A.M. Quite similar to this is nal distribution of the aqueous vapour in July at Lisbon nica, the minimum occurring from 10 A.M. to 8 P.M. At of the year the climate of this part of the peninsula is dry and the rainfall insignificant in amount As the nce between the high atmospheric pressure so characteristic of the meteorology of the Atlantic in summer and the tively low pressure over the continents southward and d, the winds are almost wholly north-westerly. In this on it is instructive to note that the time of maximum pressure is from 1 to 7 A.M., when the velocity of the wind the minimum, and the chief minimum vapour pressure ors to 1 P.M., when the velocity of the wind and ascending rent reach the daily maximum The results show that rmation in the vapour pressure during the hours when ature is logically, which characterizes the climates of large the globe, is due to descending air filaments or currents, ences only accompany the ascending currents that rise from ted land

neva during the summer months the vapour curve exhibits ly minima very strongly marked, the one shortly before and the other from 2 to 4 P.M., and two maxima, one to 11 A.M. and the other from 6 to 10 P.M., and with e diurnal variations of cloud are in accordance. The ly marked features of the vapour curve at Geneva are y due to the size of the lake, which is large enough to e to a decided breeze during the day from the lake all its horizon and during the night to a breeze from the land ed upon the lake On the setting in of the breeze, the air composing it having been for some time resting on e, is rather moist and thus one of the daily maxima is about from 8 to 11 A.M. As the breeze continues the air ng it is necessarily drawn from the higher strata of the here more copiously than in different situations; and, having quired more cool dryness in the descent and having blown e lake for too short a distance to materially influence its e, the air becomes constantly drier, till the minimum to 4 P.M. is reached. The lake breeze thereafter begins to h in force, and the air consequently becomes moister till the um vapour pressure of the day occurs when the lake breeze ay and the land breeze has not yet sprung up. In the months when these breezes do not prevail, the curve of vapour pressure shows only one zero maximum and minimum.

relative humidity of the atmosphere must not be nded with its vapour pressure or absolute humidity. lative humidity, or, as it is more frequently called, midity, of the air is the degree of its approach to ion. Complete saturation is represented by 100 and air absolutely free of vapour by 0, the latter st things never occurring in the atmosphere, a humid 10 being of rare occurrence even in such arid regi those of Arabia. The great significance of this elem climate is in its relations to the diathermancy of t and consequently to solar and terrestrial radiation. supposed that perfectly dry air would allow rays o to pass through it with at most only a very increase to its temperature therefrom. Let, howe little aqueous vapour be added to it, a partial obstr to the passage of radiant heat is offered, and the te ture of the mixture, or common air, is sensibly Hence, other things being equal, the less the amo vapour the more are the effects of radiation felt, greater the heat of the days and the cold of the The mere amount of vapour in the air does not det the degree of radiation, but it is the amount of together with a certain temperature in other word absolute and relative humidity of the air taken toge that determines the heating power of the sun a degree of cold produced by terrestrial radiation.

The diurnal variation of the relative humidity different from that of the vapour pressure, and p features of the simplest character. The following diurnal variations from the mean humidity 80 ov North Atlantic, from the "Challenger" observati 1873:—

2 A.M.	+2	10 A.M.	1	6 P.M.	−
4 ,,	+2	Noon	−2	8 ,,	
6 ,,	+1	2 P.M.	3	10 ,,	+
8 ,,	0	4 ,,	2	Midnight	+

Thus the maximum humidity occurs from midnig 4 A.M., or when the daily temperature is at the min and the minimum humidity at 2 P.M., when the te ture is at the maximum, the curve of humidity bein inverse to that of the temperature. With two modifications this is the diurnal humidity curve climates and seasons. In the calm which interve the morning between the land and the sea bree humidity continues high, or even increases, though time the diurnal increase of temperature has alre in. The other modification is seen in the humidity for Nertchinsk and Barnaul during winter, these being not inverse but coincident with the daily cu temperature. In the climates of Central Asia in the amount of vapour is very small, and the incre the relative humidity during the day is probably occa by the more active evaporation from the snow duri day and the stillness of the air favouring the accum of aqueous vapour near the surface of the earth.

Next to the winds, the aqueous vapour of the sphere, in the diverse ways in which in different lo it is distributed through the hours of the day, pla most important part in giving to the different parts globe its infinitely diversified climates.

Dew.—Dew is deposited over the earth's surf comparatively clear and calm nights. As the cool terrestrial radiation continues, the temperature of on the surface is gradually lowered to the dew-poi when this point is reached the aqueous vapour be be condensed into dew on their surfaces. The q deposited is in proportion to the degree of cold pr and the quantity of vapour in the air. Dew deposited in cloudy weather, because clouds obstru escape of heat by radiation, nor in windy w cause wind continually renews the air in contac the surface, thus preventing the temperature from sufficiently low. When the temperature is below 3 freezes as it is deposited, and *hoar-frost* is produced dew-point practically determines the minimum temp

night,—because if the temperature falls a little the dew-point the liberation of heat as the vapour lensed into dew speedily raises it, and if it rises the loss of heat by radiation speedily lowers it. onsideration suggests an important practical use of grometer, it being evident that by ascertaining the int the approach of frost or low temperature likely re vegetation may be foreseen and provided against.

rnal Oscillations of the Barometer.—The general er of the daily oscillations of atmospheric pressure wn by the two curves of fig. 2. The solid ives the mean oscillation for Bombay and the

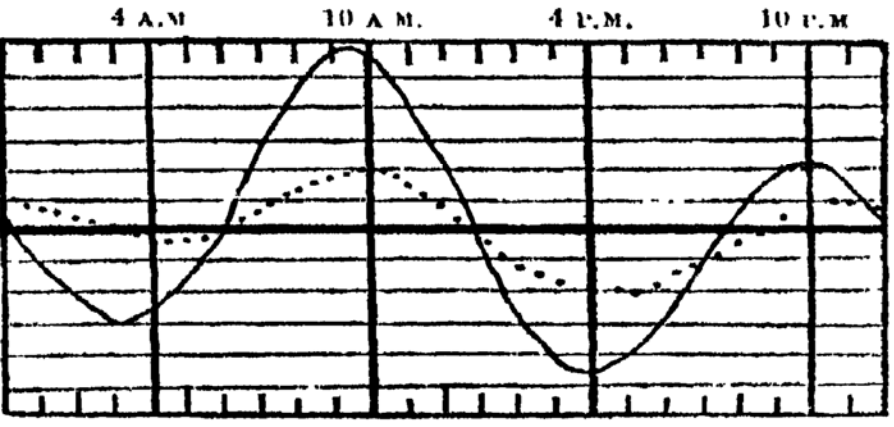


FIG. 2.—Daily Oscillations of Atmospheric Pressure.

line that for Vienna, these two curves being to extent typical of diurnal barometric oscillations in l and temperate regions as regards the two maxima nima and the time of their occurrence.

ries of twelve maps of the globe were prepared for showing, for all stations whence observations have btained, the deviations at noon, 2 P.M., 4 P.M., reenwich mean time, from the mean daily pressure: ar lines were drawn indicating the positions of the ily maxima and minima at these hours. For fully rth and south of the equator the lines of maxima nima run north and south, but in higher latitudes irections are changed, and the changes are chiefly uous as regards the A.M. maximum and the P.M m. Thus, for example, at 6 P.M. (G. M. T.) the P.M. minimum is for the latitude of London near long.; in 30° N. lat. it is in 35° W. long., in which runs south as far as 30° S. lat.; its course thence outh-westwards to near the Falkland Islands, 60° g. Hence in June the P.M. minimum occurs about hours earlier in the Falkland Islands than to the west of Ireland, thus showing in a striking manner uence of season on this phenomenon. In the middle igher latitudes in summer, proximity to the sea the time of occurrence of the A.M. maximum and M. minimum; whilst in continental situations the aximum occurs much earlier than in lower latitudes, e P.M. minimum nearly as late as at places near the In cases where the lines of maxima and minima region such as southern and western Europe, whose is diversified by large tracts of land and sheets of the deflexions are of a remarkable character.

retardation of the time of occurrence of the A.M. um is greatest in situations which, while eminently in character, are at the same time not far from an ve tract of land. Of this Holland presents the best le in Europe; and there the A.M. maximum, which s occurs at 8 A.M., does not occur at Utrecht till .M., at Amsterdam till 12.30 P.M., and at Helder till There is thus as regards the same diurnal phenoin June a difference of six hours between Paris and . Sicily and the south of Italy on the one hand adrid on the other present also the most striking sts. Again at Sitka (56° 50′ N. lat., 135° W. long.), has one of the most truly insular climates in the the A.M. maximum is delayed to 2.30 P.M.; whereas at Astoria, ten degrees to southward, it occurs a A.M., and at Fort Churchill, in Nevada, as ea 7 A.M. There is thus as regards the same phen a difference of 7h 30m between Sitka and Fort Chu

From hourly observations made in this month base, the top, and two intermediate points on Washington (N. H.) it was found that the time of rence of the A.M. maximum at the base of the mo which is 2898 feet above the sea, was 8 A.M.; a feet, 10 A.M.; at 5533 feet, 11 A.M; and at th 6285 feet, noon. Hence, as regards the time of rence, the influence of an isolated mountain like Washington brings about a result similar to w observed in insular situations. But the analogy i closer. In insular climates the minimum in the morning is very greatly in excess of that in the afte and the same relation is observed on the top of Washington, where the former is - 0·020 inch a latter - 0·004 inch. Again in continental climat minimum in the early morning is much the smaller two, and the same relation was observed at the base mountain, where the observed minima were respe 0·006 inch and 0·020 inch. The differences presen the daily curve of pressure at the top as compared that at the base of the mountain have their explana the effects which follow the diurnal range of tempe As the temperature is at the minimum at the time pressure in the morning, the atmosphere is more com in the stratum between the base and the top, and quently the barometer at the top reads relatively As the temperature continues to rise during the d stratum of air above the base of the mountain ex thus placing more air above the barometer at the that, while at the base pressure begins to fall at at the top it continues to rise till noon, simply fr mechanical upheaval of the air owing to the higher te ture. In the afternoon, when the minimum at th falls to - 0·020 inch, it is only 0·004 inch at the to relatively higher pressure at the top being due to exp from temperature. The peculiar feature of the p curve at the top is essentially a temperature effect

The diurnal oscillations of the barometer occu over the open sea and over the land surfaces globe. The atmosphere over the open sea, a shown, rests on a floor or surface subject to a range of temperature so small as to render that temp practically a constant both day and night. This con tion leads to the vital and all important conclusion t diurnal oscillations of the barometer are not caused heating and cooling of the earth's surface by sol terrestrial radiation and by the effects which follo diurnal changes in the temperature of the surface, b they are primarily caused by the direct and ind heating by solar radiation, and cooling by nocturna tion to the cold regions of space, of the molecules air, and of its aqueous vapour. These changes perature are instantly communicated through th atmosphere from its lowermost stratum resting earth's surface to the extreme limit of the atm which the light of meteors proves to be not less th miles. There are important modifications affecti amplitude and times of occurrence of the four pr phases of the phenomena observed over land surfa temperature of which is being superheated during and cooled during the night; but it is particularl noted that the barometric oscillations themselves a pendent of any changes of temperature of the which the atmosphere rests.

Let us first look at the phenomena in the simple as found in the Pacific, or in the midst of the larges

of the globe. The following are the mean varia- pressure from observations made on board the enger," September 1 to 12, 1875, in mean latitude . and long. 150° 10′ W., the mean being 29·928

	Inch.		Inch.		Inch.
M.	0·012	10 A.M.	0·032	6 P.M.	0·028
,,	0·022	Noon	0·006	8 ,,	0·004
,,	0·003	2 P.M.	0·013	10 ,,	0·013
,,	0·028	4 ,,	0·035	Midnight	0·012

ost striking feature in the e oscillations is the ude of the range from the A.M. maximum to the minimum, amounting to 0·087 inch, and the rapidity fall from 10 A.M. to 2 P.M. The same feature in all means deduced from observations made at 2° on each side of the equator.

n October 12 to 22, 1875, in mean lat. 35° 1′ S., long. 5′ W., the mean atmospheric pressure was 30·298 and the difference between the A.M. maximum and minimum was only 0·036 inch; and from July 12 1875, in mean lat. 36° 16′ N. and long. 156° , the mean pressure was 30·328 inches, and the e between the A.M. maximum and P.M. minimum 0·025 inch. Thus, with a mean pressure in the about lat. 35° 36° N. and S. much greater than equator, the oscillation is much less, being in the Pacific less than a third of what occurs near the . Similarly, this oscillation is small (or even smaller) ich pressure areas in the North and South Atlantic ared with the same oscillation near the equator.

well known that aqueous vapour absorbs the heat the air considerably more than does the dry air of sphere, how much more physicists have not yet ly determined. Consequently air heavily charged queous vapour will be heated directly by the sun's they pass through it in a greater degree than atively dry air is. Now it is shown further on that evailing surface winds outflow in every direction areas of high mean pressure in the Atlantic and about lat. 36° N. and S. Since, notwithstanding, same continues high, it necessarily follows that the ssure is maintained by an inflow of upper currents, the low descending movement of the air connects owing upper currents with the outflowing prevailing of the surface, it follows that the air over high- areas is very dry, and that it is driest where is highest and the high-pressure area best defined. over the best defined anticyclonic regions the air will ed in temperature through all its height by ay of the sun.

the other hand, between these high-pressure areas of t one there is a belt of comparatively low pressure which the north and south trades pour their ncessingly. The atmosphere of this belt of low than highly saturated with aqueous vapour rises in a vast ascending stream of moist air to the regions of the atmosphere. These equatorial regions e out to the sun a highly saturated atmosphere g to a very great height. It is in these regions re that the atmosphere will be most highly heated sun's heat rays as they pass through it. One of st striking facts of meteorology is the suddenness hich this barometric oscillation increases in amplitude ering on these parts of intertropical regions; and pidity with which it amplitude diminishes on ng on the high-pressure regions of the horse s is equally striking. The following are the mean ons in the middle regions of the four great oceans t. 36° from the A.M. maximum to the P.M. minimum he time of the year in each case when the sun est in the heavens.—South Pacific, 0·036 inch; North Pacific, 0·025 inch; South Atlantic, 0·02 and North Atlantic, 0·014 inch. These amp diminish as the ocean becomes more land-locke continents, or as the anticyclonic region becomes defined and currents of air are poured down more from the higher regions of the atmosphere.

If the temperature of the whole of the earth's atm were raised, atmospheric pressure would be dimi for the simple reason that the mass of the atm would thereby be removed to a greater distance fr earth's centre of gravity. Quite different results, h would follow if the temperature of only a section earth's atmosphere were simultaneously raised, such section comprised between long. 20° and 60° W immediate effect would be an increase of bar pressure, owing to expansion from the higher tempe and a subsequent effect would be the setting in ascending current more or less powerful, according differences between the temperature of the heated and that of the air on each side. These are esse the conditions under which the morning maxim afternoon minimum of atmospheric pressure take pl

The earth makes a complete revolution round in twenty-four hours, and in the same brief inter double crested and double troughed atmospheric tide makes a complete circuit of the globe. The w the diurnal phenomenon of the atmospheric tides i fore rapidly propagated over the surface of the eart east to west, the movement being most rapid in equ regions, and there the amplitude of the oscillat greater than in higher latitudes under similar atmos astronomical, and geographical conditions. Owing rapidity of the diurnal heating of the atmosphere sun through its whole height, some time elapses bef higher expansive force called into play by the incr temperature can counteract the vertical and latera ance it meets from the inertia and viscosity of t Till this resistance is overcome, the barometer co to rise, not because the mass of atmosphere over increased, but because a higher temperature has in the tension or pressure. When the resistance ha overcome, an ascending current of the warm air sets tension begins to be reduced, and the barometer fa continues to fall till the afternoon minimum is r Thus the forenoon maximum and afternoon minim simply a temperature effect, the amplitude of the osc being determined by latitude, the quantity of a vapour overhead, and the sun's place in the sky.

All observations show that over the ocean, latitu latitude, the amplitude of the oscillations is greate atmosphere highly charged with aqueous vapour a in a dry atmosphere. It is also to be noted that elevated situations, particularly in tropical region amplitude is greater proportionally to the whole p than at lower levels. This is what is to be expecte the law of radiant heat by which more of the heat the sun is absorbed by the air, and particularly aqueous vapour, mass for mass, in the higher than lower strata.

When the daily maximum temperature is past, a temperature has begun to fall, the air become condensed in the lower strata, and pressure conse at great heights is lowered. Owing to this lower p in the upper regions of the air, the ascending which rises from the longitudes where at the ti afternoon pressure is low flows back to eastwar increasing the pressure over those longitudes wh temperature is now falling. This atmospheric qua movement occasions the P.M. increase of pressure, reaches the maximum from 9 P.M. to midnight, ac

ude and geographical position. This maximum is
caused by accessions to the mass of the atmosphere
d, contributed by the ascending currents from the
les of the afternoon low pressure immediately to
rd.

idnight and the early hours of morning advance,
ontributions become less and less and at length
ltogether, and pressure continues steadily to fall.
tween the time when the increase of pressure from
rflow through the upper regions of the atmosphere
nd the time when pressure increases from the heat
rect or indirect, of the returning sun, or during the
of the night when the effects of nocturnal radia
e the maximum, pressure is still further reduced
nother cause. Radiation towards the cold regions
e takes place, not only from the surface of the
ut also directly from the molecules of the air and
eous vapour. The effect of this simultaneous cool
he atmosphere through its whole height is neces
diminution of its tension. Since this takes place
re rapid rate than can be compensated for by any
ical or tidal movement of the atmosphere from the
adjoining, owing to the inertia and viscosity of the
ssure continues to fall to the morning minimum.
inimum is thus due, not to the removal of any of
s of air overhead, as happens in the case of the
on maximum, but to a reduction of the tension or
e of the air consequent upon a reduction in the
ature through radiation from the aerial molecules
s the cold regions of space. In the open ocean the
g minimum is largest in the equatorial regions, and
nishes with latitude; but the rate of diminution
titude through anticyclonic and other regions is
ly less and more uniform than in the case of the
n minimum.

mplitude and times of occurrence of the phases of
rual barometric tides are subject to great modifica
ver the land. The amplitude of the oscillation
e morning maximum to the afternoon minimum is
where the atmosphere is driest and the sky
, and least where the atmosphere is highly saturated
e sky more frequently and densely covered with
being thus generally the reverse of what is observed
place over the open sea. The meteorology of India
the most striking illustrations of this remark. At
in April during the dry atmosphere and clear
f the north-east monsoon, the oscillation is 0·118
ut in July during the humid atmosphere and
skies of the south-west monsoon it falls to 0·067
In the Punjab, where the air is drier, it is much
rising in exceptional years, such as 1852, to 0·187
The much greater amplitude of this oscillation on
compared with the open sea is entirely due to the
of the earth. By this heating of the surface the
trata of the air become also highly heated and the
is increased; and, since the air does not expand
ertically and laterally, from its inertia and viscosity,
rometer rises. When, however, the resistance is
ne, the ascending current which sets in is stronger
to its higher temperature. Since this higher
ature which has its origin in the superheated
is in addition to the direct heating of the air by
at rays of the sun as they pass through it, the
g maximum and the afternoon minimum over land
h more extreme than over the open sea. It follows
is oscillation is much larger over land, and largest
ates where insolation is strongest.

aces already referred to where the morning maxi
greatly retarded, such as Helder, Sitka, Valentia,
almouth, the afternoon minimum in the summer
months is singularly small, so small indeed that it
not fall so low as the mean pressure of the day.
peculiarity in the diurnal barometric tide is in all p
ability due to their insular position to the westward
a more or less extensive tract of land, by which a t
overflow is propagated through the upper regions from
continental towards the insular situations. This t
overflow receives its impulse from the ascending cur
from the land, which rises sooner and stronger from inl
than from insular situations. On the other hand, on
open sea, and away from land in regions where the m
ing maximum and afternoon minimum are both small,
minimum always falls below the mean of the day, and
time of occurrence of the maximum is not retarded
the case in insular situations. A map of deviations f
the daily mean pressure of the morning minimum
summer shows, as regards the middle and higher latitu
that it is greatest near the sea, and least in inland
tinental situations. Indeed in the interior of the Old W
continent the dip in the curve in the early morning i
small that the minimum does not fall below the daily m
pressure, but at most places remains considerably above
The same relations are seen in north-western Europe, wh
the morning minimum is 0·020 inch at Valentia
Falmouth, −0·018 inch at Helder, and 0·012 inch
Amsterdam, whilst at Kew it is only 0·002 inch. Fr
its compact form and relations to the surrounding oce
the Spanish Peninsula well illustrates the peculiarities
this phase of the pressure. The deviations from the d
mean pressure of the morning minimum are at Lis
0·022 inch and Coimbra −0·011 inch, but at Mad
in the interior +0·009 inch, pressure in the last case,
as happens in the interior of Asia, not falling so low as
daily mean.

The larger minimum near the sea arises from the hig
temperature there during the night as compared w
more inland situations, from which results a tidal overf
through the upper regions from the sea towards the la
as the temperature of the latter falls lower than the
during the night. The effect of this overflow is to red
the pressure over those regions whence it proceeds and
increase it in those regions over which it advances.
shallowing of the morning minimum is greatest in
higher latitudes of continental climates and most compl
at great elevations, where in some cases the minim
vanishes, in other words, where the amount of aque
vapour is small and the time is short during which no p
of the atmosphere overhead is touched by the sun's ra
Since the peculiarity is observable in the curves over nea
the whole continent, appearing even in the low latitu
of Calcutta and Madras, it might be suggested whether
have not evidence here of a vast tidal movement propaga
through the higher regions towards that trough-like sec
of the atmosphere as it moves westwards over the contin
where the temperature of the lower strata of the ai
about the minimum of the day and pressure also ab
the minimum.

Reference has been made under ATMOSPHERE to
smallness of the range from the A.M. maximum to the
minimum in the North Atlantic during summer.
phase in the diurnal distribution of pressure is represen
in fig. 3, which shows for June the mean amount
the oscillation by lines of 10, 20, 40, 60, 80, and
thousandths of an inch, or 0·010 inch, 0·020 inch,
This abnormality begins in March, attains the maxim
in June, and terminates in October. It is thus confi
to the warmer months of the year, and, unlike m
meteorological phenomena, is not cumulative, but foll
the sun, so that its maximum occurs in June, and no
July as that of the temperature of the air, or in Augus

perature of the sea. The smallness of this range e North Atlantic, which is less than occurs in any ocean in the same latitudes, is to a large extent by the small dip in the diurnal curve of the after- inimum.

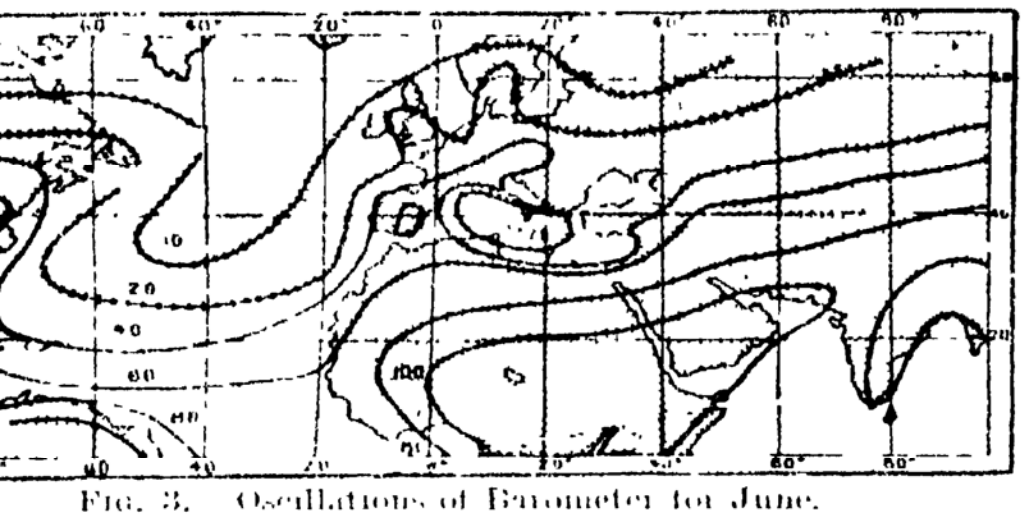


FIG. 3. Oscillations of Barometer for June.

e map of the distribution of pressure over the globe y be examined (fig. 17) it is seen that this part of ntre is occupied by a well defined area of high ressure, higher indeed than occurs at any season y ocean; and it is shown below that out of this e surface winds blow in all directions. But, since constantly being drained out of this region by d without diminishing the pressure, it follows of y that the high pressure must be maintained by ns of air received from above through the upper s. Now the regions whence such accessions can e the upper currents which have their origin in the ng currents that rise from the heated plains of Africa, the belt of calms, and the two Americas sur- g the North Atlantic. It is evident that the major of each day's overflow of air from the continents the upper regions of the air upon the Atlantic. r this overflow takes place by convection currents or tidal movement similar to what has been already d, will take place during mid afternoon. In other the overflow will occur about the time of the after- inimum of the Atlantic, thus diminishing the dip of nimum, and so producing the abnormally small range der examination. It is in favour of this view that ormality follows the sun's course and is not cumula- d is felt also on both sides of the Atlantic, even h the weather on the east side is dry and all but , and on the west moderately moist and characterized ther copious rainfall. It is also full of significance e peculiarity is most strikingly seen in that part ocean of the globe which is closely hemmed in by sses of land.

nce of the Moon on Atmospheric Pressure. Fifteen nonthly observations have been made at Batavia and ed by the late Dr Bergsma in their relation to the ay, which was assumed in the calculations to com with the time of the upper transit of the moon. The f the inquiry is that atmospheric pressure at Batavia nar tide quite a distinctly marked as the ordinary barometric tide, except that its amplitude is much The four phases are these:—

1st max.	0·0062 inch	at lunar hour	1
1st min.	−0·0021	,, ,,	7
2d max.	+0·0025	,, ,,	13
2d min.	−0·0024	,, ,,	19

nar tide has the important difference that its phases the moon's apparent course much more closely than inary diurnal fluctuations of the barometer follow the sun. The two maxima occur about the 1st and nd the two minima about the 7th and 19th, whereas our daily phases of the diurnal barometric fluctua- ur with respect to the sun's apparent course from one to six hours later. It is interesting to note that higher latitudes in inland situations during winter times and in situations where the disturbing influe temperature and humidity tend towards a minimu times of occurrence of the four phases of the daily tion of the barometer approximate to those of the lunar atmospheric tide.

Since a distinct lunar tide is traced to the att influence of the moon, it follows that the att influence of the sun will enter as one of the several which determine the phases and amplitude of the barometric curve. It also follows from the muc attractive influence of the sun than that of the m the earth's atmosphere that the effects of the sun's tion on the pressure will be wholly concealed by the larger effects of the other forces concerned in deter the diurnal oscillation, except in the case or cases the variation in the fluctuation is small at 1 and and 1 and 7 P.M. Now at places north of lat. 45° variation at 1 A.M. is small during the winter, and singular fact that some years ago Rykatchew Petersburg drew the attention of meteorologists existence at these northern stations of a faintly third maximum; and it is further of importance to that, at many places where on the mean of years th maximum is scarcely or not at all marked, it app the mean of some of the separate years. Thus, the does not appear in the mean of the twenty years 1873 at Greenwich for January, it appears in nine individual years. It is highly probable that this mum, which may be named Rykatchew's maximu its discoverer, is due to the attractive influence of t its amplitude and time of occurrence being in acc with such a supposition.

Diurnal Variation of the Force of the Wind.— the three and a half years' cruise of the "Chall ending with May 1876, observations of the for direction of the wind were made on 1202 days, a

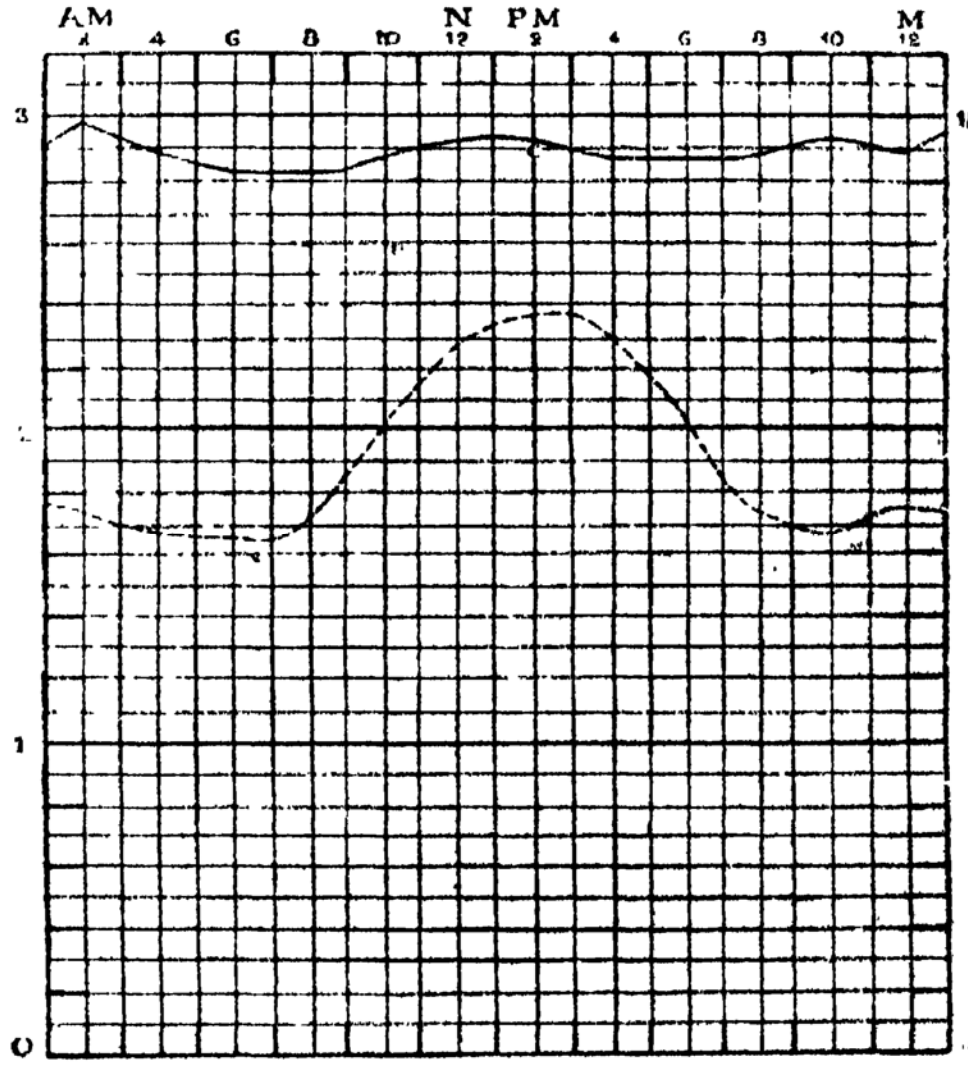


FIG. 4.—Diurnal Force of Wind at Sea and near Lan

twelve times each day,—650 of the days being on t sea and 552 near land. The observations of for made on Beaufort's scale 0–12, being the scale o force observed at sea. The mean diurnal force wind on the open sea and near land respectively is

, where the figures on the left are Beaufort's scale, se on the right the equivalents in miles per hour. olid line shows at the different hours of the day an force on the open sea, and the dotted line the orce near land.

egards the open sea it is seen that the diurnal on is exceedingly small, there being two apparent maxima, about midday and midnight respectively. mining, however, the separate means for the North outh Atlantic, North and South Pacific, and the rn Ocean, there is no uniform agreement observable their curves, the slight variations which are met eing different in each case. It follows therefore e force of the winds on the open sea is subject to inct and uniform diurnal variation. The difference n the hour of least and greatest mean force is less mile per hour.

e different is it, however, with the winds encountered "Challenger" near land, the force of the wind giving a curve as pronouncedly marked as the y diurnal curve of temperature. The minimum a at 2 to 4 A.M. and the maximum from noon to 4 he absolute highest being at 2 P.M. The curves cted for each of the five oceans from the observa ear land give one and the same result, or a curve accordant with the curve of diurnal temperature. fferences between the hours of least and greatest re as follows:—Southern Ocean 6½ miles, South 4½ miles, South Atlantic 3¼ miles, and North c and North Pacific 3 miles per hour

he case of each ocean the velocity of the wind on en sea is considerably in excess of that near land, no case does the maximum velocity near land, ch about midday, reach the velocity of the wind on n sea. The 650 daily observations on the open sea mean hourly velocity of 17½ miles, whereas the 552 nd give a velocity of only 12½ miles per hour. The nce is greatest at 4 A.M., when it amounts to upwards iles an hour, but is diminished by the rising tem re till at 2 P.M. it is less than 3 miles an hour.

auritius, which is situated within the south-east trades, the n velocity of the wind is 9·7 miles per hour, occurring from .M., from which it rises to the maximum 18·5 miles from M., the influence of the sun being thus to double the wind's . At Batavia, situated in a region where the mean baro- gradient is much smaller, the differences are still more de- From 1 to 6 A.M. 85 per cent. of the whole of the obser are calms, whereas from noon to 2 P.M. only 1 per cent. ns. In all months, the minimum velocity occurs in the orning, when the temperature is lowest, and the maximum to 3 P.M., when the temperature is highest, the mean m and maximum velocities being to each other as 1 to 21. mbra the mean maximum hourly velocity is five times than the minimum hourly velocity in summer, whereas in it is only about a half more. At Valentia, in the south- Ireland, one of the windiest situations in western Europe, e summer months of 1878 gave a mean hourly velocity of les per hour, the minimum oscillating from 10 to 11 miles from 9 P.M. to 6 A.M., and the maximum exceeding 16 hour from 11 A.M. to 5 P.M. The absolute lowest hourly as 10 miles at 11 P.M., and the highest 18 miles at 1 P.M., ocity about midday being thus nearly double that of the Many observations might be added to these, including ublished by Hann, Koppen, Hand , and others, which go lish the fact that the curves of the diurnal variation of the of the wind generally conform to the diurnal curves of ture. The curves are most strongly marked during the months; and the maximum velocity occurs at 1 P.M. or thereafter, being thus before the time of occurrence of the m temperature of the day, and the minimum in the early g, or about the time when the temperature falls to the The rule also holds good with all winds, whatever be their n. The exceptions to this rule are so few and of such at they are probably to attributed to causes more or local character.

has shown, for a number of places in northern Europe, that clear sky the velocity is doubled from the minimum the maximum, with a sky half covered the velocity is three greater, and with a sky wholly covered the velocity is only more. On the other hand at the strictly inland situation of with a clear sky the velocity is double, and with a sky half it is two-thirds greater, but with a covered sky the diurnal tion in the wind's velocity becomes irregular and faintly Hann has also examined the winds at Vienna, and found that of a velocity not exceeding 30 kilometres an hour show diurnal increase from 11 kilometres at 6 A.M. to 16·8 at 1 that winds of velocity exceeding 30 kilometres an hour exhibit a faintly marked and irregular increase of velocity during the

In offering an explanation of this remarkable fact ing the diurnal variation in the velocity of the wind climates, it is to be remarked that the minimum occurs when terrestrial radiation and its effects are g but the increase of the velocity closely follows the and the maximum is reached nearer the time t crosses the meridian than perhaps any of the other t or minima of meteorology which are dependent sun's diurnal course. It is also to be noted that the over the open are practically uninfluenced by and terrestrial radiation, for there the diurnal cu variation in the force of the wind is all but a straight On nearing land, however, the wind's force exhi diurnal curve of variation as distinctly marked a bearing a close resemblance to the analogous cu temperature; while on the land itself these f become still more decidedly pronounced. Last amount of the diurnal variation of the temperature surface of the sea is less than a degree, whereas o land surfaces the diurnal variation of the tempera large, even where the ground is covered by vegetatio enormously large over sandy wastes.

From this it follows that, so far as concerns any influence on the air itself, solar and terrestrial ra exercise no influence on the diurnal increase of the v of the air with the increase of its temperature, or, influence at all, such influence must be altogether unificant, as is conclusively shown by the wind obser of the "Challenger" over each of the five great oc the globe. The same observations show that on land the wind is everywhere greatly reduced in The retardation is greatest during the hours when th temperature is at the minimum; and it is particu be noted that, though the temperature rises consid no marked increase in the velocity sets in till about when the temperature has begun to rise above the mean. From this time the increase is rapid (see the maximum is reached shortly after the period of st insolation; and the velocity falls a little (but only a during the next three to five hours, according to latitude, and position, and falls again to near the mi shortly after the hour when the temperature is mean. Even at the maximum, the velocity nea falls considerably short of the velocity which is maintained over the open sea by night as well as by

The period of the day when the wind's velocity creased is practically limited to the hours when the te ture is above the daily mean, and the influence higher temperature is to counteract to some extent tardation of the wind's velocity resulting from friction from the viscosity of the air. The increase in the velocity of the wind is in all probability due to the heating of the surface of the ground and to the con ascensional movement of the air, tending to counte effect of friction and of viscosity between the low stratum of the air and the ground. It is of imp in this connexion to keep in view the fact that in weather a temperature much higher than might ha supposed is often radiated from the clouds down u earth's surface,[1] which accounts for the phenomenon

[1] *Journal of Scottish Meteorological Society*, vol. ii. p. 2

variation in the wind's velocity occurring frequently
cloudy weather. On the other hand, during the
when terrestrial radiation is proceeding, the tempera-
the surface falls greatly, and instead of an
onal movement in the lower stratum of the air there
er a tendency towards a descen-tional movement (if
nd be light there is an actual movement) of the
air stratum down the slopes of the country; and
he friction between the wind and the surface of
th is thereby increased the diurnal velocity of the
falls to the minimum during these hours (see also
).

ong the most marked exceptions to the general rule
diurnal distribution of wind force may be cited the
y cold furious blast of wind encountered in narrow
in such mountainous regions as the Alps during
nd comparatively calm nights. These are simply
rush of the cold air poured into the upper basins
valleys by the descensional currents from the slopes
the chilling effects of terrestrial radiation set in

On the other hand, the air of the valleys becomes
and expands during the day, thus giving rise to a
wind blowing up the valleys, which, on account of
som it carries with it from the lower level, fre
covers the higher slopes and tops of the mountains
oud and drizzling rain

nal Variation in the Direction of the Wind. In all
near seas and other large sheets of water, where
ribution of atmospheric pressure is tolerably equable,
barometric gradient small, and the sun heat
tely strong, land and sea breezes are of daily
nce. In such places a breeze from the sea gradually
in the morning, which gradually rises to a stiff
during the heat of the day and again toward-
sinks to a calm. Soon after this a breeze sets in
land, blows strongly seaward during the night,
s away in the morning, giving place to the sea
as before. These breezes are occasioned by the
of the land being heated in a much higher degree
at of the sea during the day; the air over the land
thereby made lighter ascends, and its place is
d by the cooler air of the sea breeze drawn land
nd partly also by descending currents, as shown
humidity observations of the "Challenger," which
e increasing dryness when the sea breeze is strongest.
during the night the temperature of the land and
air over it falls below that of the sea, and the air of
d thus becoming heavier and denser flows over the
a land breeze. As the best marked and most fre
occurring cases of the sea breeze begin some
out at sea and gradually approach the land, it is
robable that, as suggested by Blanford, the ascend
ated air flows seaward as an upper current, and that
creased barometric gradient thus caused largely
ts for the e breezes.

nd land breezes are thus determined by the relative posi-
the land and its coasts subject to a further modification
from the rotation of the earth. Thus on the coast of the
f Lyons the sea breeze from the south veers to south-west
s away as a west wind, while the land breeze from the north
ly veers to north-east and dies away as an east wind. On
st of Algeria, on the other hand, the sea breeze veers from
o north-east and dies away in the east, whereas the south
reeze veers to south-west and dies away in the west. Sea
also occur in such unsettled climates as that of Scotland,
e weather conditions are favourable. These conditions are
d when an anticyclone overspreads the country, with its
nying fine settled weather, small variation in the distri-
of atmospheric pressure, clear skies, and consequently strong
. Under these conditions the following are the veerings of
d off the coast of Berwickshire. In the morning the wind is
st till about 10 A.M., when it veers to north, falling all the
finally it sinks to a calm. A little before noon it springs up
from north-east or east, veers to south-east from 2 to 3 P.M.
it continues till 7 P.M., about which time it veers to south-wa
south-west, diminishing in force and finally sinking to a calm.
sunset it springs up from west, veering to north-west dur
night, where it continues till the following morning. The wi
virtually makes the round of the compass, is strongest from
west and south-east and weakest at north-east and south-wes
thus strongest when its course is perpendicular to the line o

The observations made by the "Challenger" in the regio
north-east trade in 1873 show a small diurnal variation
direction of the wind, the variation being from E. 47° S.
to 6 A.M. to E. 56° N. at 10 A.M. to 2 P.M., the variatio
thus 8° 55' towards north during the hottest hours of the d
Mauritius observatory, which is several miles from the
daily period in the direction of the wind is from E. 22°
at 4 A.M., being the most southerly point, to E. 7° S. at
and thence back to E. 22° 15' S. at 4 A.M. The diurna
tion is 15° 15', and thus the influence of the sun impresse
wind at this observatory a more truly easterly character.

At the Austrian naval station at Pola, near the head
Adriatic, the daily variation in the direction of the wind
marked. Starting from a point east of south at 5 A.M., it g
veers round to westward, the most westerly point, almost d
being reached at 5 to 6 P.M., after which it gradually shifts
its starting point in the morning. Here we have evidently a
wind system different from that of the land and the sea
Pola is situated near the south-western extremity of the pe
of Istria, and the direction in the early morning of east by
the direction the wind would take if a small anticyclone ov
the peninsula, and the direction from the west in mid af
is the direction the wind would have at Pola if the peninsu
occupied by a small cyclone with the lowest pressure in the
Now the influence of solar radiation is to form, throu
ascending current from the heated land, a diminution of
over the land, in other words, what is essentially a cyclo
the other hand, during the night the influence of terrestri
tion is to generate, through the cooling of the land and
resting above it, a relatively higher atmospheric pressure
interior of the peninsula with its characteristic system
blowing winds.

At Coimbra, in July 1878, the diurnal variation of the win
tion was from W. 49° 37' N. at 2 to 6 A.M. to W. 35°
at 4 to 6 P.M., the amount of the variation being thus 16° 2
direction of west. At Valentia, in the south-west of Ireland
the summer months of 1878 the diurnal variation of the
direction was from W. by S. at 7 to 9 A.M. to S.
W. at 5 to 7 P.M. The variation was thus from a poin
south to a point nearly south-west, or through nea
in the direction of west. On the other hand, at A
during the same months of 1878, the diurnal variation
wind's direction was from S.W. at 6 to 7 A.M. to S. by E
to 4 P.M. the variation being thus 56° from south-west
direction of east through south. "Attention is here draw
exactly opposite ways in which the diurnal veering or shi
the wind takes places at Valentia and Aberdeen, but partic
the important circumstance that in each case the diurnal
in the wind's direction which actually occur are precisely th
would take place on the supposition that during the hotte
of the day an ascensional movement of the air sets in f
heated lands of the British Islands, and that an in-draug
place all round, which with the descending currents mak
the loss caused by the up-draught. Thus then both the
increase in the wind's velocity and the change in its
which observation shows to take place during the hottest
the day are traced to the same cause, viz., the heating
surface by the sun, the heating of the lowest stratum of ai
on the surface, and the ascensional movements which are th
sary result.

It is instructive to note that at Nukuss, at some distanc
south of the Sea of Aral, where the summer direction of the
northerly, the north component is at the daily maximum a
having shifted into this direction from north-east, where
9 A.M. Much or nearly everything remains to be done in
out this problem in its practical details as one of the in
elements of climatology, with the view of arriving at some
knowledge of the influence of physical configuration and
vegetable coverings of the surface on radiation and on the
and direction of the wind.

Diurnal Variation in the Amount of Cloud. Mi
fogs are visible vapours floating in the air near the
of the earth, and clouds are visible vapours at a co
able height. These forms of visible vapour are all pr
by whatever lowers the temperature of the air bel
dew point,—such as radiation from the molecules
atmosphere towards the cold regions of space, the

on of the air of ascending currents, the mixing of with air that is warm and moist, and the cooling air in contact with the surface of the earth when its ature has been lowered by nocturnal radiation.

forms of clouds are endless. Since clouds are to certain distinct modifications from the same which produce other atmospheric phenomena, the the sky may be regarded as indicating the operation causes, just as the face of man indicates his mental ysical states. Hence the importance of the study ds, and hence the necessity of a nomenclature of as the basis of accurate and comparable observations. equate nomenclature of clouds is still a desideratum. Howard's classification, which continues to hold its as a provisional nomenclature, was proposed by 1803, and by it clouds are considered as divided ven kinds. Of these, three are simple forms, the the *cumulus*, and the *stratus*; and four intermediate pound, the *cirro-cumulus*, the *cirro-stratus*, the *-stratus*, and the *cumulo-cirro-stratus*, *nimbus*, or *rain*

cirrus cloud consists of wavy, parallel, or divergent ts, which may increase in any or all directions. It loud of the least density, the greatest elevation, and eatest variety of figure. It is probable that the s composing it are minute crystals of ice or snow The cirrus is intimately connected with the great ents of the atmosphere; and it is solely from the ents of the cirrus that we have any direct know- f the upper currents of the atmo-phere. In recent much has been done, particularly by Professor randsson of Upsala and Clement Ley, in investi- the relations of this cloud to storms and other s of weather.

cumulus is the name applied to those convex or heaps of clouds which increase upwards from a tal base. They are generally of a very dense re, are formed in the lower regions of the atmo- and are carried along by the aerial current next th. They form the tops of the ascending currents rise from the heated ground, and have a diurnal so well marked that they are often named the of the day." The form of stratus comprehends nists and fogs which in the calm evening of a warm r day make their appearance in the bottom of valleys er low-lying grounds, and sometimes spread upwards e surrounding country like an inundation; they n equally well marked daily period, and are ntly called the "cloud of night." The cirro- us is made up of small roundish masses, lying near ther, and quite separated by intervals of sky. It considered as formed from the cirrus by the fibres cloud breaking, as it were, and collapsing into sh masses, thus destroying the texture but retaining angement of that cloud. This singularly beautiful is commonly known as a mackerel sky, and is of equent occurrence during dry warm summer weather. rro-stratus consists of horizontal masses thinned s the circumference, bent downwards or undulat- d either separate or in groups. Since this cloud eat extent and continuity of substance, but little dicular depth or thickness, it is the cloud which requently fulfils the conditions for the phenomena ona, solar and lunar halos, parhelia or mock suns, araselenæ or mock moons. The cumulo-stratus ed by the cirro-stratus blending with the cumulus, eading underneath it as a horizontal layer of vapour. umulo-cirro-stratus, or nimbus, is the well known oud, which consists of a cloud or system of clouds which rain is falling. At a considerable height a sheet of cirro-stratus cloud is extended, under cumulus clouds drift from windward; these rapi creasing unite and appear to form one continuo mass from which the rain falls. The breaking up lower grey mass indicates that the rain will soo When a rain cloud is seen at a distance, cirri ap shoot out from its top in all directions; and it is o that the more copious the rainfall the greater is play of cirri. The cirrus, cirro-cumulus, cirro- cumulo-stratus, and nimbus are connected more closely with the great atmospheric movements cyclone and anticyclone. In what follows here amount of sky covered will be taken into account, the species of cloud covering.

The diurnal variation in the amount of cloud in on the open sea is very small. The following are the of two hundred and seventy-seven days' observat board the "Challenger," stated in percentages covered:—

2 A.M.	59	10 A.M.	58	6 P.M.	
4 ,,	59	Noon	56	8 ,,	
6 ,,	62	2 P.M.	58	10 ,,	
8 ,,	62	4 ,,	59	Midnight	

Two maxima are here indicated, the one about or after sunrise and the other in the early part afternoon, and two minima, the one at noon and th from sunset to midnight. The difference betwe extremes is only 6 per cent. of the sky.

At Batavia the daily maximum is from 6 to 11 P.M., minimum from 8 to 11 A.M., the extremes being 73 per 9 A.M. and 69 per cent. at 7 P.M.—a difference of 17 per c four daily observations at Mauritius, the maximum is 50 p at 1 P.M. and the minimum 38 per cent. at 6 A.M. At C observations of clouds have been made five times daily, years' results give the maximum 63 per cent. at 9 P.M minimum 52 per cent. at 9 A.M. At this place, during August, the greatest amount of cloud occurs at 6 P.M., and months the rainfall at Coimbatore is very small. The minim more pronounced at 9 A.M. than at any other period in this phase occurs about four hours later. At the con-stantinople of Vienna, during the warm months of the year th mum is at 2 P.M., with a secondary maximum about 6 A the minimum from 10 P.M. to 2 A.M.; but during the cold the maximum is at 6 A.M. and the minimum during the and night. In the Rocky Mountains, the chief maximum cent., is at 3 P.M., with a secondary one 30 per cent. at 5 A the chief minimum 20 at 3 A.M. and a secondary one 24 at A.M. At Helsingfors the maximum of cloud occurs from 10 A.M. to and the minimum from 10 P.M. to 2 A.M.

Much yet remains to be done with regard determination of the diurnal variation of cloud, bu the above one or two deductions of a general ch may be drawn. A maximum occurs in the morn continues till shortly after the sun has risen, a maximum is more decidedly pronounced over the o than over land. Its appearance is without a doubt the general cooling of the atmosphere through its height by terrestrial radiation, and its disappearan the heating of the air, which commences about Then follows one of the diurnal minima, which co till midday, or a little later; in other words, it co till, owing to the diurnal heating of the air by t the ascending current has fairly set in. The pe this ascending current marks the second maximum during the warmer months is larger than the maximum over land. The cumulus is the chara cloud of this maximum. These clouds are mer summits of the ascending currents which rise fr heated land, where the aqueous vapour i condens cloud by the expansion which takes place with inc height.

These cumulus clouds throw a not unimportant l the behaviour of the ascending currents which ri the surface when heated by the sun,—inasmuch

to the fact that the current ascending from the
e is broken up and thereafter grouped into separate
defined ascending currents, which are marked out and
pped by these cumuli; and further it is probable,
their well-defined position, that the air composing
ascending currents is not only warmer but also more
d than the air in the clear interspaces at the same
ts. It may also be regarded as highly probable that
lown through these clear interspaces that the descend-
ir filaments shape their course on their way to take
lace of the air-molecules that ascend from the heated
ce of the earth.

e secondary minimum occurs from about sunset
rds during the time of the P.M. maximum of atmo-
ric pressure. In a highly saturated atmosphere, which
characteristic a feature of many tropical climates at
n seasons, the time of the day is remarkable for the
unt of cloud, and it is during those seasons and hours
heat-lightning, or lightning without thunder, attains
nual and diurnal maximum period, which is from six
ght hours later than that of thunderstorms. The
ng maximum, shortly before and after sunrise, has
quite distinct and characteristic clouds accompanying
One of these is the cumulo-stratus, which is a con
nce of the cooling of the atmosphere through all its
t by nocturnal radiation. As the colouring of the
llets is often singularly fine, it has been a favourite
e with poets of all ages and climes. The other, which
ts from the cooling of the surface of the earth by
strial radiation and thence of the lower stratum of
atmosphere, is quite different, being a low creeping
appearing first in low-lying situations, and gradually
nding upwards as the temperature falls. Fog is a
known form of this cloud, having its diurnal maximum
e morning and early part of the day.

urnal Variation in the Amount of the Rainfall.
the sixteen years during which hourly observations
e rainfall were made at Batavia Dr Bergsma has given
le showing the diurnal variation, of which the follow-
shows how much per cent. of the total daily amount
very two hours

to 2 A.M.	8·7	8 A.M. to 10 A.M.	9·5	4 P.M. to 6 P.M.	13·5
,, 4 ,,	6·4	10 ,, ,, Noon	6·3	6 ,, ,, 8 ,,	10·5
,, 6 ,,	6·1	Noon ,, 2 P.M.	9·3	8 ,, ,, 10 ,,	7·1
,, 8 ,,	9·2	2 P.M. ,, 4 ,,	12·2	10 ,, ,, Midt.	8·7

diurnal curve of rainfall is thus very distinctly
ed at Batavia. The minimum is from 6 to 10 A.M.
the maximum from 2 to 6 P.M.,—10·7 per cent. falling
the four hours ending 10 A.M., but 25·7 per cent.
e four hours ending 6 P.M.

observations were arranged and averaged by Dr Bergsma
the view of seeing how far the phases of the moon influence
rainfall. The results for the eight phases of the moon,
ming with new moon, showing the mean amount of rain in
ty-four hours during the seventeen years ending 1880, are
: 0·213, 0·195, 0·193, 0·181, 0·212, 0·183, 0·189, and 0·203,
daily mean 0·205 inch. The influence of the moon's phases
e rainfall at Batavia is thus quite decided from these seventeen
s, for, while the mean daily rainfall is 0·205 inch, it rises at
noon to 0·213 inch, from which time it gradually falls to
inch at the third octant, rises to 0·212 inch at the fourth
nt, falls again to 0·183 inch at the fifth octant, and finally
to the maximum at the time of new moon.

Coimbra, where the rainfall has been observed every two
s for the six years ending 1881, the means show a minimum
08 inches from midnight to 2 A.M., a maximum of 4·03 inches
2 to 4 A.M., a second minimum of 3·20 inches from 10 A.M.
oon, and a second maximum from 2 to 4 P.M. These four
es of the rainfall are pretty nearly accordant with the four
es of the barometric pressure, the maximum periods being
the times of minimum pressure, and the minimum periods
the times of maximum pressure. The rainfall at Philadelphia
s a decided maximum at 6 P.M. and minimum at 3 A.M. At
na during the summer half of the year there are three maxima
three minima in the curve of the daily rainfall, the chief

maximum, which is nearly double of each of the othe
occurring from 2 to 4 P.M., and the chief minimum from
A.M. At this place the number of hours of rain has been re
showing two maximum periods, the first from 2 to 8 A.M.
second from 4 to 7 P.M. Since the time of maximum
indicates a number of hours for the fall under the mean of t
it follows that the showers from 2 to 4 P.M. are often very
At Prague the chief maximum is from 2 to 6 P.M. and the m
from 1 to 6 A.M. At Zechen the maximum is from 2 to
with a secondary maximum from 5 to 8 A.M., and the m
from midnight to 4 A.M. At Bern the maximum fall is from
to midnight. Twenty one years' observations at Calcutt
the maximum occurrence of rainfall during the rainy seas
June to October to be from 11 A.M. to 6 P.M., the absolute ma
being from 2 to 3 P.M. and the minimum from 9 P.M. to
and during the hot dry season from March to May the maxi
from 5 to 9 P.M., and the minimum from midnight to 9 A.M.

The data already collected show the general occu
of a diurnal maximum from about 11 A.M. to 6 P.M
this feature of the curve is particularly well seen
rainfall of continental climates during the summer
the year. A marked diminution of the rainfall i
generally observed from about sunset to midnight
the diurnal amount of cloud in many climates falls
minimum, and the evening maximum of atmo
pressure takes place. The time of the morning mi
pressure from about 2 to 6 A.M. is, curiously, s
marked in some places with an increase, while in ot
is as strongly marked with a diminution, in the r
The "Challenger" observations show that the occ
of rain on the open sea is inversely as the tempe
684 days' observations giving 96 cases from 9 to
and 135 from midnight to 2 A.M., these being the mi
and maximum periods.

Diurnal Variation of Thunderstorms. It has ju
remarked that a prominent feature of the diurnal
in continental climates during the summer month
increased rainfall from about 11 A.M. to 6 P.M., a
Vienna observations point to unusually heavy falls
ring at these hours. This is caused by the rains
accompany the thunderstorms of these regions.
following table gives for the hours of the day the t
occurrence of thunderstorms at Ekaterinburg in th
Mountains during the fourteen years ending 1872:

	April.	May	June.	July.	Aug.	Sept
Midnight to 1 A.M.	...	...	5	5	5	...
1 A.M. ,, 2 ,,	...	...	1	5	2	...
2 ,, ,, 3 ,,	...	...	1	4	1	...
3 ,, ,, 4 ,,	...	...	1	2	3	...
4 ,, ,, 5 ,,	...	...	2	1	1	...
5 ,, ,, 6 ,,	...	...	3	3	...	...
6 ,, ,, 7 ,,	...	...	2	3	...	...
7 ,, ,, 8 ,,	1	...	5	2	2	...
8 ,, ,, 9 ,,	1	...	4	4	1	...
9 ,, ,, 10 ,,	1	...	6	7	5	...
10 ,, ,, 11 ,,	1	...	8	12	4	...
11 ,, ,, Noon.	1	2	14	30	5	1
Noon ,, 1 P.M.	3	4	19	25	5	4
1 P.M. ,, 2 ,,	2	8	21	29	12	2
2 ,, ,, 3 ,,	3	10	22	35	15	4
3 ,, ,, 4 ,,	3	6	26	45	20	1
4 ,, ,, 5 ,,	2	5	24	33	9	...
5 ,, ,, 6 ,,	1	6	25	30	11	2
6 ,, ,, 7 ,,	2	7	15	20	10	...
7 ,, ,, 8 ,,	2	5	16	20	9	...
8 ,, ,, 9 ,,	2	6	14	14	6	...
9 ,, ,, 10 ,,	2	3	8	10	5	1
10 ,, ,, 11 ,,	...	1	6	6	5	...
11 ,, ,, Midnight...	...	1	7	6	8	...
Sums ...	27	64	255	351	144	15

Hence the thunderstorms at this place have a
period as strongly marked as any other meteor
phenomena, and in this respect Ekaterinburg i
representative of extratropical continental climates
summer. For the fourteen years no thunder

the six months from October to March. The mean six hottest months shows the maximum to take om 3 to 4 P.M. and the minimum from 4 to 5 A.M., oing the times of occurrence of the two minima of e. At this season, however, the morning minimum e is but faintly marked in such climates as those of During the twelve hours from 9 A.M. to 9 P.M., ne temperature is above the daily mean, 717 of the number occurred, thus leaving only 139 for the hours when the temperature is below the daily The great majority of the thunderstorms occur the part of the day when the ascensional movement air from the heated ground takes place, and they the maximum when the temperature and this movement are also at the maximum. Owing to sterly winds from the Atlantic which prevail over and western Siberia during summer, the maximum of the year occurs over this extensive region in this and the importance and significance of the inquiry s element of climate lie in the fact that the greater of the summer rains is discharged over these regions thunderstorm. The "Challenger" observations on n sea show the maximum occurrence of thunder to be from 10 P.M. to 8 A.M., 22 being observed these ten hours and 10 during the other fourteen f the day,—a result which suggests that over the terrestrial radiation is more powerful than solar on in causing vertical disturbances in the equilibrium atmosphere.

ospheric vapour and ascending currents thus play ortant part in the history of these thunderstorms. the climate is dry and rainless, like that of Jerusalem ner, thunder is altogether unknown. On the other where during a particular season an anticyclone with descending current in the centre remains over a as happens over the centre of the old continent the winter, over that region thunder is equally n during that season. Further, in such places as and Coimbra, where the summer rainfall is small occurrence infrequent, thunderstorms become less t, and the hours of their occurrence are later in the an they are before and after the dry season.

hunderstorms at Mauritius call for special notice. There maxima in the diurnal curve, the larger from noon to 4 l the smaller from 3 to 6 A.M., which are near the times of ometric minima, and two minima, from 9 P.M. to 1 A.M. n 8 to 10 A.M., these being near the times of the barometric . But the important point as regards the thunderstorms itius is that for twelve years none were recorded in June y, one only in August, one in September, and three in The annual period of the thunderstorms of this island from near the end of October to the middle of May, or he time of the greatest rainfall, practically none occurring the rest of the year. But rain continues to fall during r months of no thunder, the mean monthly rainfall being out 2 inches, falling, however, in September to 1·37 During these four months, therefore, there is in the air eous vapour, and, these being dry months, there is the n of ascending currents. There appears, however, to n wanting another element which seems essential to trical manifestations of the thunderstorm, viz., the con- which give masses of descending cold air along with ending current of warm moist air. During the months hunder is of no unusual occurrence the high pressure of Asia lly advances, as Dr Meldrum has pointed out, close on us; and so frequently is this the case that he considers the calms between the two trade winds to stretch in a slanting n from Madagascar to Ceylon. As long as this state of occurs with more or less frequency, the conditions of a ing cold current of large volume are provided, and thunder- occur. But during June, July, August, and September, tmospheric pressure is low in Central Asia, and there is an on increase of pressure from Asia southwards to Mauritius, ile Mauritius remains in the heart of the south-east trades, nditions of descending cold currents of any considerable are not present, and thunder is there unknown at that

Now in situations which afford the three conditions of a vapour, ascending currents, and descending cold currents, the diurnal and annual periods are quite distinctly marked phenomena are more uniformly distributed through the hour day and months of the year than elsewhere. Pola and Fiu the head of the Adriatic, being shut in and encompassed b Alps, are illustrations. At Fiume the greater maximum from 11 A.M. to 1 P.M. and the smaller from 2 to 4 A.M., minima from 10 P.M. to 1 A.M. and 6 to 9 A.M. While dur twelve hours the temperature is above the mean of the da May to September the number of the thunderstorms here for the nine years ending 1879, the number during the hours the temperature is under the mean was 185. The tively large number during the colder hours of the night is due to the warm moist atmosphere of this confined sea close proximity of the Alps.

There is still another set of conditions favourable of thunderstorms in certain climates which the obser made at Stykkisholm in the north-west of Iceland ill During the four and a half years ending 1879 there occurred here three thunderstorms, but there was only one in the six months from April to September, in other words, the t storm of the climate are essentially winter phenomena. I of the twenty-three hours in which they occurred, only thr at a time of the day when the sun was above the horizo twice in March and one in September: in other words, the t storms of Stykkisholm are nocturnal phenomena. It is most ob the north and north-west of Scotland t occurs most frequently during the day and in summer the thunderstorms in the are approximative in type to those of Iceland and in the to those of Edgeworthstown. A little reflexion shows that in western Europe it is during winter and during night that moist ascending and cold dry descending currents are mo quently brought into close proximity during the great storms of the season, and it is at the changes of wind, hu and temperature accompanying the passage of the centre cyclones that the thunder peals are heard. On the other in the east and south of Scotland it is during the hot of the year that these ascending columns of warm moist descending columns of cold dry air are most frequently together, and there, accordingly, thunder with the heavy which accompany it is of most frequent occurrence from to 5 P.M. from May to September. These essentially differen of thunder-storms have been classed by Mohn as heat thunde and cyclone thunder-storms.

Given an initial difference of electric potential, it to understand from the effects which follow the extraordinary condensations of the aqueous vapour take place how the most violent thunder-storms a duced. The difficulty is to account for the produc the initial difference of electric potential, ho example, in the same great aerial current of the sou monsoon, this difference of potential is produced molecules of aqueous vapour at Calcutta but not aqueous vapour at Mauritius. It is to the physici meteorologist still look for the explanation.

Diurnal Period in the Occurrence of the Whi Waterspout, Dust Storm, and Tornado. Whir waterspouts, dust storms, and tornadoes are essentia ame, differing from each other only in their dime their intensity, or the degree in which the moisture densed into visible vapour, while the hailstorm a rainstorm are simply the manner and degree of t cipitation accompanying them. In several im respects they differ widely and radically from cyclon Atmosphere, vol. iii. p. 33). The largest tornad of so decidedly smaller dimensions when compare the smallest cyclones as to admit of no shading of into the other. Cyclones occur at all hours of t and night, whereas whirlwinds and tornadoes diurnal period as distinctly marked as any in mete Finally, cyclones take place under conditions which unequal atmospheric pressures or densities at the heights of the atmosphere, due to inequalities geographical distribution of temperature and humidi whirlwinds occur where for the time the air is un warm or moist, and where consequently temperat

ty diminish with height at an abnormally rapid rate. es are thus phenomena resulting from a disturbance equilibrium of the atmosphere considered horizon- ut whirlwinds and tornadoes have their origin in a l disturbance of atmospheric equilibrium

g the most remarkable of the [illegible] portions of the e certain portions of the United States [illegible] to the examina these the meteorological [illegible] of the States has given attention by a systematic [illegible] climate observation attendant phenomena and the destructive effects. The s of the last eighty [illegible] years, numbering about six d, have been classed under [illegible] present State where they rted to have occurred, and [illegible] relative distribu

tion over the States. The areas of greatest frequency are distances from each other. That part of the great bas west of the Mississippi, including the States of Iowa, M Kansas, and Nebraska, is the region in which tornadoes frequent. Tornadoes occur at all seasons, being most f however, from April to September, and least frequent in D and January.

The hour of occurrence of one hundred and sixty-two tornadoes is given in the official report as follows:—

Midt to 2 A.M.	2	8 A.M. to 10 A.M.	1	4 P.M. to 6	
2 A.M. ,, 4 ,,	5	10 ,, ,, Noon	7	6 ,, ,, 8	
4 ,, 6 ,,	3	Noon ,, 2 P.M.	13	8 ,, ,, 10	
6	4	2 P.M. ,, 4 ,,	47	10 ,, ,, M	

Thus the diurnal period of tornadoes is analogous to th

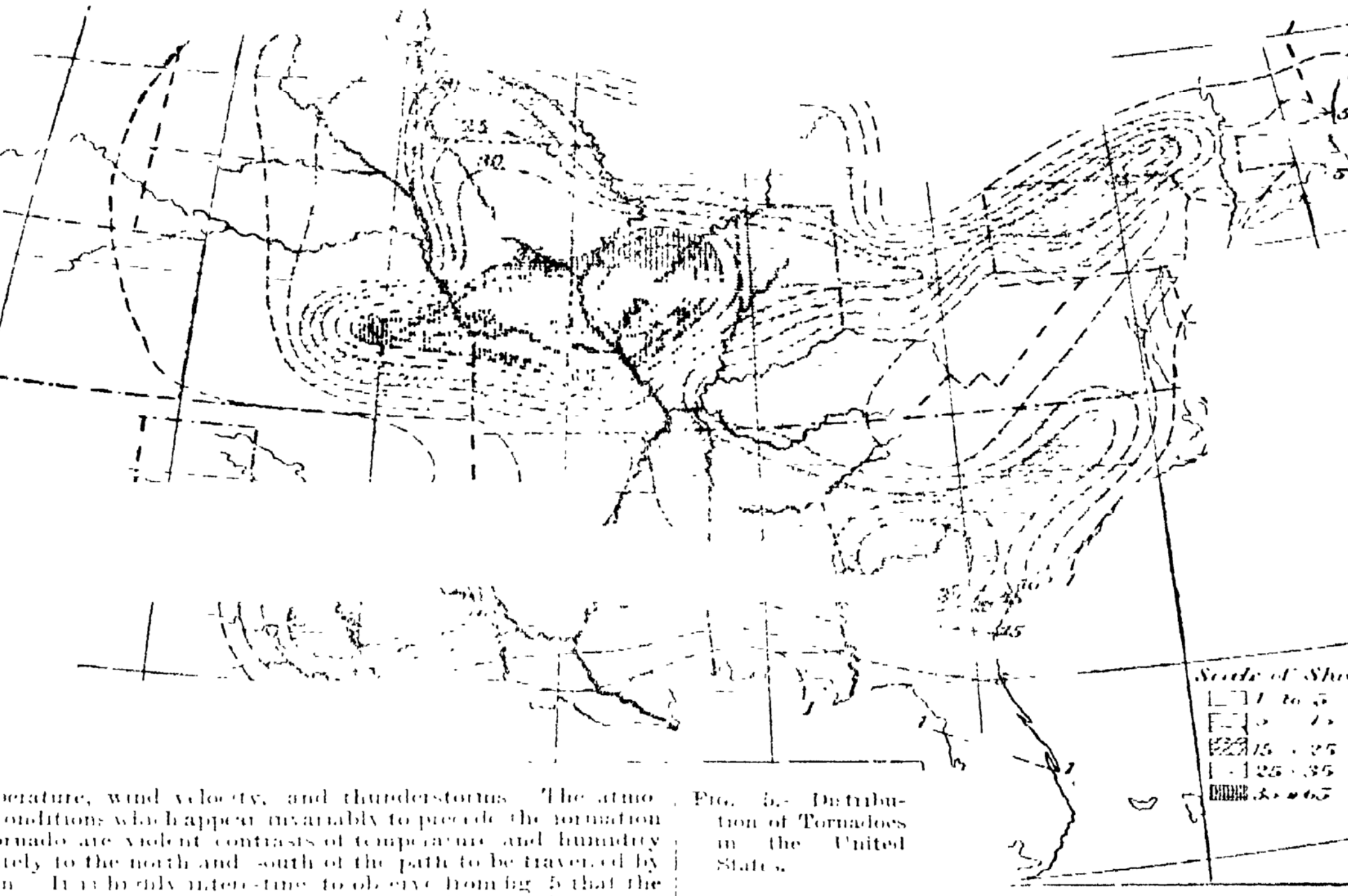


FIG. 5.—Distribution of Tornadoes in the United States.

perature, wind velocity, and thunderstorms. The atmo onditions which appear invariably to precede the formation rnado are violent contrasts of temperature and humidity tely to the north and south of the path to be traversed by n. It is highly interesting to observe from fig. 5 that the t most frequent occurrence of tornadoes is the region large number of the cyclones of the United States appear nate (and the enumeration [illegible] has shown to be remark violent contrast of temperature occurring within limited nd moist, and that as appears in the regions of the ne, they decrease in frequency with height.

6 show the waterspout in different aspects. A loud covers the sky, from which a projection is let n the form of an inverted cone, as at A, which es to increase and extend downwards. The sea iately beneath is soon thrown into violent agitation, g that the whirling movement which began in the has extended to the sea, and is doubtless continuous hout, though the portion of the column from A ards is not yet made apparent by the condensation ontained vapour into cloud. As the whirling move t the column becomes more intensely developed, the d rapidity of the gyrations being increased ion of the air within, with the inevitable result of d condensation of the vapour into cloud downward. otrusion of the cloud and its extension downwards s not due to the descent of vapour from the clouds, he visible condensation of the vapour of the spirally ng air currents arising from an increasing rarefac- e solely to the accelerated rate of the gyrations, the condensation being analogous to that of the cloud exhausting an air pump.

Under each of the columns of fig. 6 the surface ea is seen to be more or less heaped up, as we violent agitation, showing that atmospheric p immediately under the gyrating columns is less th all round. On land, when the tornado passes over a dwelling house or other closed building, i happens that the whole building, walls and roof, is outward with great violence, the wreckage present appearance of a sudden explosion, proving that atmo pressure outside the building was instantaneous largely reduced, and the building shattered to fra by the expansion of the air within. It is in this w the tornado does some of its most dreadful work.

The wind of the tornado reaches a velocity p never equalled in cyclones. During the Ohio tor February 1, 1842, large buildings were lifted enti their foundations, carried several rods through the a then dashed to pieces, some of the fragments being distances of 7 and 8 miles; and large oaks nearly 7 girth were snapped across like reeds. This tornado on its course at the rate of 34 miles an hour, and

id its fearful work in the brief space of a minute nado which passed over Mount Carmel (Illinois), 1877, swept off the spire, vane, and gilded ball of thodist church, and carried it bodily 15 miles to astward. The velocity of the ascending currents kept this heavy object suspended in the air for 15 iles must have been very great

ne tornadoes the progressive courses of which were d, 310 advanced towards N.E., 38 towards S.E., 16 E.N.E., 14 towards E., 7 towards N.N.E., 5 towards and 3 towards S.S.E. The course is thus always

FIG. 6.—Forms of Waterspouts.

some easterly direction, the great majority being the north-east. The velocity of their onward ent varied from 12 to 60 miles an hour, the average 30 miles an hour. The time occupied in passing a lar spot varied from 10 seconds to half an hour, an time being nearly six minutes and a half. The of the path of destruction marked with debris and lies of the violence of the tornado varied from 40 00 feet, the average being 362 yards. The direction whirling movement of the tornado was invariably from left, or the opposite of the movement of the hands atch, resembling in this respect the vortices move f cyclones in the northern hemisphere. The passage tornado cloud is often described as accompanied markable noises, which observers variously charac as terrible, deafening, a terrific crash, the roar of a d trains of cars, or the uproarious din of innumer ces of machinery.

usual position of the gyrating columns of cloud ; but occasionally a curving form or slanting n is assumed. It is probable that to these atter many stationary or slowly moving dangerous squalls be referred, which spring up with unexpected ness in lakes and arms of the sea in mountainous .

dust storm of India, Arabia, and Africa is a well type of the whirlwind. Previous to the outbreak st storm the air is unusually calm and sultry, just ens in the case of the tornado. The simplest form dust storm is that of a tall aerial column of sand onwards, and drawing into itself, as it whirls round ourse, dust and other light bodies within the sweep of the strong air currents which blow along the surf the ground and converge vortices round the bas column. A form commonly seen is shown in no. 7, represents several dust columns grouped toget whirling independently round its own axis with ne air currents at the base, while the whole group of co is borne bodily forward, and presents striking aspe the forms and relative positions of the columns are cha The importance of the observations made on dust s as leading to a correct understanding of the whir consists in this that it affords conclusive evidence there is a strong inflow of air along the surface o ward all round vort towards the base of the wind, and that the air flowing in current after current through the air the central axis of the which, carrying with ther evidence of their ascent, visible solid particles of sand, and other light b they whirl up with the their ascending course.

Owing to the extreme d of the air current mixed the dust storms, the rare generated by the rapidity gyrations is insufficient t duce condensation of the a vapour in the interior column. Quite different, even if with water par tornadoes, where, in the majority of cases, the air the surface before being into the ascending vortex a high temperature and near the point of satu From the extreme rarefaction to which the air-c are subjected, owing to their sudden ascent in a r gyrating column, excessive condensation follows, w aqueous precipitation at times so astonishing that only be fitly described as an aerial torrent of solid water, or an aerial avalanche of hail and ice.

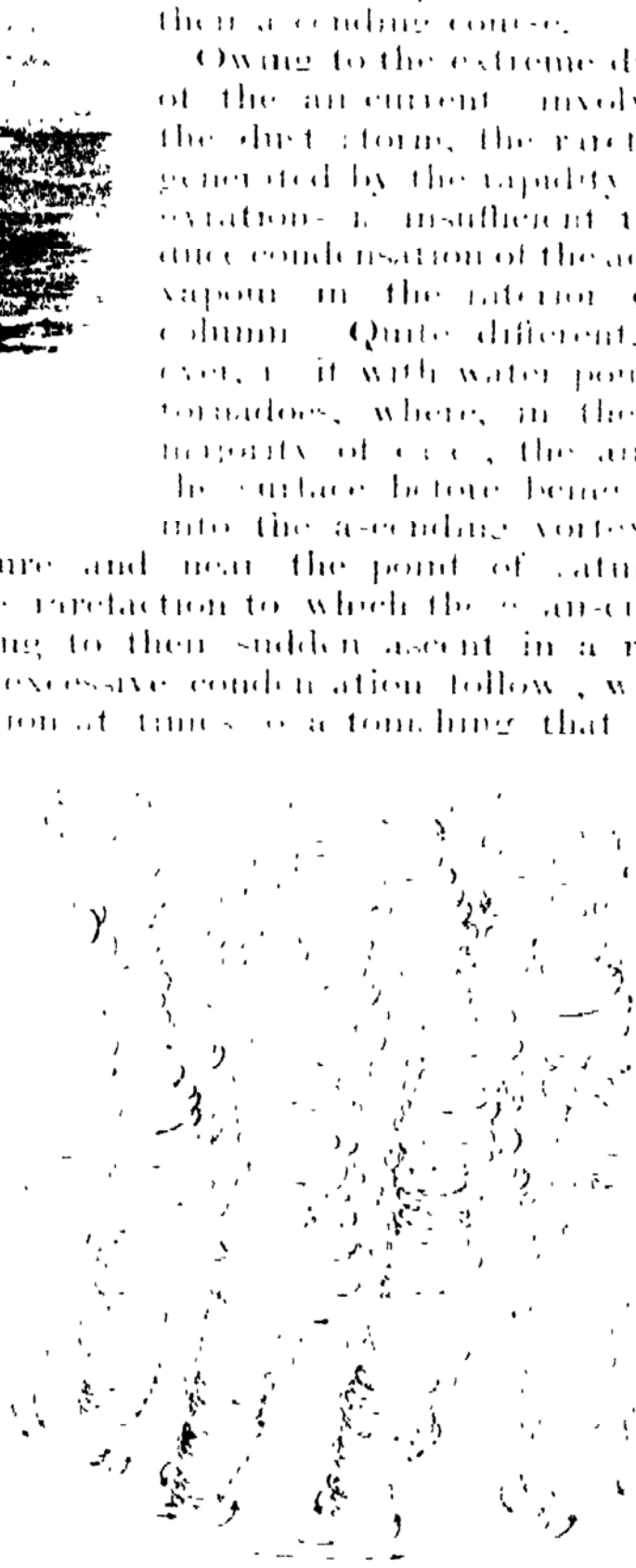


FIG. 7.—Dust-Storm.

Certain tracts of the ocean included within what may be called permanent anticyclones, where atmospheric pressure is higher than all round, are characterized by an absence or comparative absence of rain. These regions are also remarkable for clear skies and strong sun heat. Similarly small anticyclone areas ring between or in the vicinity of cyclone are charact by dry air and clear skies, and it is under these cond that the strongest sun heat is felt. When, as repe

s in the warmer months of the year, anticyclones practically stationary for some time, the lowermost of the air become abnormally heated, thus bringing vertical disturbance of the equilibrium of the atmosont of which whirlwinds originate. It is under these ons that white squalls or fair weather whirlwinds the originating cause of the spiral form being the ryness of the air due to its place in the anticyclone, e abnormally rapid diminution of temperature and ty with height owing to the more or less adiabatic through ar dry atmosphere. The clouds accompanying the squalls are at a great height, but the commotion and of the sea under them and following them as they wards show that the squalls are true whirlwinds, pout column of the water spout not being formed on account of the extreme dryness of the air which the column. The white squall accompanies the r, and its appearance is sudden, its duration brief, destructive power at times so dreadful that it has known to trip a ship of every sail and mast in a few s, and leave it rolling a helpless log amidst the ious sea which follows it. In sailing through such a close lookout should be made, particularly when ather look singularly fine, the skies beautifully he air calm or nearly so, and the temperature and re of the air on board the vessel noticeably high.

nual Period of Hail.—The hail here referred to is hard, and compact, and in the form of clear or n ice, the hailstones sometimes being found when acro-s to be composed of alternate layers of the e ates of ice. The following figures show the number s it has occurred during the different hours of the Coimbra during the last six years:—

0 2 A.M.	0	8 A.M. to 10 A.M.	3	4 P.M. to 6 P.M.	3
2 „ 4	1	10 „ „ Noon	20	6 „ „ 8 „	1
4 „ 6	2	Noon „ 2 P.M.	15	8 „ „ 10 „	6
6 „ 8	1	2 P.M. „ 4 „	13	10 „ „ Midt.	0

nal period is thus well marked at Coimbra, where ght out of the fifty nine cases have occurred from to 4 P.M. This period is essentially the same as alculated for a large number of places in repre enta nute, care having been taken to limit the inquiry particular hail described above. The important o be noticed in the diurnal period of hail is that the l maximum is about two hours earlier than the um period of thunder storms. The maximum period thunderstorm is when the ascending current from ated land is at its greatest force for the day: but aximum period for hail is some time before the ng current has fully established itself, or at that the day when the vertical disturbance of the phere is greatest, in other words, when atmospheric erature and vapour fall with height at a much greater m the normal. In the higher latitudes hail falls exceptionally during the warmer months of the year. ions where the summer climate is practically rainless l falls; and where the rainfall is small and at distant l few cases of hail occur. Thus at Coimbra, where ain fall in summer, hail was recorded as having only once in the six years during the four dry hot s from June to September.

hail is probably connected immediately with whirl- more or less developed; and it is when the hail- s one of the phenomena attendant on the tornado or eat thunderstorm that it assumes its most destruc- rm. The theory of the formation of hail has been by Ferrel in his *Meteorological Researches for the Use Coast Pilot*, part ii. p. 85. The vapour carried aloft gyrations of the tornado is below a certain height sed into cloud and rain, but above that height into snow. Let the raindrops formed below be carried u the snow region by the powerful ascending currents tornado and be kept suspended there a little while, an become frozen into hail. If now these be thrown outside the gyrations of the tornado, they fall to the as a shower of compact homogeneous hailstones o ice of ordinary size. If, however, they are caught descent and carried in toward the vortex by the in currents on all sides, they are again rapidly carrie into the freezing region. A number of such revo of ascent and descent may be made before they fall earth. While high up in the snow region, the hai receive a coating of snow; but, while traversing the lower down where rain yet unfrozen is carried up receive a coating of solid ice. Thus alternate coat snow and ice are received, and the number of ea indicates the number of revolutions described bef hail-stones fell to the ground. When the nucleus posed of compact snow, as is generally the cas hailstone had its origin high up in the snow regi small ball of snow, or soft hail (*Graupel* in Germa *grésil* in French); but when it is composed of cl throughout it was formed in the rain region, carr into the snow region and there frozen, and imme afterwards fell to the ground.

Monthly, Annual, and Irregularly Recurr Phenomena.

The Temperature of the Sea.—Figs. 8 and 9, rep ing the distribution of the temperature of the water of the ocean for the two extreme months Fe and August, are reproduced chiefly from *The Wi Current Charts for Pacific, Atlantic, and Indian* published by the British Admiralty in 1872.

In February (fig. 8) the temperature of the surface of the to the annual minimum over the northern hemisphere, a to the maximum in the southern hemisphere. The cours isothermals more closely follows the latitudes in the Pacific and South Atlantic Oceans; but the divergence from the great and striking over the North Atlantic. The wider a open the ocean the more does the distribution of the tem approach the normal; and the more confined the ocean the the divergence from the normal. The key to the an distribution of the temperature of the ocean is furnished chart of the distribution of atmospheric pressure and the p winds of the globe. So far as observation has gone it woul that the surface currents are practically altogether cause prevailing winds over the respective oceans, subject to such d in their courses as are occasioned by the land.

In the southern hemisphere the currents on the west sid Indian Ocean flow southwards along the east coast of Afr since the currents here pass from lower to higher latitu temperature along the whole extent of this coast is raised considerably above the normal. On the other hand, since the cu the west coast of Africa flow from south to north—in othe from higher to lower latitudes—the ocean currents which on this coast have a temperature much under the norma winds and currents on the coasts of South America are analogous to those of Africa, and the distribution of the tem of the seas also similar. The temperature of the ocean on coast of that continent is for the same latitudes everywhe than on the west coast. Even in the smaller continent of A the same law holds good.

In the northern hemisphere a different distribution of t perature of the sea is seen at this season. In the Atlantic petature is very much higher on the west of Europe tha east of America. On the east of America from Wilmi Boston occur the most rapid transitions in the mean tempe the ocean anywhere on the globe, the temperature falling short distance from 70° to 30°, whereas on the eastern sid Atlantic these isothermals pass Cape Verd Islands and Spi respectively. In the winter months the prevailing wind east side of North America are north-westerly, whilst in th and eastern portion of the Atlantic they are south-weste pouring along the east coast of America the icy current Arctic regions, but over the central Atlantic and along the shores of Europe the warm waters of southern climate

and south-easterly winds of Scandinavia in winter lower nermals along these coasts A striking feature of the winter nals of the Atlantic is the singularly high temperature along re stretching from Spitzbergen towards the south-west and g in a modified degree as far south as the West Indies In fic this feature of the mid-ocean temperature is much less pronounced, and the excess of temperature on the west of over what occurs in the same latitudes of eastern A great as the difference observable between the two side Atlantic

The highest mean temperature in February (85°) occu Indian Ocean to the south west of Sumatra, and there is a p

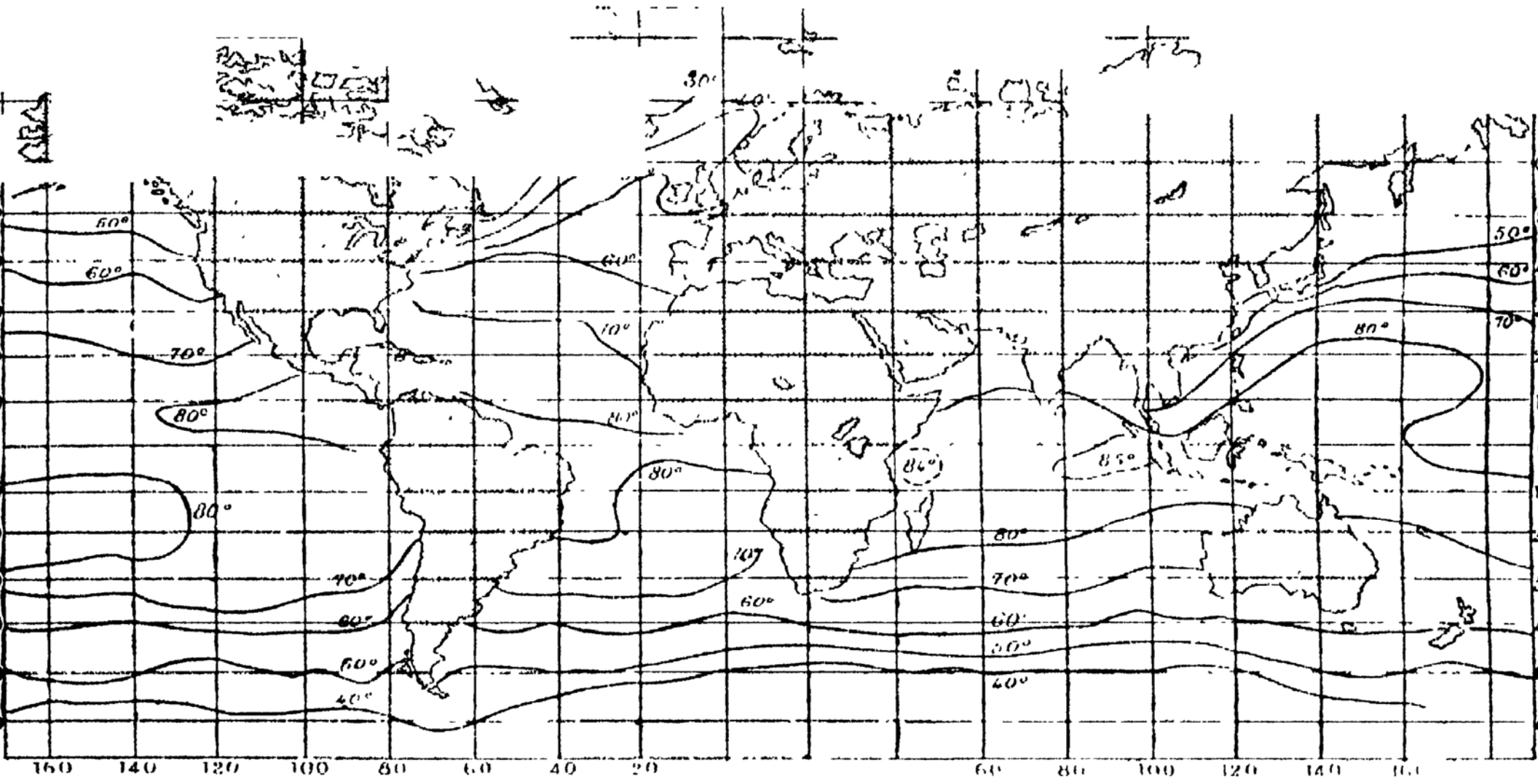


FIG. 8. Isothermals of the Surface of the Sea for February.

ture of which is 84° to the north of Madagascar. The means in the Atlantic are 82° in the north east angle of the Guinea, and 81° off the north east coast of Brazil In the he highest are 83° to the north of the Fiji Islands and 81° Marshall Islands.

In August (fig. 9) the southern half of the Red Sea shows temperature of 90°, being the highest mean recorded for t anywhere at any season Patches showing a summer mea occur in the Chinese Sea to the east of Tonquin, in the Bengal to the east of southern India, about Socotra, and

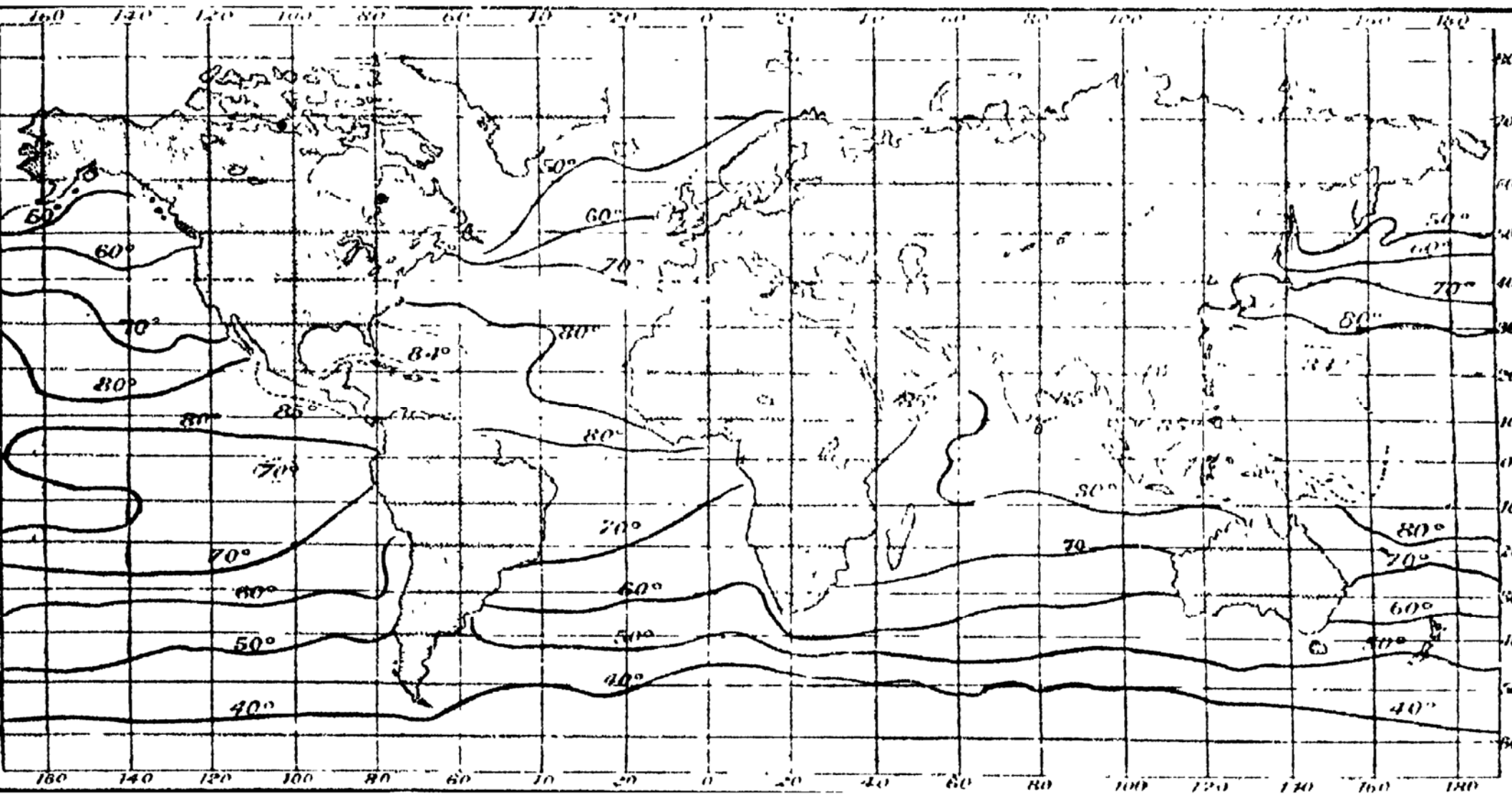


FIG. 9.—Isothermals of the Surface of the Sea for August.

Central America. But the most extensive regions of high ture are in the west of the Pacific between long. 165° the Philippines northward nearly to Japan and south- New Guinea, and the Gulf of Mexico and the adjoining the Atlantic as far east as long. 57° W. A patch of bly low temperature occurs in the Pacific a little to the west of Galapagos, where the mean is only 70°, being 10° lo what occurs anywhere else near the equator at this season,

The influence of currents is strongly expressed in the tem of all the oceans In the south of Asia the monsoons a S., and S E Under the impulse of these monsoonal w extensive surface drift of the waters of the equatorial r

l northwards towards southern A ia, and consequently very
emperature characterize these seas in summer. Its influe-
more the direct on the temperature of the air resulting from
gion of high atmospheric pressure in the North Atlantic at
r on. One of the reflections from the wind blowing all
ions, causing it to arrive part of its journey in the same direc-
Thus to the west of Africa the wind does not arrive from
to south, and hence the temperature of that part of the ocean
ormally reduced. On the other hand, on the west side of this
re area, the prevailing wind does not arrive from south
th, and it will be expected that the temperature of the whole of
ion swept by the southerly wind is abnormally raised. On
other side of the area the wind and current are westerly as
about lone 35 W and hence it is that here the isothermals
the parallels of latitude. In the tropical and northward
ovation wind becomes northwesterly, this propelling northe-
along the western coast of Europe by means of surface drift,
rmer water of southern origin. Meanwhile the currents of
ater and ice from the Arctic regions keep the temperature
ff America to the south of Newfoundland at a figure con
bly lower than observed on any other region in the same
les. In August under relation exists in January between
st and west coast respectively of South Africa, South
a and Australia, all of which have readily explained by the
of mean atmospheric pressure and the prevailing winds
of the most striking fact of ocean temperature is that the
ature of the Southern Ocean from about 50° to 60° S. lat.
tically the same in January and August, a circumstance due
to the preponderant icebergs of that ocean.

Temperature of the Land.—In regions where the
ll is distributed through all the months of the year,
where snow covers the ground for only a small part
year, the mean temperature of the soil nearly equals
of the air. But when the year is divided into wet
ry seasons, and when snow lies during a considerable
on of the year, the mean annual temperature of the
ay be above or below that of the air. The greatest
nce between the temperature of the soil and that of
occurs where the surface of the ground is covered
several months with snow. Snow is a bad con
r of heat and thus obstructs the free propagation of
old produced by radiation downwards into the soil,
e escape of heat from the soil into the air. In this
over a considerable portion of the Russian empire,
mperature of the soil is considerably in excess of that
air. Thus at a place 120 miles south of Archangel
mperature of the soil is 10° higher than that of the
and at Semipalatinsk it is 9° higher.

daily changes of temperature only affect the soil to
s of about 4 feet. The precise depth varies with
ence of the sun's heat and with the nature of the soil.
ally the heat of summer and the cold of winter give
a larger annual wave of heat propagated downwards,
mplitude of which diminishes with the depth till it
s to be perceptible. Principal Forbes showed from
sations on the Calton Hill, Edinburgh, that the annual
ion is not appreciable lower than 40 feet below the
e, and that under 25 feet the change of temperature
gh the year is small. The depth at which the annual
ion ceases, or where the temperature remains constant,
variable depending on the conductivity and specific
of the soil or rock, but particularly on the difference
en the summer and winter temperatures. The rate
ch the annual wave of temperature is propagated
wards is so slow that at Edinburgh, at a depth of 24
the highest annual temperature does not occur till
ry 1, and the lowest till about July 13, thus revers-
e seasons at this depth. At Greenwich, at a depth
feet, these phases of the annual temperature occur
vember 30 and June 1.

e of Everett in the *Report of the British Association* for 1879
mmarizes the results of the observations of underground tem
e. The temperature of the surface of the ground is not
influenced by the flow of heat from below upwards, but is
ned by atmospheric and astronomical conditions. The tem
perature gradient is defined as the rate of increase of the tem
downwards, and it may be taken as averaging one degree Fa
for every 50 or 60 feet, the exact rate in particular cases be
variable. Thus the temperature gradient of the soil is a
times steeper than the temperature gradient of the ai
temperature gradient is steepest beneath gorges and le
beneath ridges, and hence the underground annual isother
flatter than the uneven surfaces above them. This is the
with the uppermost isothermal of the soil, and the f
increase as we pass downwards until at a considerable de
become horizontal. Where the surface of the ground and
thermal surfaces beneath it are horizontal, the flow of heat
ical, and the same quantity of heat flows across all section
lie in the same vertical. In this case the flow across a h
area of unit area is equal to the product of the temperature
by the conductivity of the latter term be used in an extend
so that it includes convection by the percolation of water
as conduction proper, and hence, in comparing different
the same vertical, the gradient varies in the inverse rat
conductivity.

Since the effects of the cold generated by nocturnal
nevertheless accumulate on the surface of the earth, but the
solar radiation are spread to some height by a cending curre
the heated ground it might be expected that the annual
ture of the surface layer of the soil would be lower than th
at resting over them. Observations prove that such is t
spaces which have their source at greater depths than
which the annual wave penetrates have a constant tem
throughout the year, and if they do come from a depth cons
great as this they may be regarded as giving a ve
approximation to the mean annual temperature of the pla
temperature of cellars is often very near the mean annual tem
of the locality; at any rate this temperature may be se
cellar anywhere.

Distribution of Temperature in the Atmosphere.—
larger problems of meteorology, the distribution of te
ture in the atmosphere over the land surfaces of th
was the first that received an approximate solut
Humboldt). But as regards the ocean, which co
three fourths of the earth's surface, the question
monthly and annual distribution of temperature
atmosphere over it can scarcely yet be said to ha
erously looked at. The isothermals of the temp
of the atmosphere which cross the oceans continue
be drawn essentially from observations made on the
and along the coasts of these oceans. The firs
towards the solution of this vital problem in elim
and other branches of meteorology is the construc
charts of mean monthly temperature of the surface
of the sea over all parts of the ocean from which o
tions for the purpose are available. In prosecuti
line of inquiry, excellent work has been done
Meteorological Office as regards parts of the A
between the tropics and the ocean to the south of
and also by the Dutch, French, and German meteoro
With such charts it would not be difficult, by a
comparison during the same intervals of time betw
temperature of the surface of the sea and that of
resting over it, to construct monthly charts of the te
ture of the atmosphere over the oceans of the globe.

In this connexion the whole of the observations of the t
tures of the air and sea made on board the "Challenger" ha
examined, and sorted into one hundred and seventy-four
according to geographical position, and the differences ente
chart of the route of the expedition. In the Southern Ocean
latitudes 45° and 60° the temperature of the sea was low
that of the air, the mean difference being 1°·4. The tem
of the air is here higher owing to the prevailing W.N.W
and that of the sea lower owing to the numerous iceber
south of lat. 60° S. the sea was nearly 2°·0 warmer than
the result in this case being due to the open sea, which ke
higher surface temperature, and to an increased prevalence
higher latitudes of southerly winds, thus lowering the tem
of the air.

The period during which the temperature of the sea e
that of the air was from June 1874 to March 1875, or duri
part of the cruise from Sydney to New Zealand, and thro
East India Islands to Hong Kong and thence to the Ad
Islands. During the whole of this time, except when pas
north of Australia, the sea was much warmer than the

excess being from 2° to 3°, rising even near Tongatabu to of 4°. The climate of the southern part of this extensive t the seasons visited has a large rainfall, much cloud, and ently a comparatively small evaporation and sunshine In hen the "Challenger" passed the north of Australia the was very dry, the sunshine strong, and the evaporation nd there the sea was slightly colder than the air In the between lat. 20° N and 20° S the sea was everywhere the mean excess being about a degree, and in the Pacific lat 30° N. and 30° S the sea was also warmer, the mean eing a degree and a half

e other hand, in the Atlantic from lat 10° to 20° N the on the mean, half a degree colder than the air This region kable for the high pressure which overspread it for the nd currents which flow out in all directions for its clear ong sunshine, and consequently free evaporation, by which perature of the surface of the sea is lowered, and that of esting on it, being open to the heating influence of the sun, is raised. Similarly in the North Pacific from lat. 40° to temperature of the surface of the sea was half a degree low that of the air.

These remarks apply only to the observations made at the open sea Near land very great differences were o which varied with season Thus at Hong Kong during th half of November 1874 the sea was 3°·7 warmer than the low temperature of the air at this season being caused by th temperature of the land and the northerly winds which then on the other hand, at Valparaiso in November and Decembe following year the sea was 3° colder than the air during t week the "Challenger" was there the difference being du of the Humboldt current which sweeps northwards past that co the rapid increase in the temperature of the air at that time year. These results will help us in gaining some knowledg temperature of the air over the oceans of the globe in Febru August taken i temperature of t nexion with a careful examination of nonths represented in figs 8 and 9.

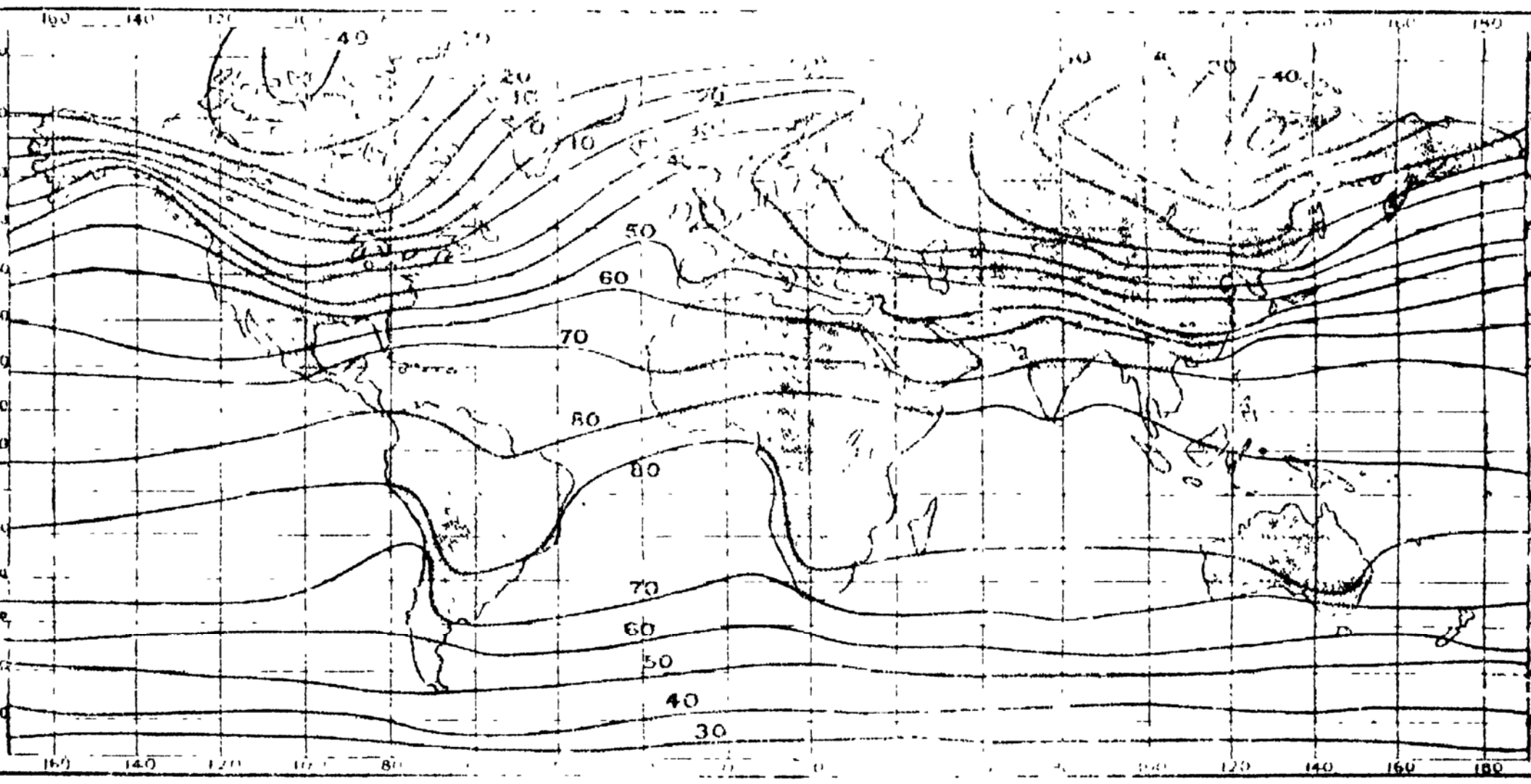


FIG. 10.—January Isothermals of the Surface of the Globe.

distribution of temperature over the surface of the s shown by figs. 10 and 11, which represent the ature of the two extreme months January and July eleven years 1870 to 1880. The region of highest ature, which may be regarded as comprised between th and south isothermals of 80°, forms an irregularly zone, lying in tropical and partly in subtropical es. On each side of this warm zone the tempera minishes towards the poles, and the lines showing ively the gradual lowering of the temperature are, speaking, arranged parallel to the equator, thus g in an unmistakable manner the predominating e of the sun as the source of terrestrial heat. While crease of temperature corresponds in a general way t may be called the solar climate, there are great ons brought about by disturbing causes ong these disturbing causes the unequal distribution and water holds a prominent place. In January rth presents to the perpendicular rays of the sun the niform surface, or the largest water surface, and the most diversified surface, or the greatest extent . Hence the zone of the earth's surface comprised n the isothermals of 80° is less irregular, and also s over an area more restricted, in January than in In July the areas enclosed by the isothermals of nd 90° are much larger in the Old World than New, it being the former which presents the larger land surface to the perpendicular rays of the sun, January, the summer of the southern hemisphere, th extensive area of high temperature seems in Afr the least in Australia, the high temperature area of America being intermediate In contrast to this of temperature exceeding 80° of least breadth w crosses the Pacific and Atlantic Oceans, the a minimum breadth being in July in the Pacific, the ocean, where the disturbing influence of the land is

During the cold months of the year, when the sun is least and the effects of terrestrial radiation att maximum, the areas of cold are over the large surfaces which slant most to the sun Thus the mean temperature that occur anywhere or at any on the globe is 55°·8 at Werchojansk (lat 67° long. 133° 51′ E.) in north-eastern Siberia In America the lowest isothermal is −10°·0 Dur winter the ocean everywhere maintains a high perature in all regions open to its influence, as is only in the higher latitudes to which the isotherma their way as they cross the Atlantic and Pacific, in their irregular course over and near the Mediter Black, Caspian, and White Seas, Hudson's Bay, the of the St Lawrence, the American lakes, and all oth sheets of salt and fresh water. The disturbing in of sheets of water on the temperature in all season strikingly shown when the isothermals are drawn fo

these marking out the prominent features of local s, a knowledge of which is of so great importance to iculturist, the horticulturist, and the invalid. Figs.

12 and 13 represent charts of temperature of this tion for the British Islands for 1870 1880 fr *Jour. of Scot. Meteor. Soc.*, vol. vi. In the winter

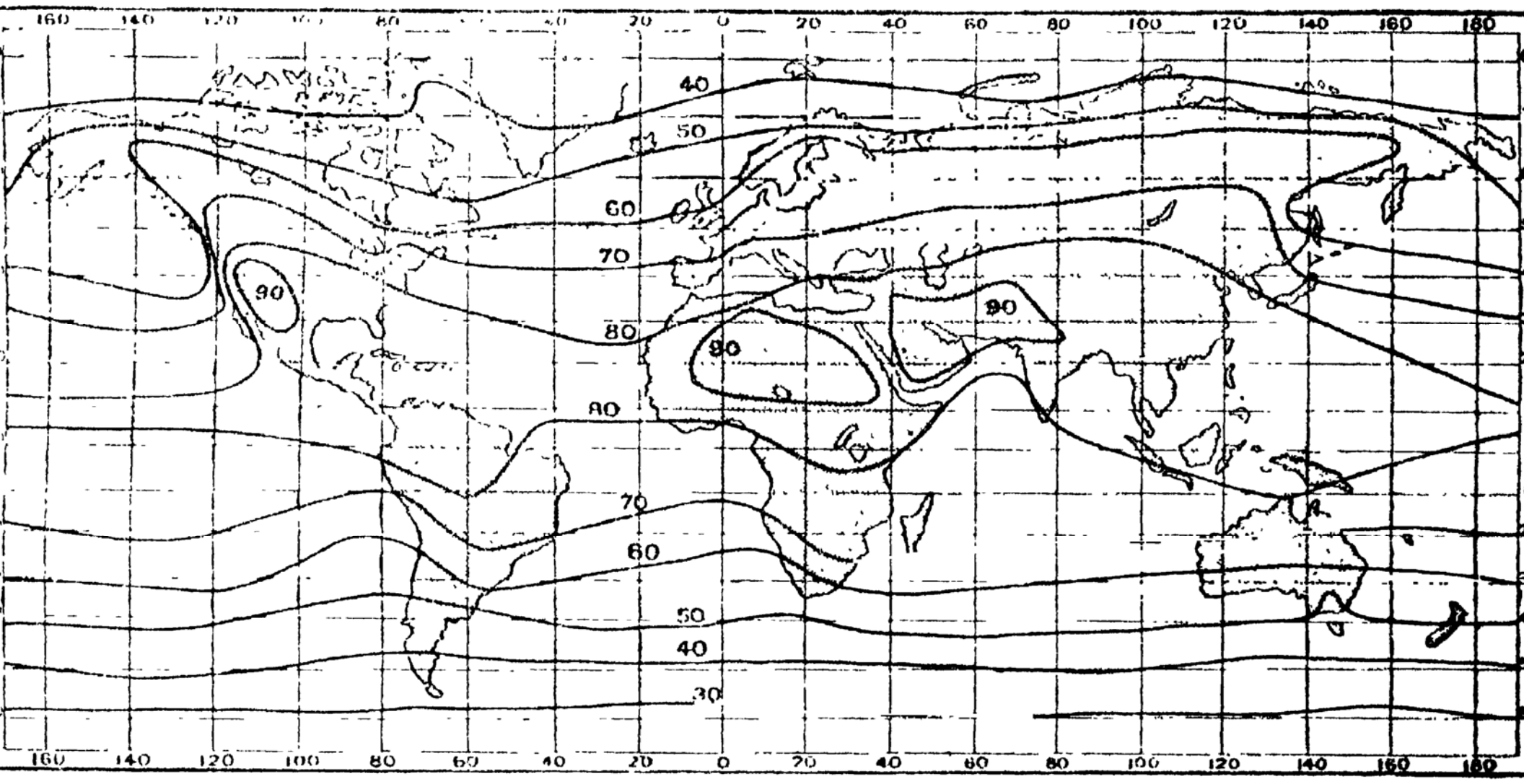
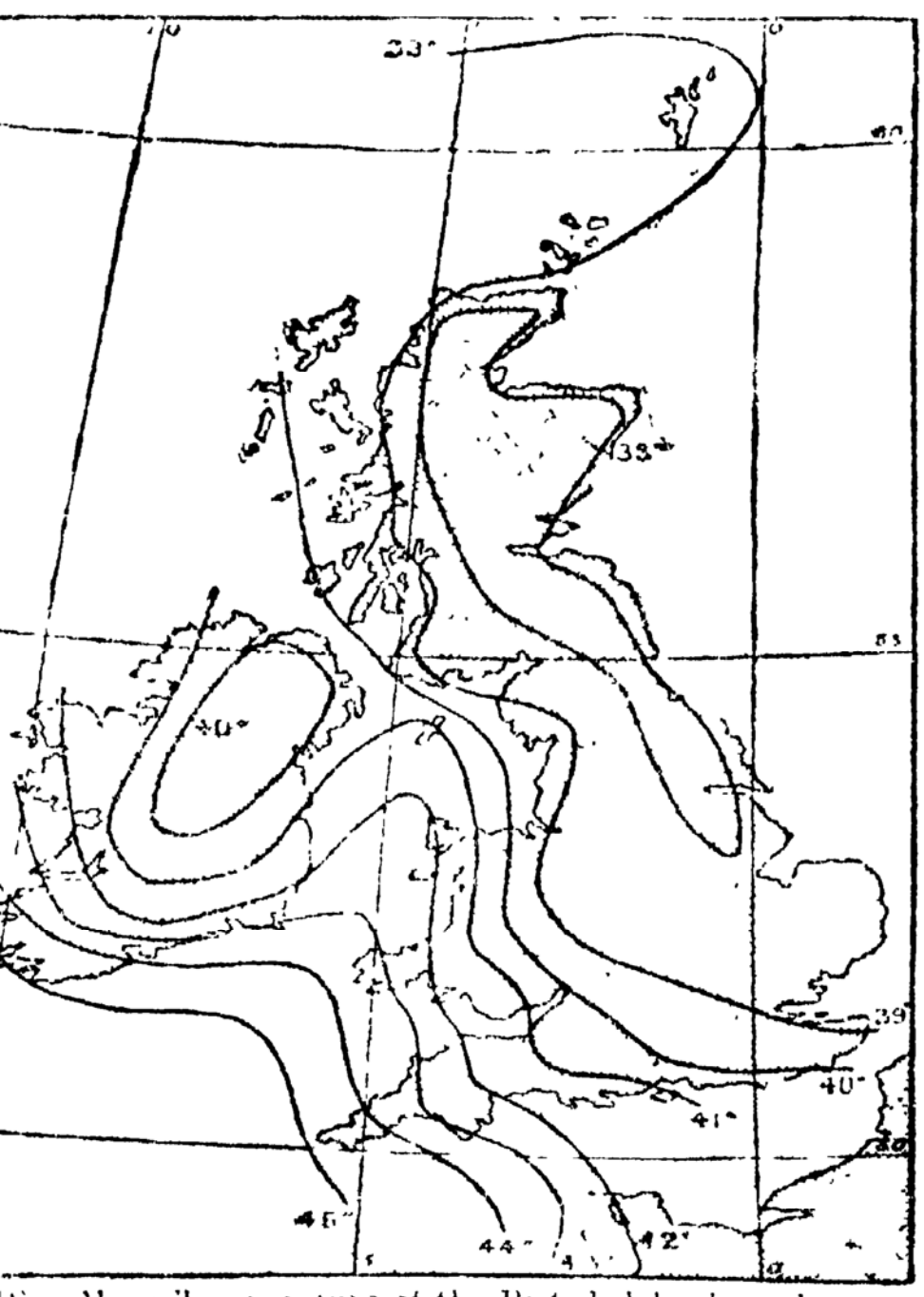


FIG. 11.—July Isothermals of the Surface of the Globe.

n hemisphere the depressing influence of the land temperature is but slightly felt, owing to the small



Mean Temperature of the British Island in January.

or the land surfaces and the comparatively low s to which they extend southwards. In the south

east of Australia and in the basin of the La Plata, temperature prevails in the interior.

Another prominent disturbing cause operating

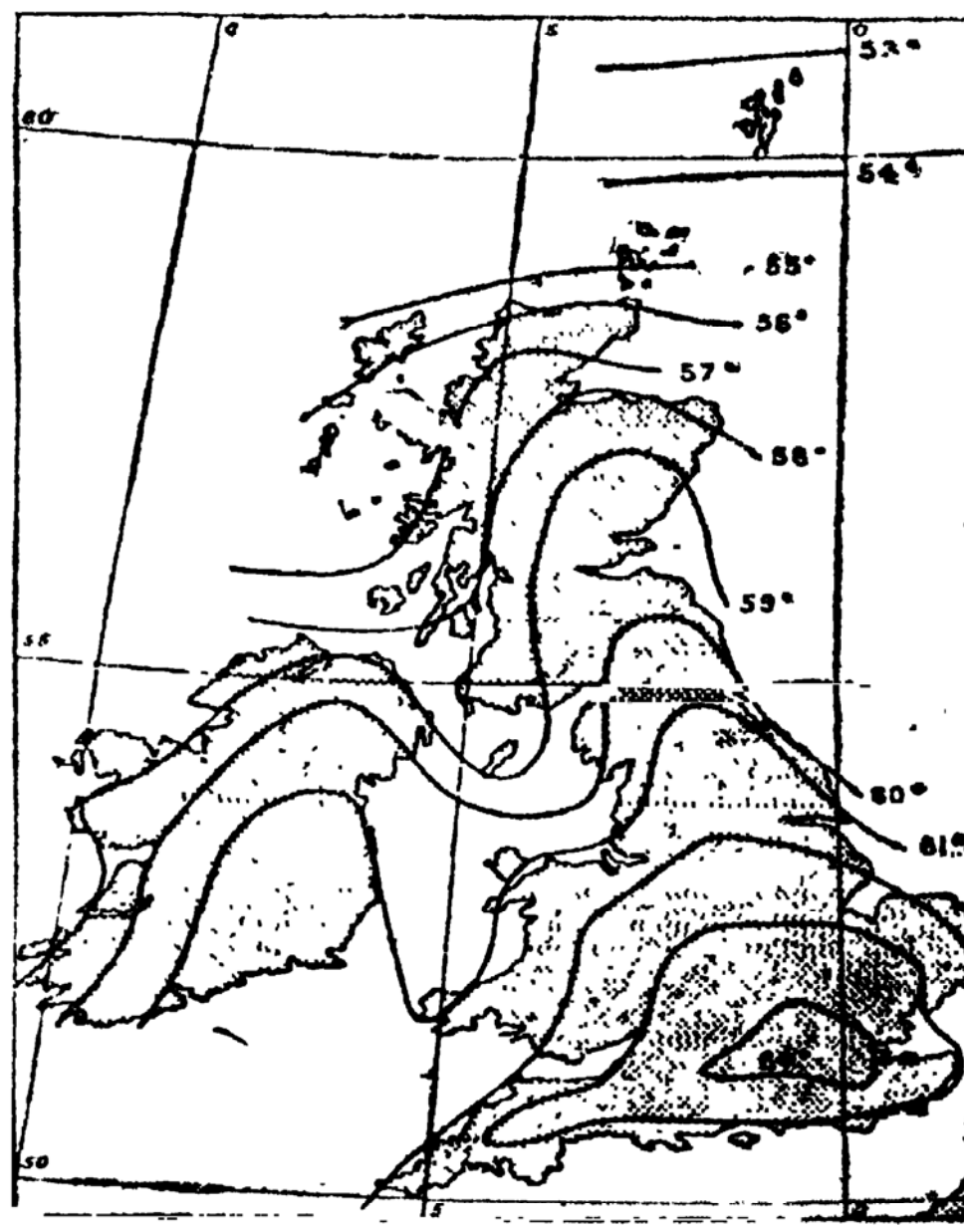


FIG. 13.—Mean Temperature of the British Islands in J

mean temperature is to be found in the seasonal low and high mean pressure in their connexion with vailing winds. Of these the most marked is the sy

low pressure about Iceland during the winter months (see fig. 14). Since this region of low pressure gives to western Europe its prevailing south-west and south winds, and to North America its north west winds in winter, it is plain that the temperature of western Europe is thereby abnormally raised by the simple fact of its prevailing winds coming from the ocean and from lower latitudes, and that the temperature of North America is abnormally lowered by its prevailing winds coming from the Arctic regions and from land. The opposite action of these two winds, which are part and parcel of the same atmospheric disturbance about Iceland, is shown from the fact that while the mean temperature of the south coast of Hudson's Bay in January is −20°, in the same latitude in the Atlantic to the west of Scotland it is as high as 44° or 64° higher. A similar though less striking result accompanies the low-pressure area in the north of the Pacific in winter.

Another area of low mean pressure which powerfully affects the temperature is the low barometer which overspreads the interior of Asia during the summer months (see fig. 17). Since from this disposition of the pressure the prevailing winds of Europe and western Asia are north west and west, and over eastern Asia south east and east, it follows that the temperature is abnormally raised on the eastern side and depressed on the western side of the continent by the direction from which they severally receive their prevailing winds. This is well shown by the course of the summer isothermals of 80°, 70°, 60°, and 50° across the Old Continent.

Since the strongest insolation occurs where the air is driest, the hottest summer climates are met with in those tropical and subtropical regions where no rain falls. The most extensive of the rainless regions during the summer months is perhaps that which extends from the Punjab westwards through Persia, Arabia, and North Africa to Spain. This is the region where the hottest climates of the globe are to be encountered. Similarly no rain falls at this time of the year in lower California and the States adjoining, and this feature of the climate, taken in connexion with the relatively low temperature of the coast due to the winds and ocean currents from the north which sweep past it, results in sharp contrasts of temperature within short distances such as have no parallel in any other climate.

Of the areas of seasonal high mean pressure, the high barometer of Central Asia in winter stands out in characteristic prominence (see fig. 14). Now, since the prevailing winds which necessarily form a part of this feature are south and south-west over Russia and western Siberia, the temperature of these inland regions is considerably higher than would otherwise be the case. On the other hand, since the prevailing winds are north west in eastern Asia, the temperature of these regions is thereby abnormally depressed. It is this consideration chiefly which explains how it is that, while the mean January temperature in latitude 60° and longitude 120° E. is −30°, in the same latitude but in longitude 43° E. the mean temperature is 10°, or 40° higher, even though both regions are equally continental in their character.

The high mean pressure in the summer in the Atlantic between Africa and the United States has with its system of winds the most decided influence in bringing about the abnormal distribution of the temperature of that and adjoining regions. Since on its west side the prevailing winds are necessarily southerly, the temperature of that region is abnormally raised, and, on the other hand, since on its east side the winds are northerly, the temperature of the region is abnormally depressed. The result of these two opposite winds is seen in the slanting direction of the isothermal of 80° across the Atlantic, which direction is continued far into the interior of North for the reasons already stated.

These important bearings of cyclonic and anticyclonic areas on temperature and climate may be thus summarized. The temperature is abnormally raised on the east sides of cyclonic areas, and abnormally depressed on the west sides; but, on the other hand, temperature is abnormally depressed on the west sides of anticyclonic areas and depressed on their east sides. In the southern hemisphere the conditions are reversed.

Another set of influences, powerfully affecting temperature, come into play where the surface of the land rises above the sea into elevated plateaus, lofty table-lands, or mountain ranges. Thus it has been observed on Ben Nevis and other mountains that the wind during the day in summer exhibits an ascensional tendency due to the circumstance that the temperature of the surface of the mountain is heated in a much greater degree than the air or strata at the same levels all around it. An ascending current consequently rises from the mountain, which is maintained at a steadily stronger rate than at lower levels because the drain from the updraught is easily supplied from the free surrounding atmosphere. It is this excessive insolation at high elevations in the summer months which explains the excessively high day temperatures encountered in the Rocky Mountains, and from the same cause, viz., the rarity and purity of the atmosphere, by which terrestrial radiation is but little checked, come the low temperatures of the nights of these climates in the summer season. From this cause it follows that the elevated regions in the interior of continents tend to reduce mean atmospheric pressure in summer to a greater extent than would otherwise be the case. In winter, on the other hand, the temperature of elevated regions in the interior of continents is very much colder than that of the surrounding atmosphere at the same heights, because in such regions the air is exceedingly dry and rare, and consequently radiates into the cold regions of space but little checked. Hence on the slopes of these high lands there are powerful directions descending currents of very cold air which intensify the rigours of the winters experienced on the lands round their base, where accordingly the lowest winter temperatures occur. These elevated lands also materially add to the high atmospheric pressure in the interior of continents during the cold months of the year.

But it is ocean streams and ocean currents which produce the greatest abnormalities in the distribution of the temperature of the air, and a glance at figs. 10 and 11 will show that it is in the North Atlantic where this cause is most strikingly seen. The increase thus accruing to the mean temperature is greatest about the north of Norway, but also very great in the British Islands, thus, if the heat were received than is due to their position on the globe in respect of latitude, the mean winter temperature of Shetland would be 3° and that of London 11°, mainly owing to the heat given out by the Gulf Stream and other warm currents of the Atlantic their mean winter temperatures are respectively about 39°·5 and 39°, being thus benefited 36°·5 and London 22°. The high winter temperature of the British Islands well illustrates the influence of the surrounding ocean in maintaining a higher temperature. It will be seen that the south coast of Ireland is 7° warmer than the east coast of England in the same latitudes. The strong drift current from Behring's Strait southward along the coast of America has a powerful influence, particularly in lowering the winter temperature of that coast, thus bringing about, in conjunction with the dry rainless climate of the interior, what are perhaps the most violently contrasted climates

limits, as regards their temperature. The deflexions isothermals near the Baltic, Mediterranean, Black, aspian Seas and the freshwater lake of America nt to the disturbing influence of the sheets of on the temperature

height and direction of mountain ranges is an ant element in determining climate If the ranges pendicular to the prevalent wind and of a con le height, they drain the wind of much of their e, thus cause to place to leeward colder winters tter summers, by partially removing their protecting of vapour, and exposing them more completely n and terrestrial radiation Of this Norway and n and the British Island form excellent illustrations hin that makes the most important distinctions climate in regions near each other, as respect both and vegetable life With regard to the decrease of ture with height, very much yet remains to be done an approximation to the law of decrease can be

During the five months observations were made n Nevis in the summer of 1881 the difference n the mean temperature at sea-level adjoining and top of the Ben, 4406 feet above the sea, was 15 7, how a mean decrease of 1 Fahr for every 280 elevation The actual differences from day to day from 1 1 to 23 2 As Ben Nevis forms a peak, in the very middle of the strong winds from the r, it is highly probable that this rate of decrease is approximation to the true decrease of the tempera the air during the summer months in that part of itish Islands When observations are made on l plateaux of some extent, the rate of decrease l from the observations will be less than the true the free atmosphere in summer and greater in The rate is thus a variable quantity, varying with , situation, dampness or dryness of the air, calm or weather, and particularly with the season of the One degree Fahrenheit for every 300 is the rate of generally assumed

ount of Aqueous Vapour It is scarcely possible to mate the importance of a knowledge of the hori and vertical distribution in the atmosphere of its vapour, for it may be truly said that it forms one prime factors in all the larger problems of atmo physics A first rough approximation to the ac- al distribution of the vapour of the atmosphere was d by Mohn in 1875 in his *Grundzüge der Meteoro* 81, in which vapour pressure curves are drawn for ne for January and July. These leave much still one, not only in a further discussion of observations made, but also in improvement of the methods of tion and in the tables for their reduction. The nt of interest in Mohn's vapour curves is their e resemblance to the isothermal of the same months, which goes to show that this line of inquiry is yet des- to make large contributions to our knowledge of the ne change which occur in the pressure, temperature, ture, and movement of the atmosphere.

less is known of the vertical distribution of aqueous It decreases, like temperature, with the height, the statement generally made be at all correct, that the whole vapour of the atmosphere is contained in est 6000 feet, and that at 20,000 feet high there is bout a tenth of what is at the earth's surface, the rate ase with height proceeds at a greatly more rapid rate consistent with the supposition that it forms an ndent vapour atmosphere existing under its own e. The establishment of an increased number of vel stations, and a more systematic inquiry than has en attempted into the upper currents of the atmo sphere, are much needed in the further development branch of meteorology. In carrying out the i invaluable assistance will be obtained from observa the diurnal range of the barometer and from well- methods of observing the effects of solar radiation earth's surface.

Amount of Cloud. In Scotland, which lies com within the region swept by the south westerly win the Atlantic, and presents a well-defined mountain lying across the track of these winds, the clouds distinct annual period. In the west, at places qui to these westerly breezes, the amounts of cloud in summer, autumn, and winter are respectively 67, and 74, and the annual mean 70.[1] In the east, districts as East and Mid Lothian, which have ex ranges of hills between them and the Atlantic, the tions are 59, 63, 62, and 60, and the annual me Thus about a tenth more of the sky is covered wit at the western as compared with the eastern situatio the distribution of cloud differs materially in weste eastern climates In the west winter is the cl season, but in the east it is summer, and these are tively the months when most rain falls in the climates. Everywhere spring is the season when is clearest. In England, owing to the protection a by Ireland and Wales to the west and the comp absence of ranges of hills, the amount of cloud is le in Scotland, and it is more equally distributed o country. The minimum amount occurs in spring, a maximum in winter and autumn.

Some of the best illustrations of the seasonal variation distribution of cloud are afforded by the Old Continent variations are the simple consequence of the systems caused by the high winter and low summer pressures of th ment. In eastern Siberia the prevailing winds in winter a or continental, and in summer S E. or oceanic, and acc at Yan, Nertchinsk, and Blagoweshtchensk the mean of cloud in these two seasons are 18 and 11. On the oth in western Siberia and eastern Europe the prevailing w winter are S W., or from lower to higher latitudes, summer N W, or from higher to lower latitudes. Kazan taken as fairly representing this extensive region and t amount of cloud for the four seasons beginning with are 71 48, 44, and 62. As the N.W. winds of summer r the Ural mountains in their course, condensation of the vapour is increased, and hence over this region the cloud i and summer is nearly the same, the mean amounts at Bog Ekaterinburg, and Zlatoust being respectively 53 and 52. and Kutais, situated on the high ground which lies betw Black Sea and the south of the Caspian Sea, the means fo and summer are 53 and 55 On the eastern coast of the B the westerly winds of summer are accompanied with the maximum cloud, the winter and summer amounts at Re being 59 and 69 In Central Siberia, to which the S.W. winds do not extend, and to the north of latitude 55°, the of cloud is much diminished, and the cloudiness of summer i the same as that of winter.

In India, in all regions which lie open to the summer m the minimum amount of cloud occurs during the win the maximum in summer,—the mean amounts being 19 at Calcutta, 16 and 86 at Bombay, 18 and 71 at Colom 25 and 90 at Rangoon At Trincomalee, on the east Ceylon and thus exposed to the rains of the N.E. m of winter, and largely protected from the rains of th monsoon of summer, the amounts of cloud in these seasons and 59. At Darjiling (6912 feet) and Chakrata (7022 feet both on the Himalayas, whither the summer monsoon pen the mean amounts are respectively 53 and 86, and 43 and Leh, in Kashmir, the amounts are 59 and 51, the excess be in winter In the Punjab and to westwards, or those reg southern Asia to which the summer monsoon does not exte cloud in winter is everywhere greater than in summer. T amounts are 21 and 18 at Mooltan, 38 and 25 at Peshawar, 19 at Jacobabad, and at Quetta, in Baluchistan, 5500 feet and 14 Similar relations as to cloud obtain in Australia other continents where high pressures rule in the interior

[1] In this section the amount of cloud is stated in percentage sky covered with cloud

months and low pressures during the warm months of the
The maximum cloud occurs with winds from the sea and
lvancing into the colder regions of higher latitude, and
mum with winds which have traversed an extensive track of
winds advancing into the warmer regions of lower lati-
As the subject, however, is essentially one with rainfall, it
cessary to prosecute it further.

other atmospheric movements on which the amount
l depends are the ascending and descending currents
atmosphere, the ascending currents with clouded
curring in the belt of calms and over cyclonic areas
gions, and the descending currents with comparat
clear skies over anticyclonic regions. The region
imum vapour and densest cloud-screen on the globe
equatorial belt of calms between the trades, which
annual movement northward and southward with
as already explained. To seasonal movements
ascribed part of the cloudiness of the southern and
sides of the winter cyclonic regions of the North
c and North Pacific, and of the cyclonic region of
mmer pressure in the interior of Asia and other
nts. On the other hand the comparatively small

amount of cloud in the anticyclonic regions of the A
and Pacific Oceans, and in the high pressure regions
interior of Asia and other continents during the cold
of the year, is due to the vast down-currents which
the centres of the anticyclones, and which
relatively drier as they descend owing to the in
pressure to which the air is subjected.

Distribution of Atmospheric Pressure.—The impo
of a knowledge of the distribution of atmospheri
sure, or of the mass of the atmosphere, over the
in its varying amounts from month to month i
evident. Observation teach us that winds are
the movements of the atmosphere that set in from
there is a surplus towards where there is a defici
air; and observations also teach that isobaric map
maps showing the relative distribution of mean pr
and maps showing the prevailing winds are in acc
with each other. Since prevailing winds to a large
determine the temperature and rainfall of the
they traverse, isobaric maps may be considered as f
ing the key to the more important questions of m

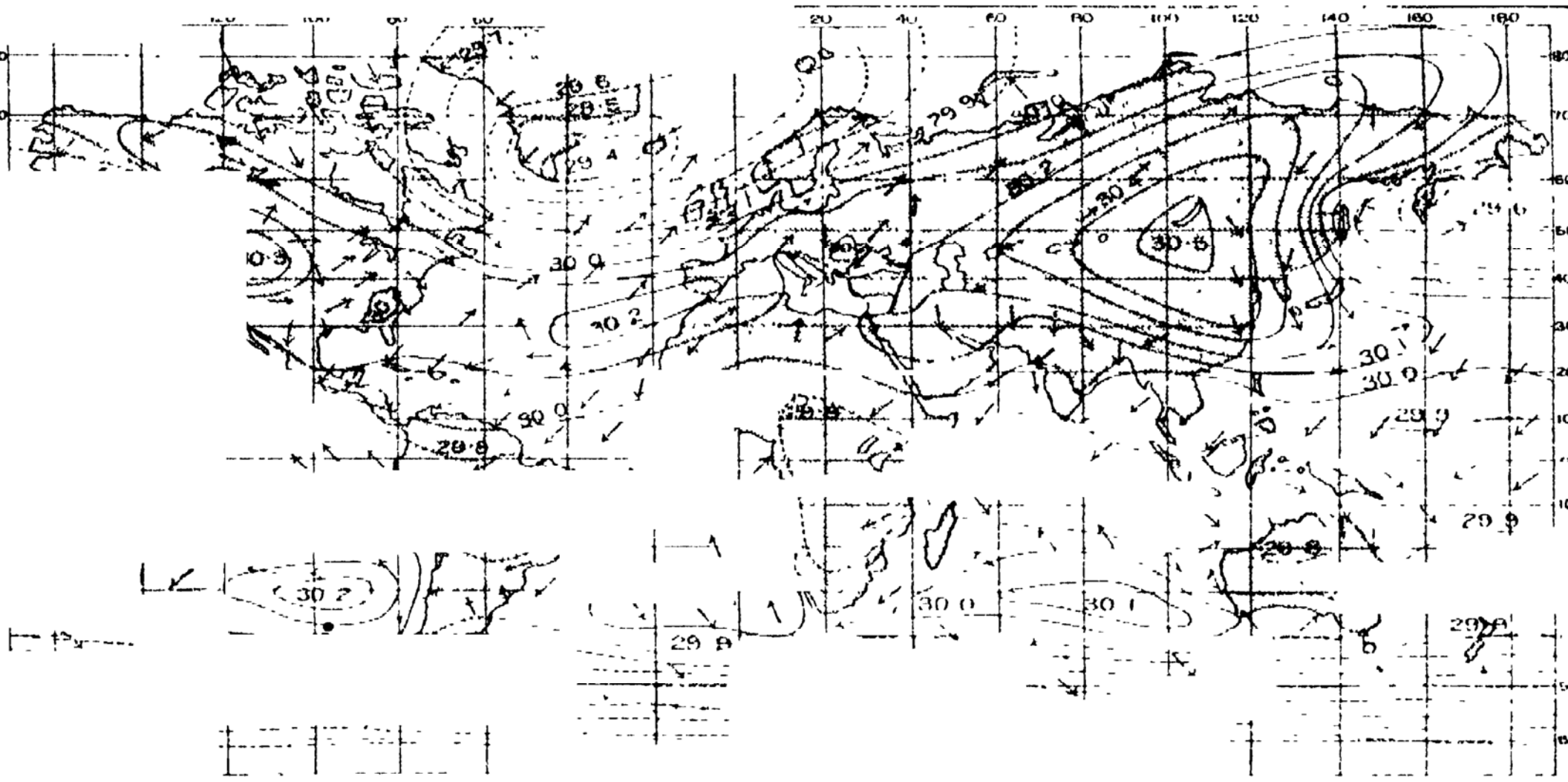


FIG. 14.—January Isobars of Globe and Prevailing Winds.

inquiry. At the time of the first publication of
maps of the globe in 1868, it was impossible to
re than present the subject in its broad general
s, owing to the scantiness and quality of the
ls then existing. But since then meteorological
s have been largely multiplied in all parts of the
d world, and the general adoption of the issue of
warnings has necessitated the use of more accurate
eters and uniform methods of observing. Since
s thus now the means of a more exact representation
s fundamental datum of meteorology we have
ed a new set of isobaric maps, showing the distribu
the earth's atmosphere and the prevailing winds
nuary (fig. 14), July (fig. 17), and the year. They
been constructed from mean values calculated for the
eleven years (1870–80 inclusive) as the isothermal
igs. 10 to 12, pressure of 30·0 inches and upwards
represented by solid lines, and of 29·9 inches and
by dotted lines, while the arrows show the directions
prevailing winds at the localities indicated by the
tive arrow-points.

Mean Atmospheric Pressure in January (fig. 14).—In this
when the influence of the sun on the northern hemisphere
the minimum, the greatest pressures are massed over the co
of that hemisphere, and
est pressures over the northe
of the Atlantic and Pa
Ocean, over the Antarctic Oc
southern hemisphere generally. In the southern hemisphe
are three patches where pressure rises to 30 inches, viz.
Atlantic between South America and Africa, south of the
Ocean, and in the Pacific between Australia and South Am
In the northern hemisphere, on the other hand, pressure
Central Asia to upwards of 30·5 inches, the mean pres
nary being at least 30·4 inches at Peking, Semipalatin
and fully 30·5 inches at Irkutsk and Nert
upper basin of the Amur. This is the region wh
normal atmospheric pressure attains to a maximum v
much higher than is reached in any other region at a
time of the year. It will be observed that the
highest pressure occupies a position near the centre of th
continent. The area of high barometer is continued w
through Europe, through the horse latitudes of the At
Carolina, and thence through the United States to C
whence it crosses the Pacific to Asia. The belt of high
thus completely encircles the globe, broadening as it pa
land and contracting as it crosses the ocean. Its greatest
is over Asia and at least over the Pacific, or where
ocean attain respectively their maximum dimensions.

res greatly under the average cover the northern portions
ne the and Atlantic and also the greater part of the Arctic
In the north of the Pacific the normal pressure falls to
29 6 inches between Kamchatka and Alaska In the
the Atlantic, however, a still lower mean pressure obtains
narrow belt stretching from Iceland to the south of Green-
e normal at Stykkisholm in the north west of Iceland being
nches and at Ivigtut in Greenland 29 61 inches This
ge for Ivigtut is the lowest monthly mean to occur any-
nd at any season in the northern hemisphere, and it is
nt that the places immediately to the north of that part
Atlantic where cyclonic disturbances of the storms which
ver Europe have their origin and where not a few of the
which cross the Atlantic to Europe develop intensity
been seen that the lowest mean pressure occurs near the
f the Irish Sea but as regards the two oceans
west pressure is met with in the northern division of the
, which is the lower ocean An inspection of fig 14 shows
that the low pressure area of the Atlantic is bounded to
nd by systems of much higher pressures than are to be
the Pacific The result of this arrangement is that much
winds flow northward over the Atlantic and round upon
, and, as the more quickly advance into colder latitudes,
ting a greater and more frequent concentration of vapour
ence of the barometer in the north of the Atlantic The
mate of north western Europe may be referred to as con
this view

of low pressure presses through the equatorial regions
und the globe This marks the well known region of calms
which on either hand the trade winds blow In the
it lies quite north of the equator even in January, when
s nearest is furthest to southward, and it lies nearly parallel
equator On the other hand, in the Indian Ocean the
of the line of lowest pressure to the south of the equator
parallel with it, but taking a fruitless course from near the
Madagascar towards Sumatra, thence towards the low pres
h prevails at this season in Australia, its course is then a
northwards, and across the Pacific to the central regions of
merica It path is thus a devious one, being north of the
only in the eastern part of the Pacific and in the Atlantic,
where to the south of it, being drawn farthest southward
nder the influence of the regions of low pressure which now
central Australia, central and southern Africa, and central
America In this trough of barometric depression nearly
ropical storms of the Indian Ocean have their origin
are several important modifications of the isobaric lines
nally published In 1865 the region of lowest pressure in
hern hemisphere in winter was represented as extending
land to north eastward, now the area of lowest pressure
o extend from Iceland south westward to Greenland. In
on with the point Captain Hoffmeyer discussed the
of the North Atlantic during several winter months, and
d the result in 1878, which conclusively showed that the
logy of Greenland and Iceland exerts on the distribution of
ric pressure a powerful influence not before properly recog-
sulting in the mean minimum of pressure being located
y to the south west of Iceland, and that in addition to this
n there are two subordinate minima, one in Davis Straits
other in the Arctic Ocean midway between Jan Mayen and
ern Isles The investigation further established the fact
o any particular one of these three minima plays an
t part the other two either do not appear at all or occupy
subordinate place, and that according as one or other of
ric pressure predominates so is the character of the
and mildness or severity of the winter of north
regions surrounding the North Atlantic As
Greenland the displacement of the minimum to west
the prevalence over it means milder winter weather,
on the direction of the north of Norway
important consequences seen in the
area of one, two distinct centres of
either the high pressure of the
separated from that of the south
low pressure occupying the region
Mississippi States Professor Loomis first drew attention to
ularity in [illegible] into the distribution of
over the United States established the fact that there
distinct areas of high pressure the larger having its centre
and the less over Pennsylvania the greater portion of the south-
and southern States, and that these two areas of high pres-
clearly separated from each other by a broad extensive
of lower pressure stretching in a south-western direction from
ion of the great lakes to western Texas The reason
by Professor Loomis is undoubtedly correct, that the
ly low normal pressure of the Mississippi States is due to
that the path usually taken by the barometric minima of
American storms in the earlier part of their course is from
the lakes Since, on the other hand, the centres of compa
few storms, with their low barometer readings, cross the s
and south eastern States, the normal winter pressure is high
than it is along the Mississippi.

Another important modification occurs in India, where th
of 30 inches is deflected to the south east toward Mad
thence towards the north east to near Akyab in Arakan
remarkable deflexion well shows the important influence ex
the course of the isobar by large well-defined sheets of wa
extensive tract of land The distribution of pressure here in
by which south of lat. 22 the normal pressure is cons
higher in the east than in the west of India, has, through the
of the winds resulting from it, the most intimate and vital
on the distribution of the winter rains and temperature o
siderable portion of India; and the same relations hold, t
degree still more striking, in the meteorology of Ceylon.

The remarkable effect in interrupting or changing the
the isobars is perticularly well illustrated by the lines in th
of the Aral Caspian, and Black Seas As the point is of
importance in meteorology, and is best illustrated by the

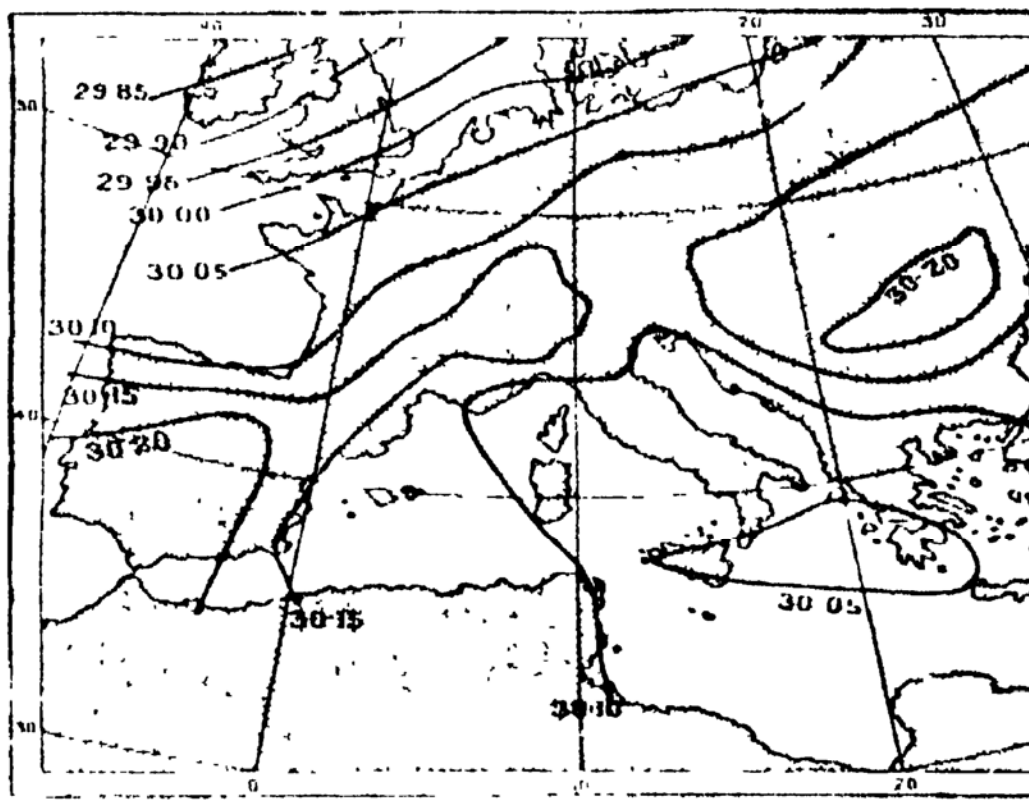


FIG. 15. Isobars of Europe for January.

ranean and the countries to the north of it, we subjoin a ma
part of Europe (fig. 15), showing the normal pressure with
distinctness and fulness than could be shown on fig. 14, the
being drawn for every half-tenth of an inch.

Here we see two distinct areas of high pressure, the
Hungary and the other in the Peninsula, where the normal
exceeds 30 20 inches The latter is the larger of the two, a
be regarded as the prolongation of the region of high pressu
characterizes the Atlantic immediately to the south west
season The high pressure area included within the isob
inches is of peculiar interest. In the Peninsula it covers
broad area, but to the north-east it contracts to a narr
between the Bay of Biscay and the Gulf of Lyons, and again
to north eastward covering the distance from Carlsruhe to
its prolongation eastward being there somewhat sudden
impeded At some distance to the eastward the second region
pressure is met with, which is properly a part of the high
that overspreads the interior of the Old Continent in the
months, its western limit being the isobar of 30 15 inche
presses round by Pinsk, Cracow, Vienna, Laibach and th
southern slopes of the basin of the Danube, Sebastopol, an
southward in the direction of Cyprus.

The position of the latter of these regions of high pre
approximately midway between the south coasts of Asia M
the Baltic In other words, its position occupies the interi
part of the Old Continent; and it is instructive to note
portion of the Black Sea and the Greek archipelago in t
portion of this region pushes the isobar of 30 15 inches a g
to northward The position of the region of high pressur
Peninsula, France, and Switzerland is also decidedly inl
does not, however, exactly occupy the middle space of
lying between the Mediterranean and the North Sea, o
doubt to the circumstance that the very steep barometric
from France to Iceland greatly lowers the pressure over th
of the northern half of France It follows that the ab
high pressure which so remarkably characterizes the interi
Old Continent during the cold months of winter is repr
though in a greatly reduced form, westwards through the
districts of that continent.

These two regions of high pressure are separated from ea

ge area of comparatively low pressure overspreading the
ortion of the Mediterranean Sea, marked off in fig 15 by
r of 30·10 inches, within which pressure is everywhere less
·10 inches. This region includes an area of still lower
within the isobar of 30·05 inches, bounded by Sicily,
thens, and Crete. Hence the singularly low pressure which
rizes the northern part of the Atlantic at this season in its
in the south of Europe, which is unquestionably due to
ner temperature and larger humidity of the climates of
Europe which they owe to the Mediterranean.

leserving of special notice that, while the increase of the
ressure of January from Genoa to Geneva is 0·081 inch,
ly 0·021 inch from Trieste to Riva, and that to the north
driatic as far as latitude 50° pressure is considerably lower
ains to the west and east of that region. An examination
aily weather maps of Europe shows that not unfrequently
ns of north-western Europe on advancing as far to east
Denmark seem to connect themselves in some degree with
anean storms prevailing at the time through a north and
olongation of a system of low pressures. The comparative
y with which this occurs is probably occasioned by the
drift to eastward of the atmosphere of Europe considered as
, taken in connexion with the high mountainous ridge
unds the Adriatic on its eastern side, from which it follows
air overspreading the deep basin of the Adriatic is often
saturated with vapour, and thus highly saturated air
northwards through central Europe when north-west
f Europe with low barometric depression centres pa across
s and the Baltic. Thus the low normal pressure to the
the Adriatic, separating the two regions of high pressure
ast and west of it, is in some respects analogous to the
nal pressure of the Mississippi valley, which separates the
normal pressures of the Rocky Mountains and of the south
f the United States.

nfluence of land and water respectively in the cold season of
is well shown in fig. 16, which represents for every 0·020
e normal pressure over the British Islands in January,
from means calculated for two hundred and ninety-two
1

n the winter months that the isobars of the British Islands
most closely together, and in accordance therewith strong
re then most prevalent. The crowding of the isobars
the maximum in January, forming what is probably the
mean monthly barometric gradient that occurs at any
anywhere on the globe. The point however, to which
is here drawn is the remarkable influence of St George's
and the Irish Sea in diminishing the pressures as they
so seas, and of the land in increasing the pressure, which
n the curves occupying approximately the central districts

of Great Britain from the Isle of Wight to Cape Wrath,
shows on a comparatively small scale the influence of the

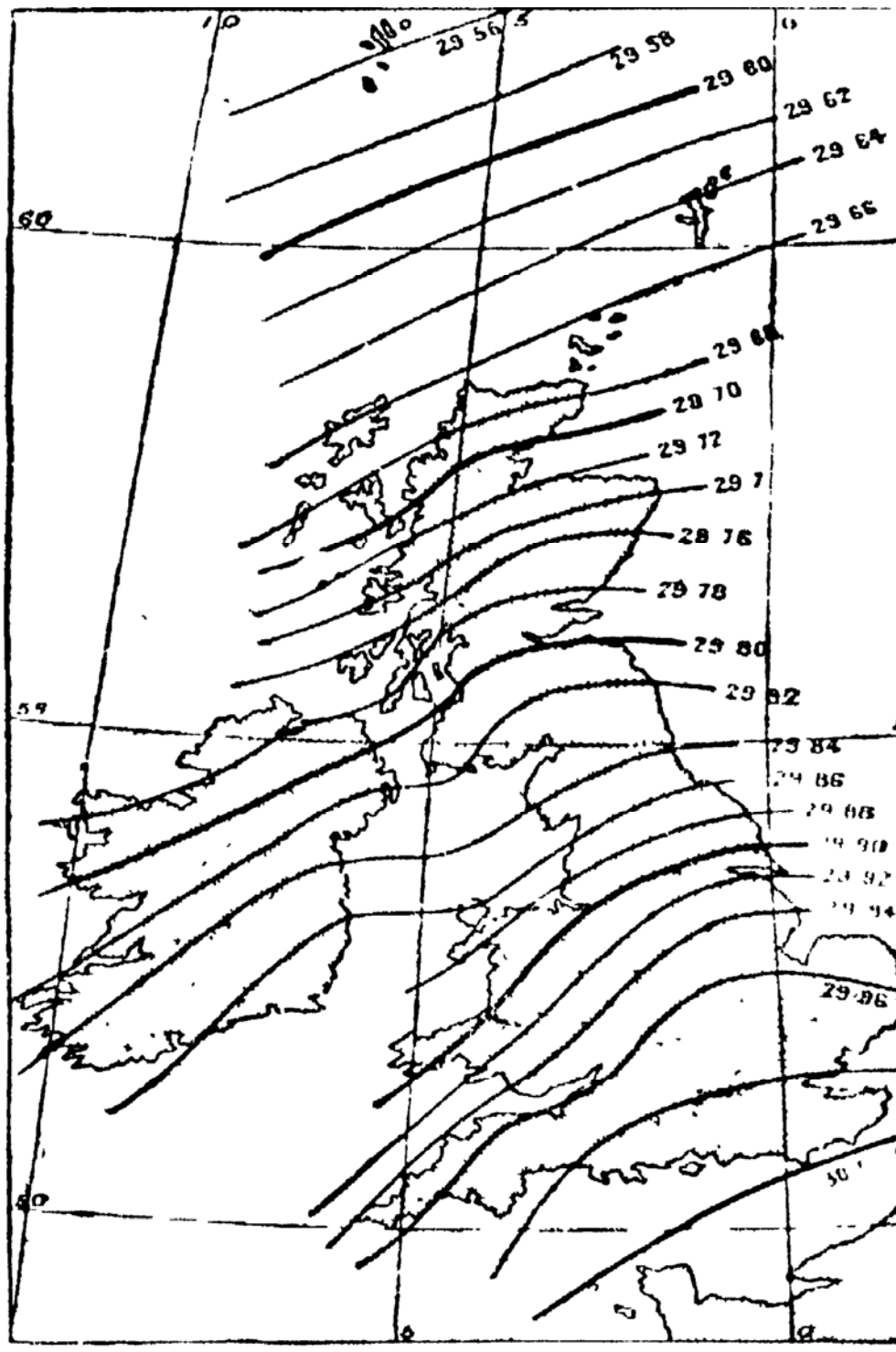


Fig. 16.—Isobars of the British Islands for January.

raising the normal pressure, and of the sea in lowering it, du

Fig. 17.—July Isobars of the Globe and Prevailing Winds.

nths of the year, just as is seen on the grand scale in central
and the north of the Atlantic.

Journal of Scot. Meteorological Society, vol. vi. pp. 4–21.

Mean Atmospheric Pressure in July (fig. 17). In this
physical conditions are the reverse of what obtains in Jan
effects of the influence of the sun on the temperature and
of the atmosphere owing to the maximum in the northern

he minimum in the southern hemisphere. With the solar
ns reversed, a comparison of figs. 14 and 17 shows that the
tion of atmospheric pressure is duly considered on a broad
e reverse of what takes place in January.
he southern hemisphere atmospheric pressure during the
season is above the general average of 30 inche between
and 40° S. This belt of high pressure encircles the globe,
by four regions where the pressure is considerably above
eral hemispheric average. The first region is in South Africa, about
where it rises to a little above 30·5 inches; in Australia,
rises on the Murray to nearly to 30·40 inches;
h America, where on the La Plata, about lat. 30°,
to 30·1 inches, and it rises eastwards and westwards, where it
30·07 inches. The pressure is lowered with respect to the
of the three centres of high pressure at this season—that they
ce surface between 25° and 30°. A comparison
nearly, pressure is duly the whole of the broa
the southern hemisphere, about two-tenths of an inch
which is the amplitude of variation. A comparison of
and Java shows that the large accession to the pressure of
hemisphere is accompanied by an extraordinary d
of pressure over the continents of the northern hemisph
pressure during the winter
northern normal pressure occurs in the continent of Asia, the
diminution of pressure in the summer months takes place
continent. The positions, however, of the two extreme
on being, in the one region or even near each other. In
continent the maximum occurs in the valley of the upper
sia, at Nertchinsk, the normal pressure in January is
·500 inches, whereas the lowest normal pressure in July is
inches, and over as far as observations enable us to locate
obtained on the west side of the basin of the Indus. The
of these two normals is 1·55 inch; and over no inconsider
tion of central Asia the normal pressure of July is much
that of January. In other words, the influence of the sum
is exerted on the temperature and aqueous vapour of the
and atmospheric movements resulting therefrom is so
as to remove a thirtieth part of the whole mass of the
the extensive region.
The extension in recent years of good meteorological stations
Russian and Indian empires enables us to lay down with
greater precision than formerly the lines of pressure. Of the
indicated by the new isobars the most important perhaps
sence of the region of minimum pressure in Asia, which is
to occupy the basin of the Indus, and thence stretches
somewhat broad region to westward nearly as far as the basin
Caspian Sea. The point is of no small importance in atmo-
physics inasmuch as it places the region of least normal
in July as close geographically to the region where at the
mid-temperature is highest as the region of highest normal
in January is situated with respect to the region where in
both cases mid-temperature is lowest in Asia.
The colour of India are of special interest, and imply con
siderable practical advantage to the empire. From
southward the normal pressure is everywhere higher and
ably so, along the whole of the west than it is on the east
India—the difference being approximately half a tenth
inch. This is represented on the map by the slanting of the
from north-west to south-east as they cross this part of
and it is to be noted that the east and west coasts of Ceylon
the same kind of distribution of the pressure. The conse-
of this peculiarity in the distribution of the pressure is that
summer monsoon blows more directly from the ocean over
the southern India than would have been the case if the
had been even and west and thus probably precipitates in
greater abundance rainfall over this part of the empire.
same anomaly in the sequence follows from the geographical
tion of the pressure over the valley of the Ganges. If the
pressure there were diminished in the manner it does over
the south of the Ganges valley, the winds would have
south-westerly and the summer climate practically rainless.
however, is not the case, but the normal pressure diminishes
ds along the valley of the Ganges as the following mean
ssures will show: Calcutta, 29·576 inches; Patna, 29·535
Lucknow, 29·502 inches; Roorkee, 29·505 inches; and in
westward into the Punjab pressure falls still lower—to
nches at Mooltan and 29·442 inches at Jacobabad. Indeed
in July is 0·290 inches lower at Jacobabad than at Sibsagar
Brahmaputra, nearly in the same latitude. It necessarily
rom this distribution of the pressure that the summer mon
which blows northward over the Bay of Bengal, is deflected
E S E wind which fills the whole valley of the Ganges,
ing on its way a most generous rainfall over that magnifi
ion.
influence of the land in lowering the pressure in summer is
strated by the course of the isobars over western Siberia
sia, where pressure is seen to fall relatively lowest along
the middle line of the Old Continent. In this connexio
interesting to note the course of the isobar of 29·90 inc
that part of Europe where the breadth of the land is cons
increased—between the Baltic and Constantinople. In co
junction to this the influence of the Aral, Caspian, and Bla
in maintaining a higher pressure appears in the remarka
longation eastward of the isobars of higher pressure over th
of these seas, being in striking contrast to the lower pressure
prevail to the north and south.
The lowering of the normal pressure is very decided in th
regions of Spain, North Italy, and Scandinavia. The effect
strongly seen in Spain, the largest and compactest of these
Thus, while the normal pressure diminishes between Lisb
Barcelona from 30·086 to 30·018 inches, the sea-level pre
Madrid falls nearly to 30·000, and the pressure at Saragos
Valladolid is nearly a low. The lowering of the pressure
interior influence materially its summer climate. As rem
an illustration of the principle can be pointed to anywhere
in the north of Italy; for while the normal pressure at Mo
is 29·941 inches, at Genoa on the coast the relatively high
of 29·992 inches is maintained, the distance of the two place
about 40 miles. To the east pressure rises to 29·970 i
Venice, and to westward to 30·023 inches at Geneva. Over
navia, along the west coast from the Arctic circle southw
normal pressure equals or exceeds 29·80 inches, the variatio
comparatively small; and along the coast from the head of
of Bothnia to the south-east of Sweden pressure is also excee
inches, and the increase from north to south proceeds at a sl
In, however, the strictly inland districts to the north
Christiania, which lie immediately to the east of the Scand
, and sheltered by that lofty range from the wind
Atlantic, pr erably lower than it is along the
west coasts of the peninsula. Owing to this peculiar dist
of the pressure, the winds which necessarily result from i
much finer summer climate to the south-east of Norway an
strictly inland part of Sweden than would otherwise be the
The remarkable curving northward of the isobar of 29·8
so as to include Lapland within it points probably to the i
of the White Sea and the wonderful lake system of Lap
maintaining a higher summer pressure over that country, b
the northerly winds that blow towards the low-pressure r
Central Asia, to the serious deterioration of the summer cl
northern Siberia, do not extend so far to westward as Lapl
The distribution of the normal pressure over North A
quite analogous to what prevails over Asia, but, the contine
less, the diminution of pressure in the interior is also cor
ingly less. The highest normal pressure, 30·077 inches, is
the south-east in Florida, and the lowest, 29·780 inches, in t
difference being thus 0·297 inch. Another region of relativ
pressure is in the north-western States and British Columb
north, the maximum, near the mouth of the Columbi
reaches 30·06 inches, being thus nearly as high as what
Florida. These two regions are merely extensions of in
high-pressure area which at this season are highly chara
feature of the meteorology of the North Pacific and North
respectively.
Of these two regions of high pressure the one overspread
Atlantic between the United States and Africa is the more
being not only the region where pressure is highest anyw
the globe during the months of June, July, and August, b
the normal pressure reaches the highest point attained at an
over the ocean. The highest point reached by the normal
over the land at any season occurs, as has been pointed out,
centre of Asia, or approximately in the middle region of th
continuous land surface on the globe during the coldest m
the year. On the other hand, the highest pressure over t
occurs during the warmest months of the year, and not
largest water surface, but in the middle regions of the North
where the breadth is only about half that of the water surfa
North Pacific.
From the essential differences between these two sets o
mena it may be inferred that the extraordinarily high
which is so marked a feature of the meteorology of Cent
during the cold months of the year is a direct consequenc
lowering of the temperature of the land of Asia and of th
sphere resting on it during the time of the year when the
solar radiation are at the annual minimum, and of terrestri
tion at the annual maximum. But the determination of t
and time of highest pressure over the ocean must be reg
indirectly brought about. The physical conditions under
occurs are these:—it happens (1) at the time of the year w
earth presents the largest surface of land to the sun, and
that part of the ocean which is most completely surrounded
highly heated land surfaces. This high summer pressure
Atlantic has its origin in the upper currents of the atmosph

Mean Atmospheric Pressure for the Year.—The distrib
annual atmospheric pressure may be considered as repr

s of the influences directly and indirectly at work throughout
in increasing or diminishing the pressure of the atmosphere
re two regions of high pressure, the one north and the
outh of the equator, which pass completely round the globe
belts of high pressure. The belt of high pressure in the
hemisphere lies nearly parallel to the equator, and is of
nuniform breadth throughout, but the belt north of the
has a very irregular outline and shows great diffe
lth and its inclination to the equator. These irregularities
depend on the peculiar distribution of land and water which
in the northern hemisphere.
two zones of high pressure enclose between them the com
ly low pressure of the tropics, through the centre of which
narrower belt of still lower pressure, towards which the trades
n either hand blow. Considered in a broad sense, there
y three regions of l qu one just
to, and one round ch pole bounded by or consisting
the zones of high pressure just described. The no
ble of these, so far as it is known, is the re
about the South pole which remains low throughout
aying the principal role in the wind systems of t Antarct
its heavy snowfall not rainfall, and in the enormous ice
hich form so striking a feature of the water of the Southern

epression around the north pole contains within its area two
centres of still lower pressure, the one filling the northern
he Atlantic and the other that of the Pacific. Of these two
pressure area round Iceland is the deeper and is probably
d by the steeper barometric gradients and stronger winds
revail over the North Atlantic. The broad equatorial zone
ressure also contains two distinct regions characterized by
ver pressures. The larger of the two stretches across
n Asia from Assam to head of Persian Gulf, and is
due to the very low pressures which form so marked a feature
mmer meteorology of that part of Asia. The regions of
he Indus and upper Ganges occupy a centre of this low
area, where normal press ort of 29·80 inches
ost area of lowest equatorial pressure is in the centre of

y be here pointed out that the whole of these areas of low
nnual pressure po ommon characteristic of
e amount of moisture in the atmosphere. The Arctic and
e zones of low pressure, and the equatorial low-pressure zone
y, may be regarded as all but wholly occupied by the com
ly large amount of vapour in their atmosphere. As regards
on of low pressure of southern Asia in summer, it is
ble that, while the eastern half which overspreads the valley
Ganges is characterized by a moist atmosphere and large
the western half of it is singularly dry and practically rain
l that the central portion of this remarkable depression
a region where at the time the climate is one of the driest
est anywhere to be found on the globe. Hence, while the
s the more important of the disturbing influences at work
mosphere, the temperature of space plays no inconspicuous part
in destroying atmospheric equilibrium, from which result
torms, and many other atmospheric chang

Prevailing Winds of the Globe. If atmospheric
e were equal in all parts of the earth we should
he physical conditions of a stagnant atmosphere.
owever, is not the case. Let there be produced a
ration of aqueous vapour over a particular region,
one region show a higher temperature than what
s around it, then from the different densities,
nsequently different pressures thereby produced,
uilibrium of the atmosphere is destroyed, and, as
be expected from the laws of aerial fluids, move-
of the air, or winds, set in to restore the equili-
Now every one of the isobaric maps we have
as well as every isobaric map which has been made
ecorded observations, indicates very considerable
ance of the equilibrium at the surface of the earth.
servation shows that the prevailing winds of any
at any season of the year are simply the expression
atmospheric movements which result from the dis
e of the equilibrium of the atmosphere indicated by
baric maps for that season and region.
winds may be regarded as caused directly by differences
ospheric pressure, just as the flow of rivers is caused
erences of level, the motion of the air and the motion
water being both referable to gravitation. The wind
from a region of higher towards a region of lower

pressure,—in other words from where there is a sur
where there is a deficiency of air; and this take
whether the differences of pressure be measurable
barometer, as is generally the case, or not readily
ible, as in se of sea breezes, squalls, and sudde
of wind which are of short duration.
So far as is known, differences of atmospheric p
and consequently all winds, originate in changes of
either in the temperature or the humidity of the
restricted regions. Thus, if two regions contiguous
other come to be of unequal temperature, the air
warmer region, being specifically lighter, will ascen
the heavier air of the colder region will flow in b
take its place. Of this class of winds the sea an
breezes are the best examples. Again, if the air
region comes to be more highly charged with
vapour than the air of surrounding regions, the air
more humid region being lighter will ascend, wh
heavier air of the drier regions will flow in bel
take its place. Since part of the vapour will be con
into cloud or rain as it ascends, heat is thereby disen
and the equilibrium still further disturbed. In th
originate gales, storms, tempests, hurricanes, and
more violent commotions of the atmosphere, except
of the form of the whirlwind, such as dust storms,
production of which very great differences of temp
are more immediately and exclusively concerned.
The Trade Winds. From fig. 11, giving the is
for January, it is seen that atmospheric pressure
Atlantic is lower near the equator than it is to
and south of it, and the arrows indicate that to th
of the tract of lowest pressure N.E. winds prev
to the south of it S.E. winds. These are th
known N.E. and S.E. trade winds, which thus blo
regions of high pressure towards the tract of lower p
situated midway between them. The trade winds
blow directly to where the lowest pressure is, but in
ing direction at an angle of about half a degree. The
tion from the direct course is due to the influence
rotation of the earth on its axis from west to ea
influence to which all winds and all currents of th
are subject.
In virtue of this rotation, objects on the earth's
at the equator are carried round toward the east
rate of about 17 miles a minute. On receding fr
equator, however, this rate of velocity is being cont
diminished, so that at 60° N. lat. it is only about S
a minute, and at the pole nothing. From this it
that a wind blowing along the earth's surface in th
tion of the equator is constantly arriving at places
have a greater eastward velocity than itself. A
thus lags behind, these places come up, as it were,
it, the result being an east wind. Since, therefo
wind north of the equator is under the influence
forces, one, the low pressure near the equator,
it southwards, and the other, the rotation of the
deflecting it eastwards, it will, by the law of the c
tion of forces, take an intermediate direction, and blo
north-east. For the same reason, south of the equ
south is deflected into a south-east wind.
In the Atlantic the north trades prevail
latitudes 7° and 30° N., and the south trades betwe
tudes 3° N. and 25° S. These limits are not stat
but follow the sun, being farthest to the
and to the north in August. The tract of low p
between these wind systems is named the region of
owing to the calm weather which often prevails the
it is also characterized by the frequent occurrence o
rains. This region of calms varies its position wi
of the sun, reaching its most northern limit, lat.

gust, and its most southern, lat. 1° N., in February. eadth varies from 3° to 8°, and it lies generally l to the equator. It is to be noted that, in the ic, the region of calms is at all seasons north of the r.

th and south trades also prevail in the Pacific Ocean, ted by a region of calms, which would appear, how o be of less breadth and to be less clearly defined s the region of calms in the Atlantic. In the eastern n of the Pacific the region of calms lies at all seasons north of the equator, but in the western division it nsiderably south of the equator during the summer s of the southern hemisphere, this southerly position n all likelihood occasioned by the extraordinarily high re in Asia in its relations to the low pressure in the or of Australia at the season. During the summer s of the northern hemisphere the region of calms disappears from the Indian Ocean and from the n part of the Pacific Ocean, there being then an ken diminishing pressure from the latitude of ms and Central Australia northwards as far as the e are of Central Asia

gion of light and variable winds and calms occur at ghest limits of the north and south trades. Except in cific, where, owing to the greater breadth of that they spread over a considerable extent, these regions but in circumscribed patches, such as characterize eteorology of the North and South Atlantic about les 26° to 36°. Of these regions of calms the most tant is that marked off by the high pressure in the Atlantic, between the United States and Africa the region of the Sargasso Sea, where the weather acterized by calms and variable winds, and the ocean comparatively still waters. These are known to n as the "horse latitudes," and are essentially nt from the equatorial region of calms. The latter, been stated, is the region of low pressure at the ge of the north and south trades, where the climate tinguished for its general sunlessness and heavy ll. On the other hand, the calm regions in the ic and Pacific Oceans about the tropics have an spheric pressure abnormally high, clear skies, and eather generally sunny and bright, with occasional s.

merous observations made in all parts of the globe ish the fact that, while the surface winds within the are directed towards the equatorial region of calms h a manner that the general intertropical movement atmosphere or prevailing winds are easterly, the ding winds of the north and south temperate zones esterly. The veering of these great aerial currents to the same cause that gives easting to the trade- viz. the rotation of the earth round its axis. For, aerial current advances into higher latitudes, it is ually arrives at regions having a less rotatory velocity it-self, it thus outstrips them and leaves them behind, her words, it blows over these places as a westerly

hile, however, the general prevalence of westerly winds been established over the extratropical regions of e, Asia, Africa, America, and Australia, the direc- which in different seasons and at different places are lly found to prevail often differ very widely from An examination of the winds at one hundred and places pretty well distributed over the northern sphere reveals the instructive fact that almost every shows two maximum directions from which winds more frequently than from the other directions, and ne of these two directions shows a considerable excess he other. Thus, for example, the following are, on a twenty years' average, the number of days at Gree each wind prevails during the year: N., 41; N.E., 4 23, S.E., 21; S., 34; S.W., 103; W., 38; N.W., 2 calms, 32. Hence S.W. and N.E. winds are there prevalent than winds from any other direction, and of two winds the greater maximum direction is S.W. two maximum directions be sorted into groups, the greater maximum direction occurs as follows:

from S.S.W.	to W.	at	47	places
,, W.N.W.	,, N.	,,	33	,,
,, N.N.E.	,, E.	,,	19	,,
,, E.S.E.	,, S.	,,	16	,,

and the other maximum direction is

from S.S.W.	to W.	at	20	places
,, W.N.W.	,, N.	,,	22	,,
,, N.N.E.	,, E.	,,	38	,,
,, E.S.E.	,, S.	,,	32	,,

This result of observation, so different from what wa accepted as being in accordance with the generally re theory of the movements of the atmosphere, teach important lesson that the region towards which the tropical winds of the northern hemisphere are dire not the region of the north pole.

Prevailing Winds in January.—On examining which shows the distribution of atmospheric press January, it is seen that pressure is abnormally lo the northern portion of the Atlantic—the lowest oc between Iceland and South Greenland—from wh rises as we proceed in a S.W. direction towards A in a S. direction over the Atlantic, and in a S.E. direction over Europe and Asia. Now what influe this remarkable atmospheric depression on the pre winds over this large and important part of the surface? The arrows in the figure, which indica prevailing winds, and which have been laid dow observations, answer this question.

At stations on the east side of North Ameri arrows show a decided predominance of north-west at the more northern places the general direction i northerly, whereas farther south it is more westerl the Atlantic between America and Great Britain, south of England, in France and Belgium, the direc nearly S.W. In Ireland and Scotland it is W in Denmark and the north-west of Russia S.S.W. St Petersburg to Tobolsk S.W.; on the west of E generally S.S.E.; and in Greenland, the north of I and about Spitzbergen N.E. Hence all the pre winds in January over this extensive portion of th may be regarded as the simple expression of the di of atmospheric pressure which prevails over the d parts of the region. In truth the whole appears vortices, or in an in-moving spiral course, towa region of low pressure lying to the south west of I and extending eastward over the Arctic Sea north of The only marked changes in these directions of th thus broadly sketched out are the deflexions by the various mountain systems which lie, so to embedded in these vast aerial currents; of the winds in the south of Norway afford excellent i tions.

The influence which this peculiar distribution pressure over the north of the Atlantic exerc absolutely determining the winter climates of the re countries is most instructive. It is to this low p which draws over the British Islands W.S.W. from the warm waters of the Atlantic, that the ope and, it must be added, rainy winters of these isla due. The same region of low pressure gives Rus Western Siberia their severe winters; and it is th consideration that fully explains the enormous defl the isothermal lines from Norway eastwards and

rds over the Old Continent. Finally, the same low
e draws over British America and the United States,
N.W. winds which it induces, the intensely dry
-current of the Arctic regions. At Portland, Maine,
is swept by these cold north-westerly winds, the
temperature in January is 23°6, whereas at
a, on the coast of Spain, in nearly the same latitude,
south westerly winds from the Atlantic prevail, the
emperature of the month is 49°1, or 25°5 higher.
region of low atmospheric pressure in the north of
cific is accompanied by prevailing winds over the
mbraced by it and by climatic effects in all respects
to the above. In Vancouver Island the prevailing
in January are S.W., at Sitka E.S.E., on Great
ake E.N.E., in Alaska N.E., in Kamchatka N.N.E.,
Japan N.W. In accordance with these winds
nter climate of Vancouver and adjoining regions
and humid, and that of the north-east of Asia dry
ensely cold.

he other hand, abnormally high pressure rules over
tinent of Asia at this season, and as regards this
of high pressure the arrows represent the winds as
g outwards from it in all directions. Over the
of Asia, where the highest normal pressures are,
ations show a marked prevalence of calms and light
but around this central region the prevailing winds
uary are—at Calcutta N., at Hong Kong E.N.E.,
ing N.W., on the Amur W.N.W., S.E. at Nijni-
k and S.S.W. at Ustjansk (in the north of Siberia),
Bogoslovsk S.W. Hence from this extensive
where pressure is abnormally high, or where at
ason there is a large surplus of air, the prevailing
flow outwards in all directions towards the lower
e which surrounds it. Owing to the excessive dry
the air of Central Asia, terrestrial radiation is less
ted there than anywhere else on the globe, and
uently the temperature falls very low, the mean of
y at Werchojansk being −55°8, which is the lowest
monthly temperature known to occur on the earth's
. And, since the winds blow outwards from the
d climates of the interior, temperatures are low,
the coasts. Of this China affords good illustrations.
he mean January temperature of Peking is 22°7 and
a Wei, near Shanghai, 35°1, whereas at Corfu and
dria the normal temperatures for January are
ively 50°9 and 58°0, or 28°2 and 22°6 higher
corresponding latitudes on the coast of China.
winds of the United States in winter, taken in
ion with the peculiar distribution of pressure already
ed, are very interesting. There are two regions of
ressure, one in the south-eastern States and the other
rger one in the region around Utah; and between
here is interposed a trough of lower pressure extend
om Chicago to the south-west of Texas. On the
n side of this depression the winds are north
y, but to the east of it they become W., W.S.W.,
some places S.W., and again on nearing the Atlantic
d they become north westerly. In connexion with
gion of higher pressure in the west, the prevailing
are seen to flow outward from it. The normal
e diminishes everywhere to southward of a line
from the Canaries to Bermuda, thence westward in
the same latitude to Texas, and then to west north-
o San Francisco. The tract of lowest pressure
es from the basin of the Amazon in the direction of
mus of Panama in about latitude 8° N., and thence
inued westward for a considerable distance into the
in nearly the same latitude. It follows from this
ution of the pressure that the north trades in a more
modified form prevail over South America to the
north of the Amazon, and in the Pacific to the n
lat. 8° N., probably as far to westward as long. 150

The low pressure systems which prevail durin
summer months in South America and South Afric
each its corresponding system of winds all round
however, in Australia, as being the most compa
isolated continent, that the influence of the summer
lowering the pressure is best illustrated. In that co
the lowest pressure occurs in the region situated
midway between the north coast and the tro
Capricorn, over which the normal pressure does not
29·80 inches. Further, everywhere in Australia p
diminishes from the coast on advancing upon the
districts. It follows from this disposition of the p
that all round the island the prevailing winds in s
blow from the sea towards the interior; and accordi
is in these months that the greater part of the rai
From the low pressure of the interior southwards to
Straits pressure rises continuously, the increase
normal over this space being about 0·200 inch. To
ward it also rises continuously to beyond the no
China, the increase on this side being about ¾ of a
In this case the greater part of the increase occu
the continent, the rate of increase from the n
Australia to the Philippine Island being only abo
rate of increase which obtains southward towards
Straits. It will be shown when the subject of the
is examined that it is the relative excess of thes
pressures, the one in the south of Australia and th
in the south-east of Asia, that determines the p
of the area of low pressure in Australia in particular
and with that position the degree and extent to wh
whole of the northern portion of Australia is wate
the rainfall. Thus, when pressure is more than
high in the south-east of Asia, and either low or
cessive in the south of Australia, then the low p
region is pushed farther southward into the intern
with it the rainfall spreads inland over a wider area
a greater depth.

Prevailing Winds in July. In the winter
southern hemisphere, the geographical distribut
pressure is exactly the reverse in Australia of what
during the summer months. Everywhere all ro
increases on advancing from the coast into inland d
The lowest pressure, about 30·00 inches, occurs
north coast, and the highest over the basin of the
river and its affluents, where it rises generally to
inches. On the south coast it is generally about
inches, falling, however, at Cabo Island, in the e
south-east, to 30·050 inches, and to 29·836 in the s
New Zealand. From the Murray river the diminu
pressure is continuous to the north, even to the low p
of Central Asia. From the arrangement of the p
the prevailing winds blow from the interior towa
surrounding ocean all round Australia, with the
exception of the extreme south-west of the continent
the prevailing winds are south-westerly, being here
ally an outflow of the high pressure which overspre
Indian Ocean to the westward. As these S.W. wi
from the ocean, the rainfall at Perth in July is
inches, and it is high over south-western districts o
Australia. The prevailing winds round Australia
on the north coast, S.W. at Brisbane, W.N.W. at S
N. at Melbourne, N.E. at Adelaide. These all re
an outflow from the high-pressure region of the
modified by the influence of the earth's rotation,
correspondence with the reversal of the distribution
pressure, are directions the reverse of the prevailing
of January.

In July the central and southern parts of A

heated by the summer sun, and, besides, the rainfall uthern parts is excessive. Consequently atmospheric is very low, being fully 0·10 inch lower in the than it is in the south of Ceylon. From the pressure rises continuously on advancing to the d, southward, westward, and northward, and from directions the prevailing winds of summer flow upon the interior, and there bring rain or parching according to they have come from the they have traversed, and according as they advance warmer or colder regions. The prevailing of Asia, being an inflow upon the interior, general, by the reversal in direction of prevailing winds

wind of Europe are mainly determined by the dinarily high pressure of the Atlantic with its relations low pressure of Central Asia and Central at the time. The winds in the Spanish Peninsula th w to the north of Africa they are northerly, ion northwesterly in Syria. The winds of the Island and western Europe have long and orthern than the prevailing winds of winter, and to t to they become ideally north west. he Atlantic origin of these winds that the summer

ely large rainfall of this season, it being at this time e rainfall reaches the annual maximum. The bear the low pressure areas and mountain systems of the of Italy and Scandinavia on the climates of these will be afterwards referred to.

centre of lowest pressure in North America is over rict about Utah, from which it rises all round, but ward and most in south easterly and north westerly ons. In California N.W. winds necessarily blow in pon this central low pressure area, and, as these winds cessively over regions the temperature of which con increases, the summer climate is rainless. On the nd, southerly and south easterly winds from the Gulf o blow up the western side of the basin of the Mis ward upon the low pressure area of the centre de e in their course, are rainfall more or less abundant, ture they have brought from the Gulf. To the north ion, and to westward of Hudson's Bay, the prevail ds become easterly and north easterly, distributing Manitoba, Saskatchewan, and neighbouring regions, continue their westerly course towards the low e area, the rainfall they have transported thither

he wide expanse of Hudson's Bay. An attentive ation of the arrow of fig. 17 shows that the prevail ol over all the States to the east of the Mississippi r rather to be regarded as an outflow from the of very high pressure over the Atlantic to south d. Thus in Florida the winds are S.E., in the te States S., and in the lake region, in the New Eng ates, and on the Atlantic seaboard S.W. Since the of these winds is thus essentially oceanic, and since r course northwards no mountain range crosses their he whole of the extensive region enjoys a large but mean excessive rainfall, which, taken in connexion he temperature, renders the summer climate of these one of the best to be met with anywhere on obe for the successful prosecution of agricultural ries.

remarkable protrusion of high pressures from the rn hemisphere, where they are massed at this time year, northwards into the Atlantic is, as has already eferred to, one of the outstanding features of the ology of the summer months of the northern hemi-

In the central area of this large region the climate rkable for its prevailing calms, light winds, occasional squalls, and clear skies. From this comparatively space the wind blows outwards in all directions towards in upon the surrounding regions of low pressure. T winds, owing to the high temperature, clear skies, and st sunshine of the region from which they issue, carry them a great amount of vapour near the surface, by w to a large extent the north of South America, the ea North America, the greater part of Europe, and a large tion of Africa are watered. The prevailing winds over region are further interesting, not merely from the str illustration they give of the intimate relation of the w to the distribution of the pressure, but as being of no importance in determining the best routes to be taken this great highway of commerce, and the more so inasm as the currents of the ocean are coincident with these vailing winds.

In the Antarctic regions, or rather to the south of 15° S., the normal atmospheric pressure is low a season, there being a gradual diminution of pressu 29·20 inches about lat. 60° S. Pressure is probably still lower nearer to the south pole, as seems to be cated by the observations made by Sir James C. Ross in the "Challenger" and other expeditions. Over zone the prevailing winds are W.N.W. and N.W. T the region of the "brave west winds," the "roaring for of sailors, which play such an important part in naviga and which determine that the outward voyage to Aust be round the Cape of Good Hope and thence eastward the homeward voyage eastward round Cape Horn globe being thus circumnavigated by the double vo That the general drift of these winds is inwards upo south pole is strongly attested by the existence of enormously thick wall of ice which engirdles these reg from which are constantly breaking away the innume icebergs that cover the Southern Ocean, none of wh ever seen of a calculated thickness less than 1400 The snow and rainfall which must take place in the polar regions for the formation of icebergs of su thickness must be peculiarly heavy, but not heavier might be expected from the strength and degree of sa tion of the "roaring forties" which unceasingly precip their moisture over these regions.

To sum up, so far as the prevailing winds are cerned, it has been shown that where pressure is high i.e. to say, where there exists a surplus of air, out of a region winds blow in all directions; and, on the hand, where pressure is low, or where there is a defic of air, towards such a region winds blow from all direc in an in moving spiral course. This outflow of air-cu from a region of high pressure upon a region of low sure is reducible to a single principle, viz., the princi gravitation. Given as observed facts the differenc pressure, it is easy to state with a close approximati accuracy what are the prevailing winds, before calcul the averages from the wind observations. Indeed so dominating is the influence of gravitation where differ of pressure, however produced, exist that it may practi be regarded as the sole force immediately concerne cerning the movements of the atmosphere. If the any other force or forces that set the winds in m independently of the force called into play by differen mass or pressure, their influence must be altogether nificant as compared with gravitation.

It has been abundantly proved that the wind doe blow directly from the region of high towards that o pressure, but that, in the northern hemisphere, the regi lowest pressure is to the left of the direction towards the wind blows, and in the southern hemisphere to right of it. This direction of the prevailing wind reference to the pressure is in strict accordance with

s Law of the Winds, which may be thus expressed:—
nd neither blows round the centre of lowest pressure
les, or as tangents to the concentric isobaric curves
ms or cyclones, nor does it blow directly towards the
; but it takes a direction intermediate, approaching,
er, more nearly to the direction and course of the
r curves than of the radii to the centre. The angle
by a line drawn to the centre of lowest pressure
he observer's position and a line drawn in the direc
the wind is not a right angle, but an angle of from
80°.

n its importance in practical meteorology Buy
s law may be stated in these two convenient form
nd with your back to the wind, and the centre of
pression or the place where the barometer is lowest
to your left in the northern hemisphere, and to
ght in the southern hemisphere. This is the rule
ors by which they are guided to veer with retar-
storms. (2) Stand with the high barometer to
ght and the low barometer to your left, and the
ill blow on your back, these positions in the southern
here being reversed. It is in this form that the
ing winds of any part of the globe may be worked
m the isobaric charts (figs. 14 and 17).

n the all-important consequence which flow from the
bhical distribution of the pressure it is evident that
ions of low and of high normal pressure must be
d as the true poles of the prevailing winds on the
surface, towards which and from which the great
ents of the atmosphere proceed. From the unequal
ution of land and water, and their different relations
and terrestrial radiation, it follows that the poles
ssure and of atmospheric movements are, just as
s with respect to the poles of temperature, very far
ing coincident with the north pole. Thus during
ter months the regions to which the origin of the
revailing winds of the northern hemisphere are to
erred are Central Asia, the region of the Rocky
ins, and the horse latitudes of the Atlantic, and
ions towards and in upon which they flow are the
ssure systems in the north of the Atlantic and
Oceans, and the tract of low pressure within the
towards which the trade-winds blow. In the
r months the reversed conditions of pressure distri-
then observed are attended with corresponding
s in the prevailing winds, and, generally speaking,
outh polar region be excepted, the poles of highest
vest pressure and atmospheric movements are at no
incident with the north pole. It is this considera
hich affords the true explanation why prevailing
t so large a proportion of stations in the northern
here do not blow in the directions in which true
rial and polar winds should blow.

causes which bring about an unequal distribution of
ss of the earth's atmosphere are mainly these two -
perature and the moisture of the atmosphere con
with respect to the geographical distribution of
d water. Owing to the very different relations of
nd water to temperature, as already stated, the
r temperature of continents greatly exceeds that of
an in the same latitudes. Hence the abnormally
emperature which prevails in the interior of Asia,
America, and Australia during their respective
rs, in consequence of which the air, becoming speci-
lighter, ascends in enormous columns thousands of
diameter. *On arriving at the higher regions of*
nosphere it flows over neighbouring regions where
face temperature is lower, and thus the atmospheric
e of the highly heated regions is diminished.
ace winds set in all round to take the place of the
air removed from the continents by these asc
currents, and since these necessarily are chiefly wa
the ocean they are highly charged with aqueous
by the presence of which, and by the condensation
vapour into cloud and rain, the pressure over conti
this season is still further and very largely dim
An charged with vapour is specifically lighter tha
without the vapour, in other words, the more
any given quantity of atmospheric air has in it t
is its specific gravity; and, further, the conde
of vapour in ascending air is the chief cause of the
effect being so much less than that which wo
experienced by dry air. From these two pri
which were established by Dalton, Joule, and Sir W
Thomson, it follows that the pressure of vapour in
and its condensation, exercise a powerful influe
diminishing the pressure. The great disturbing inf
at work in the atmosphere are the forces called in
by its aqueous vapour; and it is to these, co-operatin
the forces called into play by the differences of temp
directly, that the low normal pressure of the con
during the summer is to be ascribed. The degree to
the lowering of the pressure takes place is, as was t
been expected, greatest in Asia, the largest continen
least in Australia, the smallest continent, while in A
it is intermediate.

The influence of the aqueous vapour in diminish
pressure is well seen in the belt of calms in the
between the north and the south trade winds. Sinc
winds import into the belt of calms the vapour the
taken up from the sea on their way thither, the cli
characterized by a highly saturated atmosphere and
rains. Again the air in regions near the Atlantic c
much more vapour and is of a higher temperature
winter than is observed at places in the interior
tinents in the same latitudes. It follows thus that
over the north of the Atlantic and the regions adjoi
specifically lighter than in the regions which su
them. We have here therefore the physical condit
an ascending current; and it is plain that the stre
this current will not merely be kept up but increa
the condensations of the vapour into cloud and rain
take place within it by which a higher temperature
greater specific lightness are maintained at the su
the earth and at various heights in the atmospher
exist over surrounding regions at the same l
Accordingly it is seen from the winter isobars t
enormous diminution of pressure occurs over these
and also over the north of the Pacific and the An
as compared with the continents.

Since, on the other hand, dry and cold air is spec
heavy, the winter isobars show that where tempera
low and the air very dry pressure is high. Of th
and North America are striking examples during De
January, and February, and Australia, South Afri
South America during June, July, and August.

Since vast volume of air are thus poured into the
where pressure is low without increasing that press
vast volumes flow out of the region where pressure
without diminishing that pressure, it necessarily
that the volumes of air poured into the region
normal pressure do not accumulate over that reg
must somehow escape away into other regions, a
the volumes of air which flow out from the region
normal pressure must have their place supplied b
accessions of air poured in from above. That th
law of relation observed between sea-level pressu
surface winds obtains between pressures at different
and winds at the same heights is simply a ne
inference. We are therefore justified in expecti

ng currents will continue their ascent till a height
ned at which the pressure of the air composing the
s equals or just falls short of the pressure over the
nding regions at that high level. On reaching this
the air, no longer buoyed up by a greater specific
than that of the surrounding air, will cease to
, and expanding horizontally will thenceforth flow
an upper current towards those regions which offer
st resistance to its course, that is to say, it will
er upon those regions where, at that height, pressure
s at the time to be least. Now from the known
es of air of different temperatures and humidities it
nt that the overflow of the upper current will take
owards and over that region or regions the air of
n the lower strata of the atmosphere happens to be
and drier than that of the other surrounding
s, because, being denser, a greater mass of air is
sed or gathered together in the lower strata of the
here, thus leaving a less mass of air, or a diminished
e, in the higher region of the upper current.
n be so, then the extraordinarily high pressure of
Asia during winter is to be ascribed to these two
(1) the low temperature and excessive dryness of
at this extensive region; and (2) its relative
ity to the low pressure of the Atlantic to the north
e low pressure of the Pacific to the north-east, and
pressure of the belt of calms to the south.
ly, since in summer the temperature of air resting
e Atlantic between Africa and the United States
ower than that of the land, the ascending currents
rise from the heated lands of Africa, Europe, and
and South America, as well as from the region of
mmediately to the south, all of which are remark
a low normal pressure, will on reaching the upper
of the atmosphere flow towards this part of the
, because there, the temperature being lower and
ity of the air composing the lower strata being
pressure in the upper regions is less. And, since
face winds are constantly flowing outwards from
gion of abnormally high pressure, thus draining
e air poured down upon it by the upper currents
converge upon it, extreme saturation does not take
and the air consequently is relatively dry and cool
is view generally represents the movements of the
urrent has been strongly confirmed within the last
rs by Professor Hildebrandsson and Clement Ley
researches into the upper currents of the atmosphere
n observations of the cirrus cloud
these considerations it may be concluded that the
which prevail near the earth's surface are known
he isobaric lines, the direction of the wind being
ross where pressure is high towards regions where
s in accordance with Buys Ballot's law; and that
per current may be inferred from the isobaric lines
reversely, together with the isothermal lines taken
. In other words, the regions of lowest pressure,
ern cyclonic circuit, and relatively higher pressure
t height as compared with surrounding regions,
ut the source or fountain-head from which the upper
s flow; and the isothermal, by showing where on
of the relatively low temperatures the greater
f the air is condensed in the lower strata of the
here and sea-level pressure consequently is high,
minishing the pressure of the upper regions, point
e regions towards and upon which the upper
s of the atmosphere flow. The facts of the diurnal
ons of the barometer in the different regions
discussed afford the strongest corroboration of these

tern "monsoon" has long been applied to the pre-

vailing winds in southern Asia which blow approx
from S.W. from April to October, and from N.E
November to April. The term is now, however, ge
applied to those winds connected with continents
are of seasonal occurrence, or which occur regular
the periodical return of the season. Since they are
immediately by the different temperatures and pr
which form marked features of the climates of co
in winter and summer respectively, they are mos
developed round the coast of Asia, owing to the
extent of that continent. The monsoons of differen
of the coasts of Asia differ widely in direction fro
other. Thus in winter and summer respectively t
W.N.W. and E.N.E. at the mouth of the Amur,
S.S.E. at Shanghai, N.E. and S.W. at Rangoon,
W.S.W. at Bombay, N.W. and S.W. at Jerusale
S.S.W. and N.N.E. at Archangel. The Indian
monsoon generally begins to break up in March, b
not till about the middle of May, when the norma
sure has been decidedly diminished over the
nterior, that the summer monsoon acquires its full s
and the heavy monsoonal rains fairly set in. In C
when the temperature has fallen considerably an
the falling temperature the pressure of the interior ha
the summer monsoon begins to break up, and this
is marked by variable winds, calms, and dest
hurricanes. As the temperature continues to fa
pressure to rise, the winter monsoon again resu
sway. Monsoons, equally with the trade-winds,
most important part in the economy of the globe
relatively great force and steadiness in the direc
which they blow, and the periodical change in thei
tion, give facility of intercourse between different co
and, besides, by the rainfall they bring they spread
over extensive regions which otherwise would be
wastes.

The winds of Australia are also strictly monsoo
owing to the small extent of that continent, and
quently the smaller differences there are betwe
normal pressure of the interior and that of the surro
coasts in summer and winter respectively, they a
strongly marked than are the monsoons of southern
and particularly they neither blow with the same fo
so steadily from the same point of the compass.
same reason the Australian climates are character
the occurrence of more frequent droughts than
climates of southern Asia, and the same remark ap
the climates of southern Africa.

Since the Malay archipelago lies during the sum
the northern hemisphere between the high pres
central Australia and the low pressure of Asia, and
the winter between the high pressure of Asia and
pressure of central Australia, it follows that the w
these islands are eminently monsoonal in their cha
being in summer southerly and in winter northerly
result of this peculiar wind system of the archipela
give to these islands a singular diversity of climates
will be more particularly referred to under rainfall.

At Zanzibar the prevailing wind in July is S.E.,
January, when the low pressure of the interior is s
much farther to southward, it is N.E.: and th
influence is felt, though in a greatly modified de
far as Mauritius, where the S.E. trade changes nea
E. during the summer. On the other side of Afr
S.E. trade of the South Atlantic is changed into
monsoon on the coast of the Gulf of Guinea."

In the southern, central, western, and northern
of North America the prevailing winds have a well-
monsoonal character. The prevailing winds of win
summer respectively are N.E. and S.S.E. at New O

and S.W. in Utah, N. and S. at Fort Yuma rnia), E.S.E. and N.W. at Portland (Oregon), and E.N.E. at Fort York, Hudson Bay. These winds dily accounted for by the distribution of pressure e continent in winter and summer. On the Atlantic rd of the United States the prevailing winds of vary from N.W. in the New England States to W. h Carolina; whereas in summer they vary generally .S.W. in South Carolina to S.W. in the New Eng ates. Hence over the eastern States the summer are not directed towards the low pressure region of erior of the continent, but are determined by the s of their pressure to the high pressure of the e to the eastward, and to the lower pressure overng the Atlantic to the N.E. This influence of the e may be considered as felt westward through the as far as the Mississippi.

gh not so decidedly marked, the winds of Europe, the extreme south, are also monsoonal In winter ow from the land towards the region of low pressure north of the Atlantic; but in summer the arrows, nting the prevailing winds, show that all but the exouth of Europe is swept by westerly winds, which flow st continuous stream from the Atlantic towards the regions of the Old Continent, and which deposit in ourse the rains they have brought from the ocean.

larly, monsoons prevail on the coasts of Brazil, North Africa, and many other regions which happen between other regions whose temperatures, and re pressures, differ markedly from each other at t times of the year.

e are the chief prevailing winds of the globe when erences of the normal atmospheric pressure are such ause a decided and steady movement of the atmoover a large portion of the earth's surface, resulting l-marked prevailing winds. But there are other which are greatly influenced by local causes, such as ure of the ground, whether covered with vegetation ; the physical configuration of the surface, whether mountainous; and the vicinity of extensive sheets h or salt water. An important characteristic of in their practical relations to climate is their ,—they being warm or cold, dry or moist, according r direction and the nature of the earth's surface nich they have just passed. Thus in the northern here southerly winds are warm and moist, while ly winds are cold and dry. In Europe south y winds are moist and easterly winds dry, while in w England States and Canada north easterly winds l and raw and north-westerly winds cold and dry.

articular regions certain meteorological conditions t stated seasons intensifying these effects, resulting ssive drought, heavy rains, intense or great heat, ving rise to the following among other well known

The east winds of the British Islands occur chiefly g, but also in a less degree in November, being in ter case often accompanied with fog. The winds ferred to are dry and parching, and their deleterious e on the health is seen, not merely in the discomfort easiness they impart to the less robust of the popu but also in the largely increased mortality which ause from consumption and all other diseases more connected with the nervous system. In the es bordering on the north of the Atlantic, atmopressure reaches the annual maximum in May, and ove the average during the other two spring months. se months the normal pressure approaches nearer to btains farther south, and an examination of daily r maps shows that this is due to the repeated nce in spring of very high pressures in the north of Europe while pressures much lower prevail to sout Now these east winds are simply the outflow fro regions of high pressure to northward. Northerly a westerly winds which are truly outflows from what styled Arctic anticyclonic areas bring with them qua noxious as those of the east wind itself, and prove a ous to health and vegetation. The cold dry wind o 29, 1868, which blasted and shrivelled up vegetation land, particularly in the western counties, as effect if a scorching fire had passed across them, was a wes

In the south of Europe, during the winter and early peculiarly dry, cold, and violent northerly winds are of oc occurrence Of these winds the "mistral" is one of t notorious, which is a steady violent, and cold north w blowing from central and eastern France down on the Lyons It is particularly trying while it lasts to invalids spending the winter at the various popular sanataria w scattered along this part of the Mediterranean coast. Th cold that took place in the north of Italy and south of Fr the beginning of 1868 was a good example of the mistra meteorological conditions under which it occurred were m low pressure over the Mediterranean to southward (29·150 whilst at the same time pressure rose steadily and rapidly ceeding northward to 30·905 inches in the north of Russia. this geographical distribution of the pressure, northerly win southwards over Europe, carrying with them the low temp of the higher latitudes, and became still colder and drier on the Alps before they made the descent on the shores of the M ranean The cold tempestuous winds which descend from th Alps and sweep over the Adriatic and the dreaded "greg Malta, which is a dry cold north east wind, are in their c and origin quite analogous to the mistral

The "northers," or "nortes," are peculiarly dry cold stron which repeatedly occur from September to March in the bordering on the Gulf of Mexico, and are perfectly analogou mistral The condition under which they occur are a lower than usual to the south or south east over the Gulf of together with a pressure even higher than the high norma is so marked a feature of the meteorology of the Rocky Mo during the colder months When, as most frequently h they occur in the wake of a storm, their disagreeable qua extreme dryness, cold, and violence are all intensified temperature of upwards of 80 experienced as the storm c the thermometer rapidly falls to 18 or even lower; and, as temperature often occurs with a wind blowing with great v the northers prove most deleterious A violent wind with perature of 18 is altogether unknown in the British Island

The "pampero" is a strong, dry cold wind which blows ac pampas of the River Plate of South America, occurring at all but most frequently during the spring and summer from Oc January. They are preceded by easterly winds, a falling p a rising temperature, and increased moisture. A pampe scribed by Dr D Christison and it appearance figured, *Journal of the Scottish Meteorological Society*, vol. v p. 342, advancing on the morning of November 28, 1867, in Uruguay In the early morning the wind blew rather from north east, and by and by cloud were seen movi slowly from the west, throwing out long streamers eastwar they advanced, two dense and perfectly regular clouds appeared in front, one behind the other, in close contact intermingling, the one being of a uniform leaden grey, w other was as black as the smoke of a steamer On arrivi head, the front, though slightly wavy in appearance, was se quite straight in its general direction, and the bands were of breadth They rushed forward at great speed under th clouds without uniting with them, preserving their forms su being borne onward by an apparently irresistible force, as posed of some solid material rather than vapour They probably 50 miles in length, but as they took only a few to pass their breadth was not great, and they appeared to to mere lines in the distant horizon At the instant the fir band arrived overhead, the wind chopped round from nort north and then to south west: a strong cold blast at the s seemed to fall from the leaden cloud, and continued to both bands had passed. No rain or thunder occurred at th but in the confused rabble of cloud, which followed fow continued to roll, and in a quarter of an hour rain fell, and hours thereafter wind, rain, and thunder continued, but o moderate degree. The low temperature and in the barom change of wind are the constant and most striking charac of the pampero. On one occasion the temperature fell 44 teen hours, and on another occasion the fall was only 4° a usual accompaniment, but on rare occasions the pampero and no rain falls.

fall.—Whatever tends to lower the temperature of below the dew point is a cause of rain. It is there- the winds we must chiefly look for an explanation rainfall, and the broad principles of the connexion stated to be these five. (1) when the winds have ly traversed a considerable extent of ocean, the is moderately large, (2) if the winds advance at me time into colder regions the rainfall is largely d, because the temperature is soon reduced below nt of saturation, (3) if the winds, though arriving he ocean, have not traversed a considerable extent of rainfall is not large, (4) if the winds, even though traversed a large extent of ocean, yet on arriving land proceed into lower latitudes or regions markedly r, the rainfall is small or nil, (5) if a range of ain, lies across the onward path of the winds, the l is largely increased on the side facing the winds, duced over the regions on the other side of the The reason here is that, the air on the windward the ridge being suddenly raised to a greater ncreasing the range, the temperature is further l by more expansion and a more copious precipita the result whereas on the leeward side as the air ls to lower levels it becomes gradually drier, and ngly the rainfall rapidly diminishes with the

ave drawn attention to the diminished velocity of the wind r as compared with the open sea (p. 125). From the it that an envelope of stiller air or air of less velocity than the prevailing wind blood over the land, and by it- force the prevailing wind to a greater height than tending ce the rainfall. If the forehead rise within a few miles ght of 200 or 300 feet, the result is very striking when the om the sea blows straight upon it. Thus at Spittal near , on September 18, 7, a N.E. wind blew straight ashore it mited velocity of 25 miles an hour. To eastward the sky ently clear down to the horizon, but to westward all the beyond a mile from the shore was enveloped a dense mist or fog. About 1½ to eastward of the on the shore, the thinnest rack of cloudlets was e without intermission from the deepest stainless blue of the it as they drifted landward increased so rapidly in volume ty that the zenith was three fourths covered with cloud- r phenomenon was seen in September 1879 on board the steamer at the precipitous cliff of Hoy Island, Orkney. touched just cleared away, and a strong W.N.W. wind was straight against the cliff. The sky was absolutely cloud round except the upper 300 feet of Hoy Hill, 1570 feet high, as enveloped in a thick mist that stretched away to wind om distance to westward of the steamer's course, which out rock to rock! The western termination of the as the thinnest rack of cloud, which emerged unceasingly blue sky at a distance not less than 1 mile to wind- the cliff. The containment parts of the cloud itself were in motion eastward but owing to the fresh accessions it was centre, the cloud itself appeared stationary. Thus l was forced upward into the atmosphere for some consider- time to windward of the ridge lying across its path. the air over the land on the wind, and the con- e with it that explain how it is that during of very little rain from the north-east the rainfall over the s of the Firth of Forth, the Moray Firth, and the Pentland ncreased to the north-east so much in excess as compared e rest of Scotland. The same principle explains the heavy on plains at some distance from the range of hills lying he wind, particularly on the side of the rain bringing winds.

short intervals of time the heaviest rainfalls occur rnadoes, water-spouts, and some other forms of the nd, the reason being that not only is there rapid ion due to the rapid ascent of the air, but also great tion is produced by the extreme velocity of the gyrations round the axis of the tornado. On August 6, 3·12 inches of rain fell at Camberwell, London, hours and seventeen minutes. Of heavy falls be mentioned 4·60 inches in London, April 13, 6·00 inches at Tongue, September 7, 1870, 5·36 in Monmouthshire, July 14, 1875; 6·62 inches at Seathwaite, Cumberland, November 27, 1848; an inches at Drishaig, Argyllshire, December 7 to 8. But it is in lower latitudes that the heaviest single s have been recorded. The following are among th remarkable:—at Joyeuse, France, 31·17 inches in t two hours, at Genoa, 30·00 inches in twenty four ho Gibraltar, 33·00 inches in twenty-six hours; on the hill Bombay, 21·00 inches in one night; and on the Hills, India, 30·00 inches on each of five successive

As regards the ocean, there are no available dat which an estimate could be formed as to the a of the rainfall, since the rainfall statistics of the must be regarded as giving hardly anything mo the comparative frequency of the fall. It is, h certain that the equatorial belt of calms in the A and Pacific between the trades is the region where th rainfall reaches the maximum, and the parts of oceans are the rarest which are the longest wit belt of calms as it shifts its position northward and ward with season. While the cloud screen is undou dense and the rainfall frequent and heavy, the observations of the "Challenger" and "Novara" that the statements generally made as to these poi greatly exaggerated.

In the regions of the trades the rainfall is ever small over the open sea, seeing that the trade-wi essentially an outflow from anticyclonic regions, an original dryness is to a large extent maintained then course is directed into regions which becon stantly warmer. Thus at Ascension, lat. 8° 15′ S. is throughout the whole year within the S.E. trad mean rainfall for the two years 1851-55 was on inches. At St Helena, which lies constantly wit same trades, five years give a mean rainfall of 5·36 on the coast; but in the same island at a height o feet the annual amount rises to 23·98 inches. Eland and some other islands in the Pacific, abou 150° W., and for some distance on each side of the e have been pointed to by Scott as practically almo less, as is shown by their containing extensive deposits. These islands are situated somewhat si to Ascension with respect to the zone of calm Mauritius the annual rainfall on a mean of fou was 30 inches at Gros Cailloux, but at Cluny, o miles distant, for the same four years it was 146 in regard to which Meldrum remarks that at Cluny in the vicinity of mountains and forests, in the east of the island, and thus directly exposed to the wind as it arrives from the sea, the rainfall in alm month is from four to six times greater than a Cailloux on the north-west coast, where neither mo nor forest exists, and where the S.E. trade arriv siderably drained of its moisture.

From what has been said it is evident that the l rains will be brought by the winds which have tr the greatest extent of ocean within the tropics, and accordingly of all ocean winds have the highest temp and humidity. These conditions are most com fulfilled during the summer months of the n hemisphere by the winds which, commencing fro lat. 30° S., blow home on southern Asia as the well S.W. monsoon of these regions. Accordingly it is winds of this monsoon that a larger rainfall is dist over a larger portion of the earth's surface than anywhere else in any season; and this large rai in many regions still farther greatly increased mountain ranges which lie across the path of th bringing winds.

It is on these winds that the rainfall of India depends. Along the whole of the west coast fr

f Cambay southward, and on the Western Ghats, ntall is excessive. The following are some of the nteresting annual means in inches beginning with y and proceeding southwards: Bombay, 74; am, 217; Mahabaleshwar, 252, Ratnagiri, 101, 255; Goa, 102, Karwar, 115; Honawar, 139, lore, 134; Cannanore, 132, Calicut, 116, and , 114. In the west of Ceylon the rainfall is also being at Colombo 87, at Galle 91, and at ura, at some distance inland among the hills, 149 the S.W. monsoon is drained of much of its re in crossing these mountains, a greatly diminished is distributed over the interior and east side of and on the eastern slopes of Ceylon.

ow we cross to the eastern shores of the Bay of , we again encounter an excessive rainfall along the and up the slopes of the mountains looking down on Thus from south northward the following are the more characteristic rainfalls in inche ry, 102; Port Blair, 116, Mergui, 152 Tavoy, Maulmain, 189; Rangoon, 100, Bassein, 98, ay, 212, Akyab, 198, and Chittagong 101. On er hand, at Thyetmio, inland on the Irawadi, the rainfall is only 48 inches.

have shown how, in accordance with the peculiar ution of pressure in India in summer, the monsoon ted up the valley of the Ganges as an E.S.E. wind, uting on its way, even to the head of the valley, its ous rainfall the moisture it has brought from the Ocean and the Bay of Bengal. The rainfall does end farther westward than the basin of the Ganges, e precipitation is most copious along the lower yas, the largest falls being recorded at heights 000 feet, being, as pointed out by Hill, near the which the summer monsoon is cooled just below -point. The following are some of the larger rain inches, beginning with the more western Mus 95; Nami Tal, 92; Khatamandu, 57, Darjiling, Kurseong, 154; Buxa, 219; Kuch Behar, 131.

rainfall is very large in the north east angle of the Bengal and thence northwards towards Bhutan, or angle where the summer monsoon from the bay round to a westerly course on its way up the . Thus at Noakhally, on the coast, it amounts in o 109; at Tura, on the Brahmaputra, immediately of the Garo Hills, 129; at Silchar and Sylhet to d, 117 and 155; whilst at Cherrapunji, on the Hills, it rises to 493·19 inches on a mean of twenty ars. This last rainfall is the largest known on the he causes of which are the highly saturated state monsoon on its arrival at the lower Ganges, the ountain range of Burmah to eastward of Bengal, urns the monsoon to the north, and the protrusion rds of the Khasi and Garo Hills so as to lie in the that branch of the monsoon which passes from the anges into the basin of the Brahmaputra above ra. The consequence is that the highly saturated he monsoon in its passage across the Khasi Hills is ly raised to a height of about 6000 feet, and being reduced far below the point of saturation the undant moisture is precipitated in unequalled of rain. The amount of the annual rainfall at all laces is determined, essentially if not altogether, by s of the summer monsoon, the relative intensity of over India may be taken to be fairly represented by nfall of July

rains which accompany the N.E. monsoon of the months may be represented by the rainfall for y. These are heaviest in Ceylon, especially on its opes, and in southern India, or where the N.E. monsoon arrives after having traversed a large ex ocean. The fall for the month exceeds 6 inches large portion of the east coast, whilst at Colombo west the rainfall is only half that amount, and farthe at Pattalum the January rainfall is only 1·82 inch southern India the amount varies from about 1 to 2 Blanford pointed out in 1873 (*Phil. Trans.*, vol. 618) that, while the surface winds of northern India ter are northerly, on the Himalayas, especially the west portion, southerly winds prevail during the cold Hence these upper southerly winds which bring the rains to the Punjab, Upper India, and the highla Assam. It is further to be noted that winter rai occurs in Central India, where the prevailing surface are from east and north east. The mean rainfall of at Mussoorie 1·2700 inches and at Naini Tal 2·86 and in Assam, at Sibsagar, 1·13 inch. Over a larg of the east side of southern India from Nellore sout including Ceylon, the maximum rainfall for the year in the months of October and November.

Rainfall of the Malayan Archipelago and Australia. Un direction of the late Dr Berghaus systematic observations rainfall of the Malay archipelago were begun in 1879, the of stations being 150. The result of the first three years the mean annual rainfall over the archipelago varies from inches in Timor to upwards of 200 inches in some spots am western slopes of Sumatra. But the most important featu rainfall in its relation to climate is not the absolute amou fall annually, but rather the manner of its distribution the months of the year. Over the greater number of the rain falls copiously every month, but as regards some of the the year is divided into dry and wet season as marked as in the climates of India. The key to this essential differen the climates is the distribution of atmospheric pressure du months of the year from south eastern Asia to Australia, w resulting prevailing winds. During the winter months atm pressure is high in south eastern Asia and low in the in Australia, the difference being about three quarters of Since between these two regions the fall in the mean pr practically uninterrupted, the Malay archipelago lying them is swept by northerly winds the 11th. As these win traverse a great breadth of ocean in their course, they ar highly saturated state, and consequently deposit copious particularly on the northern slopes of the higher islands in the month the rainfall over the islands without exc large, the mean monthly amount being in many cases more inches. These winds continue their course to outward tow low-pressure region in the interior of Australia, and deposit north coasts of that continent a monthly rainfall ranging to from 11 to 20 inches. On advancing into the interior, t amount gradually diminishes at the successive telegraphic to 3·50 inches at Alice Springs near the tropic of Capricorn amount of the rainfall for any particular year, and the distan the coast to which the rains penetrate inland depend essent the height of the winter pressure of south eastern Asia as c with the low mean pressure of central Australia, by wh strength of the northerly monsoon is regulated.

On the other hand, during the summer of the northern hem pressure is high in the interior of Australia and low in Ch mean difference being about half an inch. Between the two the fall of the mean pressure is continuous and uninterrup a consequence southerly winds prevail over the intervening pelago. These winds, as they advance from the continent in latitude, are absolutely rainless in the north of Australia, Timor and the other Malay islands which are separate Australia only by a comparatively narrow belt of sea. Du three years no rain whatever fell in Timor in July and Au the fall in June, September, and October was small. As t the winds pursue their course to northward, they rapidly moisture from the sea, so that by the time they arrive at A they have become so saturated that the monthly rainfall th to nearly 30 inches. Again at some distance to the wes rain falls more or less regularly every month, the amount ing in proportion to the extent of ocean traversed by t winds, which advance towards the land from the dir Australia. These marked differences among the climates Malay archipelago, which, since they really depend on t graphical distribution of land and sea of the part of the glob be regarded as permanent differences, have played no incons part in the singular distribution of animal and vegetable lif characterizes the archipelago.

ly the prevailing wind in West Australia is N.W. and the reaches the maximum for the year, whereas in January the S.E., and the rainfall is the minimum. Southerly in since the winds of the southern half of South Australia and are from the south, and thus blow toward warmer regions, ntall is often at the annual minimum, or it is small. But ding the coast and proceeding northwards, the wind becomes n N.E., and ultimately N. in the north of Queensland. its prevalence of oceanic and open-sea winds, the rainfall time of the year rapidly rises over the whole of the eastern ull at Cape York it is about 90 inches. In the basins of the and Darling rivers, which are shut off from the east by the in ranges of New South Wales, the rainfall is only about an d a half. On the other hand, to south of the latitude of , including Tasmania, the low summer rainfall occurs in winter ose regions which slope northwards the sea. On crossing ntain range of Victoria into the basin of the Murray river, ntall rapidly diminishes. In the north of New Zealand the rainfall is the heaviest, but farther south, where westerly ail with considerable steadiness through the year, the rainfall is nally distributed through the months, and, as the prevailing re westerly, the heaviest rainfall is on the west of the islands. Hokitika on the west near sea-level, and not far from a lofty f mountains to the east, the annual amount reaches 120 and at Bealey inland at a height of 2104 feet it is 106 At Wellington the annual rainfall is 52 inches, at nd 46, at Dunedin 31, and at Christchurch 25, thus , in the rainfall of the two sides of the island, extremes s great as in Scotland.

ufall of Europe.—As regards rainfall, Europe may be ently divided into two distinct regions, western and n Europe, extending in a modified degree through erior of the continent into Siberia, and the countries ng on the Mediterranean. A vast ocean on the one a great continent on the other, and a predominance erly winds are the determining circumstances in the ution of the rainfall over western Europe. Hence niest regions are to be found in the west, where ain ranges stretch north and south. The annual exceeds 80 inches over a considerable district, ng the greater part of Skye and portions of the s of Inverness and Argyll to the south east, in the istrict of England, and in the more mountainous of North Wales, these three districts being the in Europe. As Ireland presents no continuous of mountains opposing the westerly winds of the e, no Irish rain gauge shows a mean rainfall of 80 A point of some interest is suggested by the rain the counties of Kirkcudbright and Dumfries in d. These counties offer to the westerly winds a t valleys sloping south to the Solway Firth, which ecessively a diminished rainfall on advancing east ll at several places in Nithsdale and Annandale it t exceed 40 inches. But in Eskdale, farther to the e rainfall instead of falling increases to about 60 The reason is that the westerly winds are ted in their onward course by the range of hills by Eskdale is bounded on the east, in surmounting the winds are much reduced in temperature, and their moisture falls in copious rains immediately ward of the ridge. The cause of the larger rainfall dale is thus analogous to that of the large rainfall coast in the north-east of the Bay of Bengal ately under the Assam range of mountains. In d the largest annual rainfall is 146 inches at Seat- in the Lake district, in Scotland 128 inches at oe in Argyll, whilst in Ireland the largest is only hes. The driest part of the British Islands is an ve district to south-south-west of the Wash, with a of about 21 inches. A large extent of England, the more important agricultural districts in Scotland, rainfall under 30 inches: the greater part of d, and nearly the half of Scotland, have a rainfall not ng 40 inches: but in Ireland it is isolated patches at show a rainfall less than 40 inches.

In the west of Norway the rainfall in inches is Bergen, 51 at Aalesund, 16 at the Naze and in the Isles, falling to 10 at the North Cape. At Chri Upsala, and a large part of the east of Scandina rainfall is about 21 inches, falling to 16 inches north coast of the Gulf of Bothnia. In Russia and it rises only at a few places to 20 inches, several of this extensive region having an annual rainfall o 3, or even 2 inches. The rainfall of Spain present extremes—from 68 inches at Santiago to 13 inc Saragossa. In France and the plains of Germa average varies from 35 to 20 inches, but in moun regions these figures are greatly exceeded, rising all gradations to upwards of 100 inches at some p the Alps.

An important distinction between the manner o bution of the rainfall in the west of Europe and a inland places is that the greater part of the annual q of the west falls in winter, whilst in the inter amount in summer is greater than in winter. The of January and July shows this in a very manner. The summer climates of the extreme of Europe and North Africa are rainless, and over sive regions in the south of Europe adjoining th rainfall does not amount to an inch. Over the regions the prevailing winds of summer are northe hence the drought which characterizes them. On th hand, the rainfall in the interior of the continent is In January the maximum rainfall occurs on the mo and high grounds overlooking the Atlantic, a minimum on the plains of Russia.

Owing to the way in which Europe is broken up seas which diversify its surface, the time of the yea the rain attains the maximum differs greatly in d regions. This phase of the rainfall occurs, indeed, ing to locality, in all months except February, Mar April. The month of occurrence of the annual ma rainfall over Europe is shown by fig. 18. A simil

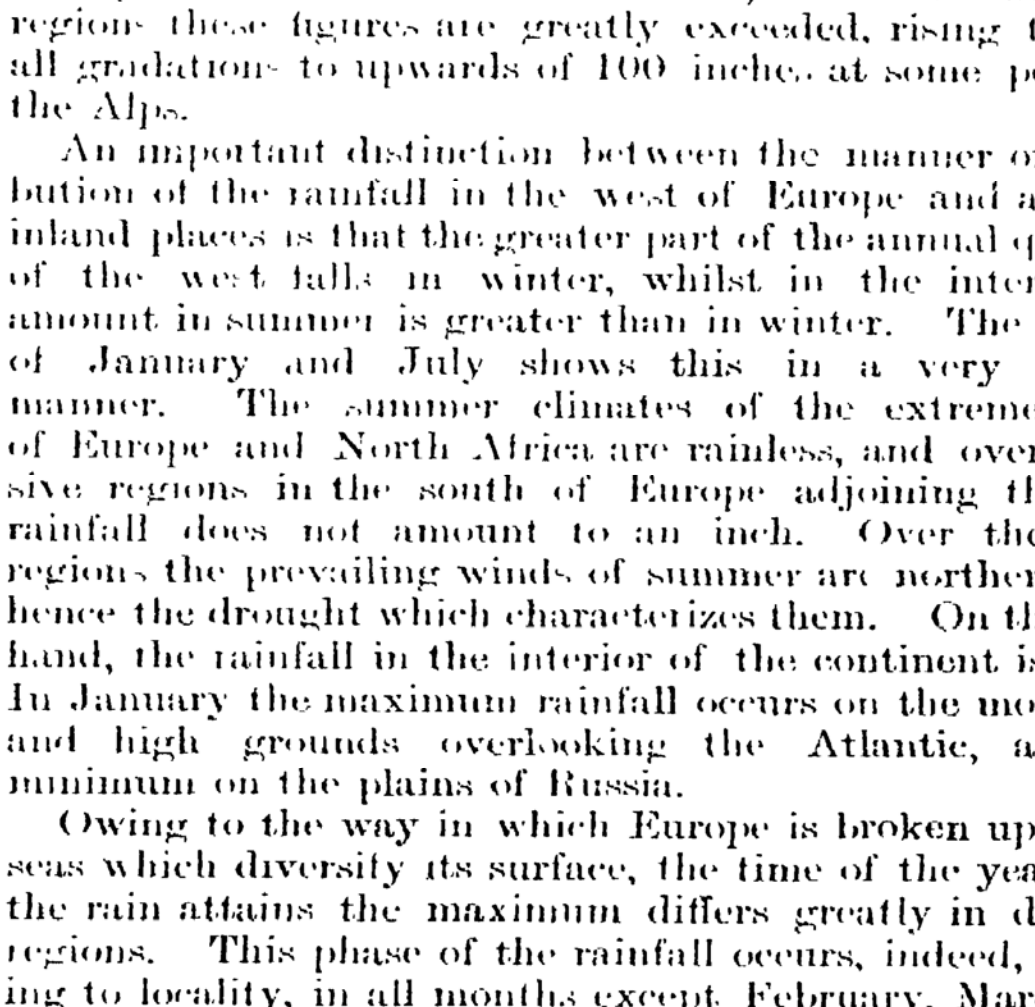


FIG. 18. Showing Month of Maximum Rainfall in Eur

representing the month of least rainfall shows still uniformity in a regular succession of the months in from region to region. Thus the month of least ra January on the lower Volga, February in western Rus the greater part of central Europe, March in the n France and south of Great Britain, April farther to the

n Scotland north of the Grampians, June in Orkney, nd, Iceland, the west of Ireland, and the north-west nce, and July over the whole of the south of Europe. riest month occurs nowhere in Europe in any of the onths from August to December.

fall of North America.—West of the Rocky Mountains the is very unequally distributed, the annual amounts varying 6 inches at Astoria, near the mouth of the Columbia river, ches at San Diego on the coast, and 3 inches at the head of lf of California. Over the whole of the region between the e and Rocky Mountains the rainfall at all seasons is extremely this being indeed that feature in the climate to which the on of the cañons of that region is chiefly to be referred. On er hand, in the United States and Canada to east of long. 100 distinguishing feature of the rainfall is the comparative eness of its distribution, an annual rainfall exceeding 50 occurring only over restricted districts, and a rainfall as low nches being scarcely met with anywhere. The regions where nfall exceeds 50 inches are Florida, the lower basin of the ippi, and the Atlantic seaboards of Nova Scotia and New nd.

nuary the annual maximum rainfall occurs over the whole west coast from Sitka to lower California, but in the r between long. 120 and 95° W. the amount is everywhere and over a considerable part in the south-west of this region falls. The region of largest rainfall extends from Louisiana t Virginia, where the mean varies from 4 to 6 inches. Over the whole of the Dominion of Canada, by much the greater the winter precipitation is in the form of snow, which has arefully measured and recorded by the Meteorological Ser- The average snowfall for January exceeds 30 inches at St Newfoundland, in Anticosti, Prince Edward Island, and y other regions.

uly the rainfall is everywhere small in the west, a large f this extensive region being absolutely rainless. table dryness of the climate at this season is due to the N W that set in towards the low pressure of the interior, which low towards warmer regions. The rainfall to the east of the Mountains is distributed by the winds which are connected he low-pressure region of the interior and with the high- e region of the Atlantic. The result is two regions of larger , the one in the south-east of the States and the other to the the lakes. The summer winds of the south-eastern coasts are rly, and as they are anticyclone in their origin and have in ourse traversed some extent of ocean, they arrive well but not aturated, and pour down a rainfall in July of 6 inches and ds along the coasts and for some distance inland from Louisi- Chesapeake Bay. Further, since in July these winds attain naximum force and persistency, the rainfall at the same aches the maximum along the whole coast from Boston to istance west of New Orleans. Since the summer winds blow line of the Alleghany mountains and not across them, the l diminishes in ascending their slopes. The comparative eness of the rainfall over the eastern States is the necessary of the winds' passing into higher latitudes, and, therefore, regions. A broad region where the rainfall is less than on de of it, extends from Michigan to the south-west as far as an River. To the west of the lakes the rainfall rises above es, and, since over this region the winds become somewhat y as they flow towards the low-pressure area, it is probable e larger rainfall of this prairie region has its origin in no degree in the evaporation of the lakes. On ascending the reaches of the Mississippi, the amount diminishes, but y falls lower than 2 inches, being thus analogous to the r rains of the Upper Ganges. On crossing the water-parting e basin which drains into Hudson Bay, we encounter E. and winds laden with vapour licked up in their passage over Hud- Bay, which they distribute in a generous rainfall of probably inches over the rising colonies of Manitoba and Saskat- n. An important point in the climate of the States is that early the whole of the extensive region stretching between anies and Rocky Mountains, except the south coast already d to, the annual maximum rainfall does not occur in summer spring, the month of largest rainfall in the great majority es being May. In the basin of Hudson's Bay July is the of largest rainfall.

fall of Central and South America. The following are, in the larger and more interesting annual rainfalls round the —Vera Cruz, 182; Belize, 75; Maracaibo, 163; Caracas, Georgetown, 95; Paramaribo, 142; Cayenne, 140; Para, 71, nbuco, 109; Buenos Ayres, 34; Bahia Blanca, 19; Puerto 102; Valdivia, 109; Valparaiso, 100; Serena, 93, Lima, a large part of Peru, nil. A remarkable feature of the of South America is the large amounts that fall in the of the Orinoco and Amazon; the fall is 91 inches in the upper basin of the Madeira, and 112 inches at Yquitos (la S., long. 72° 57' W.). The reason is that this immen where pressure appears to be almost constantly low, i- oper highly saturated winds that blow from the equatorial A Quite different is the distribution of the rainfall over Plata basin. The annual falls, in inches, are 92 at Jonv at Corrientes, 44 at Monte Video, 36 at Parana, 24 at S 22 at San Luis, and only 6 at Mendoza. The fall rapidly ascending the eastern slopes of the Brazil mountains fac South Atlantic, thus, while the amount at Rio Janeir inches, on the hills to northward it is 116 inches.

In January northerly winds prevail on the south coast Gulf of Mexico and the Caribbean Sea, and as they hav origin in the high pressure of the American continent, crossing the equator into lower latitudes, the January ra these coasts is comparatively small. In July, however, the ing winds are easterly, and as they have traversed a large e the equatorial waters of the Atlantic they are highly sa and consequently the July rainfall of these coasts is ver very large. The following are, in inches, the January a rainfalls: Caracas, 1·00 and 14·04; Guatemala, 0·28 and Vera Cruz, 2·49 and 33·90. The seasonal distribution rainfall in the basin of the Amazon is the reverse of th January the position of the belt of calms is about lat. 3° as pressure is relatively low over the basin of the especially its southern slope the trades and the west po the region of calms mutually spread their highly saturated the whole region as far as the Andes, resulting in one of t widespread heavy rainfalls anywhere to be met with other hand, since in July the belt of calms is about lat the saturated atmosphere of the tropical regions no longer the Amazon, but is carried westward into the Caribbean Sea of Mexico. Hence at this season the rainfall of the Amazo is small. The following are, in inches, the January an falls: Para, 6·51 and 3·26; Manaos, 7·93 and 1·82; Madeira, 15·90 and 0·30, and Yquitos, 10·24 and 4·26. La Plata in January pressure is low, and as winds conse blow from the upon the region of low pressure the is large; but as pressure is high in the interior in July the in that month is small. The following are, in inches, the and July rainfalls:—Buenos Ayres, 2·37 and 1·70, Para and 1·32; Corrientes, 5·21 and 2·67; Jonville, 14·26 an and San Luis, 2·62 and 0·00.

Rainfall of Africa. As regards the rainfall, Africa pres greatest diversity in its climates. The following are the amounts in inches at various points on or near the coa Said, 2; Alexandria, 8, Tunis, 13, Algiers, 31, Oran, 17, M 50, mouth of the Senegal, 17, Goree, 21; Sierra Leo Christiansborg, 23, St Thomas, 40; Gaboon, 106, Loan Cape Town, 23, Mossel Bay, 12; Port Elizabeth, 24, Dur Zanzibar, 58, and mouth of the Zambezi, 61. In the nort continent, the rainfall rapidly diminishes inland and over desert of Sahara practically none falls. In the interior o it diminishes, the amount at Laghouat being 17 inches, Biskra 9. In Egypt the rainfall is limited to a narrow str the coast; at Cairo the annual fall scarcely amounts to The January and July rainfalls are in inches, as follows Said, 0·46 and 0·00, Alexandria, 1·95 and 0·20; Algiers, 0·04, Biskra, 0·56 and 0·03; St Louis (Senegal), 0·28 an Goree, 0·00 and 4·06; Sierra Leone, 0·69 and 21·20, Christ 0·50 and 2·00; Katunga, 0·11 and 1·76, Gaboon, 9·35 an Cape Town, 0·28 and 3·83, Durban, 5·00 and 1·70; Preto and 0·71, and Zanzibar, 2·02 and 2·35. At Zanzibar the rains occur about the equinoxes, the mean for April bein inches, and for October 6·80 inches.

In the case of this as the other continents, the explanati different amounts is to be had in the seasonal changes of w the north the winter rains are to a very large extent the penitment of the Mediterranean storms of that season, but in pressure is diminished in the interior and increased in the to the north west, resulting in strong steady northerly wind as they advance into hotter regions are unaccompanied w The heavy summer rains from Senegambia to the Gold C due to the strong monsoonal winds which set in tow interior thus drawing over these coasts the highly saturat the belt of calms and of the trades immediately to the no south of it. Since in winter the belt of calms is remov latitude farther to the south, and the temperature of the n greatly reduced, it follows that the winds blowing on the from the sea are drier and less strong, and consequently the is small. At Sierre Leone the absolutely driest month is F 0·31 inch, and the wettest September, 29·15 inches. On t hand, at Gaboon (lat. 0° 25' N.) the dry season is from August, when the belt of calms is farthest to the north; absolutely rainiest about the equinoxes, the mean of Mar 14·70 inches and October 19·52 inches. At Loanda (lat 8 the annual amount is only a tenth of what falls at Gaboon

lly during the summer month of the anticyclone plac
h Africa pressure is lower on the interior,
which prevailing winds from the ocean blow and in these
into region become rapidly hotter the land all round
and for one degree more Falls to the normal minimum
more in the inland district where is a considerable
n the rainfall reaches the maximum of the year season
amounts in inches and decimals are July for Pretoria,
of 0·71 March but 1·[illegible] for Cape Town, 2·50
Lower Nile, Port Elizabeth and Natal, and Natal North,
1·000 In the winter rainfall [illegible] on the interior
of the rainfall is consequently [illegible] Though on the coast
on the mid interior [illegible] prevail yet the storms that
ward past South Africa [illegible] over large portion of
lern slope of the [illegible] table which not [illegible] the main
[illegible] general [illegible] It follows that the climate of
portant colonies [illegible] into two perfectly dis-
[illegible] the climate of the interior is cool and the Natal
[illegible] the rainy season [illegible] the hotter months and the
of the [illegible] where the rainfall [illegible] occurs during
[illegible] [illegible] [illegible] known to [illegible] the [illegible]
the interior of [illegible] It is certain however, that it is
[illegible] over these [illegible] to west of the Sahara and that it
from 1000 to [illegible] but to some distance south of the
Probably the [illegible] part of Africa [illegible] to [illegible]
the Atlantic Ocean northwards to and including the
[illegible] of the two great [illegible] of the Nile

Snow take the place of rain when the tempera
fficiently low to freeze the condensed moisture
osphere Snow is composed of crystals, often ex
star or hexagonal plates, which exhibit the
variety of beautiful forms, one thousand dif
and having been observed The numerous forms
y reduced to five principal varieties (1) thin
comprising several hundred forms of the most
beauty (2) six-sided or plane figures, studded with
shaped crystals, often six-sided, more rarely three-sided,
(3) pyramidal or six-sided (5) prismatic crystals,
of the end and middle thin plates perpendicular
length In the same snowfall the forms of the
are generally similar The flakes vary from 0·05
an inch in diameter, the smallest occurring with
temperatures and the largest when the temperature
be 32 If the temperature is a little higher, the
akes are partially thawed in falling through it, and
sleet The white colour of snow is caused by the
ction of the different prismatic colours of the minute
y crystals The density of snow is far from uniform,
nerally from ten to twelve times lighter than an
ulk of water, but varies from eight to sixteen
ghter than water.

limit of the fall of snow near sea-level coincides
with the winter isothermal of 32°, since in places
he mean winter temperature is no higher than 32°
the air falls occasionally to 31° or lower during the
month As regards Europe, the southern limit is
Gibraltar, in North America it is Savannah, New
the mouth of the Rio Grande, the head of the Gulf
Corea and San Francisco In Europe, north of lat
ow falls generally on an average of from 80 to 110
the year At Upsala the number of days is 61,
sow 15, Aberdeen 17, Oxford 18, Ostend 15, Brus
, Tarum (on the south west of Jutland) 12, Copen
23, Vienna 35, Ofen 19, Schemnitz 12, Milan
este 6, Salerno 3, Madrid 3, and Lisbon 1
enland the number of days exceeds 80, and this
s nearly reached in Newfoundland and the north-
board of Nova Scotia At Quebec the mean days
w are 66, Halifax 64, Winnipeg 54, Detroit 34,
lenry 13, St Louis 11, mouth of the Columbia
, and Charleston, S.C., 2 In Europe the time of
r when snow falls most frequently is December and
, except in the south of the empire, where February
month of the most frequent occurrence of snow.
the north of a line drawn from the entrance of the
Gulf of Finland through Warsaw, Cracow, Salzbu
Santiago March is the month of maximum occurre
the great majority of instances; while to the south
line it is January and in several cases December.

The largest falls of snow occur in the Antarctic r
as well attested by the magnificent icebergs of
snow which break off all round from the lofty walls
that engirdle the Southern Ocean Excepting perhaps
Dominion of Canada, no data have been anywhere co
from which even a rough estimate could be forme
the mean annual amount of snow that falls in di
parts of the globe.

Snow Line The snow line marks the height
which all the snow that falls annually melts during su
No general rule can be stated for this height in di
climates owing to the many causes determining it.
are the exposure of mountain slope to the sun (and
other things being the same, it is higher on the sout
on the north sides of mountains), exposure to th
bringing wind, the steepness of the mountains, a
degree of dryness of the air. Hence the position
snow line can be known by observation only. It fal
little on either side of the equator to lat. 20°; fro
20° to 70° it falls equably, but from lat. 70° to 78°
more rapidly. To this general rule there are many
tions. It is 1000 feet higher on the north than the
side of the Himalayas, owing to the larger snowfall
south, and the greater dryness of the climate of the
side, and therefore the greater evaporation from the
there. It is higher in the interior of continents tha
the coasts, because the precipitation is less and summ
greater. In the Caucasus it is 11,063 feet high, bu
8950 in the Pyrenees. In South America it rises fr
equator to lat. 18°, and more on the west than on t
slopes of the Cordilleras, owing to the large precipita
the east and small precipitation and arid climate of t
side of that chain of mountains. It is as high in l
S. as in 19° N., but south of that latitude it rapidl
owing to the heavy rains brought by the moist
winds of these regions. In the south of Chili it i
feet lower than in the same latitudes in Europe, an
feet lower than in the extremely arid climates of the
Mountains.

Storms. If weather charts representing a large
the northern hemisphere be examined, two distinct s
of pressure are seen which change their forms and po
on the earth's surface from day to day. The one
systems of low pressure marked off by concentric
enclosing pressures successively lower till the ce
approached; and the other systems of high p
marked off by concentric isobars enclosing pressures
successively higher towards the centre. The fo
the former called cyclones, and the latter anticyclones.
areas of low pressure are the distinguishing charact
of the hurricanes and typhoons of tropical regions,
the ordinary storms of higher latitudes, and they
be conveniently grouped under the general name of cy
Fig. 19 shows a storm which was passing across
western Europe on the morning of November 2, 18
it may be taken as fairly representing the general f
of cyclones. In the figure the arrows fly with th
and the force of the wind is indicated by the nu
feathers on the arrows.

It will be seen that the winds indicate, not a
movement round the centre of lowest pressure,
vortiose motion inwards upon that centre, the
being opposite to that of watch-hands. In other
the wind follows Buys Ballot's law, already exp
The winds are strongest where the isobars are
together; or they are generally proportioned to the

gradient,"—a term introduced by Stevenson in
Cyclones have diameters ranging less than 600, and
casionally exceed 3000 miles; the cyclone of fig. 19
diameter of about 1200 miles. The cyclones of
editerranean are
of smaller dimen
an those of north
Europe and
a. The rates at
cyclones advance
he earth's surface
reatly, the average
nerica being 21
an hour, in the
ic 20 miles, and
ope 26 miles. A
high as 70 miles
r has occurred in
British Islands,
nes they remain
ary, and more
their course is
time retrograde.
temperature and

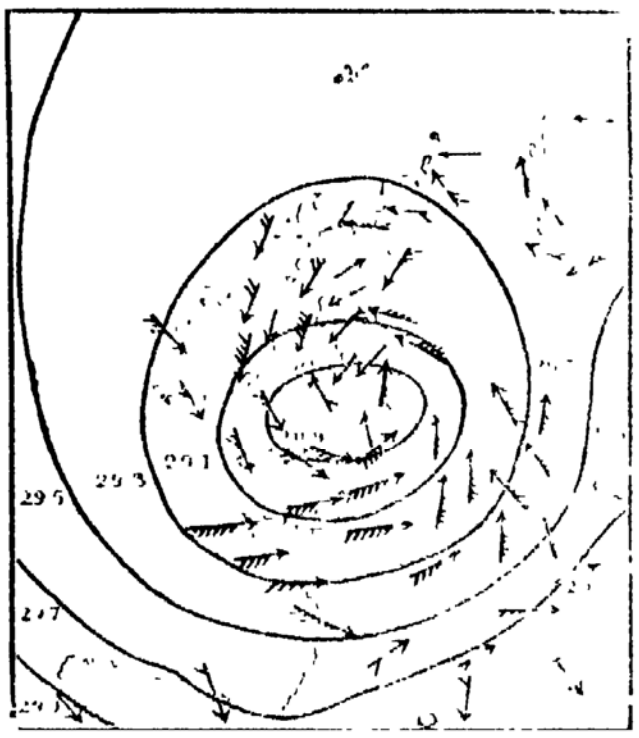


Fig. 19

ity increase at those places towards and over which
nt part of the storm is advancing, and fall at those
over which the front part of the storm has already
. In other words, the temperature and humidity
pressure falls and fall as pressure rises. This is
portant climatic significance of cyclones. Thus a
sion of low pressures passing eastwards in succes-
o northward of the British Islands are the essential
ions of open winters; whereas, if the cyclones follow
s lying to southward, the winters are severe. In a
e the broadest feature of weather is an area of rain
or rather somewhat in front of the centre, sur-
d by a ring of cloud, outside which the sky is clear.
recise form and position of these areas have been
by Abercrombie to vary with the type of pres-
istribution, with the intensity of the cyclone, and
he rate of its progress, and they are also influenced
al, diurnal, and seasonal variations.

chief point of difference between American and
ean storms is essentially the result of the mean
pressures to the west and north west of their respec-
orm-tracks. Owing to the high winter pressure in
terior of America, the barometer rises in the wake of
orms of the United States more rapidly, the wind
round more quickly and more uniformly to N.W.,
V., and N. and keeps longer in these directions,
he temperature and humidity fall to a greater
, than happens in Europe. In the New England
and Canada the easterly winds of the storms,
g as they do from the Atlantic, are disagreeably
damp, and misty in a degree and with a frequency
greater than occurs with the same winds in the
n Islands.

e chief points of difference between the hurricanes and
ons of the tropics and the cyclones of higher latitudes
ese:—tropical cyclones are of smaller dimensions,
steeper barometric gradients and therefore stronger
, and advance at a slower rate over the earth's
e. Another point of difference is that a large number
hurricanes of the West Indies and the typhoons of
n Asia first pursue a westerly course, which gradually
es north westerly, and on arriving at about lat. 30°
recurve and thereafter pursue a course to north-east
. The tropical cyclones of the Indian Ocean south
equator also first pursue a westerly course, which
ally changes to south-west, and often on arriving about
lat. 30° recurve to the south east. Many of the cyclo
India have their origin to westwards of the Nicobar Is
pursue a course to north westward, and die out
valley of the Ganges; and, similarly, a considerable n
of the cyclones of the West Indies pursue a westerly
through the Gulf of Mexico, and several die out in the

The most dreadful attendant on tropical cyclo
the storm wave, caused by the in blowing winds a
low pressure of the centre of the storm. When this
i mmu nally high and is hurled forward on a low
coast at high water it becomes one of the most destr
a cents known. The Bakarganj cyclone of Octob
1876, was accompanied by a wave which flooded t
grounds to the east of the delta of the Ganges to l
varying from 10 to 15 feet, by which more than 1
human beings perished.

*Tracks of Cyclones of North America, Atlantic
Europe.* In the *Physical Atlas of the Atlantic Ocean*,
under the direction of Dr Neumayer of the De
Scewarte, plate 28 shows by isobars the mean posit
the centres of cyclones and by lines their mean
The following are the regions where the lowest baro
or storms has been most frequently found, the
to west-south west of the lake of the United State
Gulf of St Lawrence, mid Atlantic about lat. 50° lon
to the south west of Greenland to the south west of I
which is by far the most important of the whole,
south-west of the Lofoten Isles; the region emb
Denmark, the south of Scandinavia, and Finland, a
secondary centres of frequency, the south of the
Islands, Corsica and part of Italy adjoining, and the
east of the Adriatic. The great importance of the cy
where the lowest barometers are most frequently
consists in the indication they give of the precise
either where many storms originate or where th
either retarded or arrested in their course. As rega
origin of storms, the centre west of the Mississipp
region where most of the United States storms or
the centre ... The Gulf of St Lawrence is where many
great Atlantic storms have their origin, and the cen
mid Atlantic and to the south west of Iceland a
regions where the storms of north western Europe
originate. The centres on the south west of Gre
the Lofoten Isles, Denmark, and the south of the
Islands, all appear to indicate that storms are reta
in onward course ... coming up again in large ma
land,—which may, in part at least, be occasioned
heavy rainfalls that mark the first part of their cours

Of all storm tracks the most frequently taken is
the storms of the United States, which pursue an e
course through the lakes to the Gulf of St Lawren
considerable number of storms follow a course fro
Scotia to Davis Straits, but the larger number
north-easterly course through the Atlantic towards
and thence past the north of Norway. Among t
frequent but important tracks are these: from ne
Orleans along the east coast of the States toward
Scotia; from mid-Atlantic to south of Iceland and
through France to the north of the Mediterranean
from the Atlantic about lat. 42° long. 40° in a
easterly course quite outside but at no great distan
the British Islands, and thence towards the Nort
Of the tracks more immediately affecting British
are one from Iceland in a south-easterly direction t
the North Sea and Germany, and four tracks whi
from near Scilly: (1) to the south east as already de
(2) eastward through the north of Germany, (3) no
to Christiania; and (4) north through Ireland
Hebrides. These are the storm tracks which chie
the United Kingdom its easterly and northerly wi

Inclination of Winds to the Isobars The vorticose of the winds in a cyclone towards and in upon the has been already pointed out. One of the more ant practical problems of meteorology is the deter- on of the angle of inclination of the winds to the s in the different segments of the cyclone, not only he application of the results of the inquiry to the of storms but also to practical navigation. The first ntribution to the subject, based on accurate measure was made by Clement Ley in 1873.[1] From the ations made at fifteen place in north west Europe ed by him he showed that the wind- incline from ls of higher towards those of lower pressure at a ngle of 20 or , that the inclination is much greater nd than at well exposed stations on the coast, the ive angles being 28 55' and 12 49'; and that the t inclinations are with S.E. winds. Then follow N.E., and N.W. winds, the last showing the least tion Whipple has recently compared the winds with the barometric gradients for the five years 1879, with the result that the greatest inclination with S.E. winds, the least 35 with N.E. winds, and n for all winds 52'.

egards the open sea, Captain Toynbee has shown, careful investigation of the great Atlantic storm of 24, 1873, that the mean angle of inclination ed from one hundred and eight observations was e mean at the three selected epochs examined g from 25 to 31°.

ometric Gradient and Velocity of the Wind. In g into the relation of the velocity of the wind to rometric gradient, it is necessary to have some information as to the increase of the velocity with above the ground. Stevenson recently made tions on this point on winds varying from 2 to 44 n hour from the surface up to a height of 50 feet, hich he has drawn the following conclusions: (1) ces passed over in the same time by the wind with height above the ground; (2) the curves ut by these variations of velocity from 15 to 50 gh coincide most nearly with paraboloas (fig. 20)

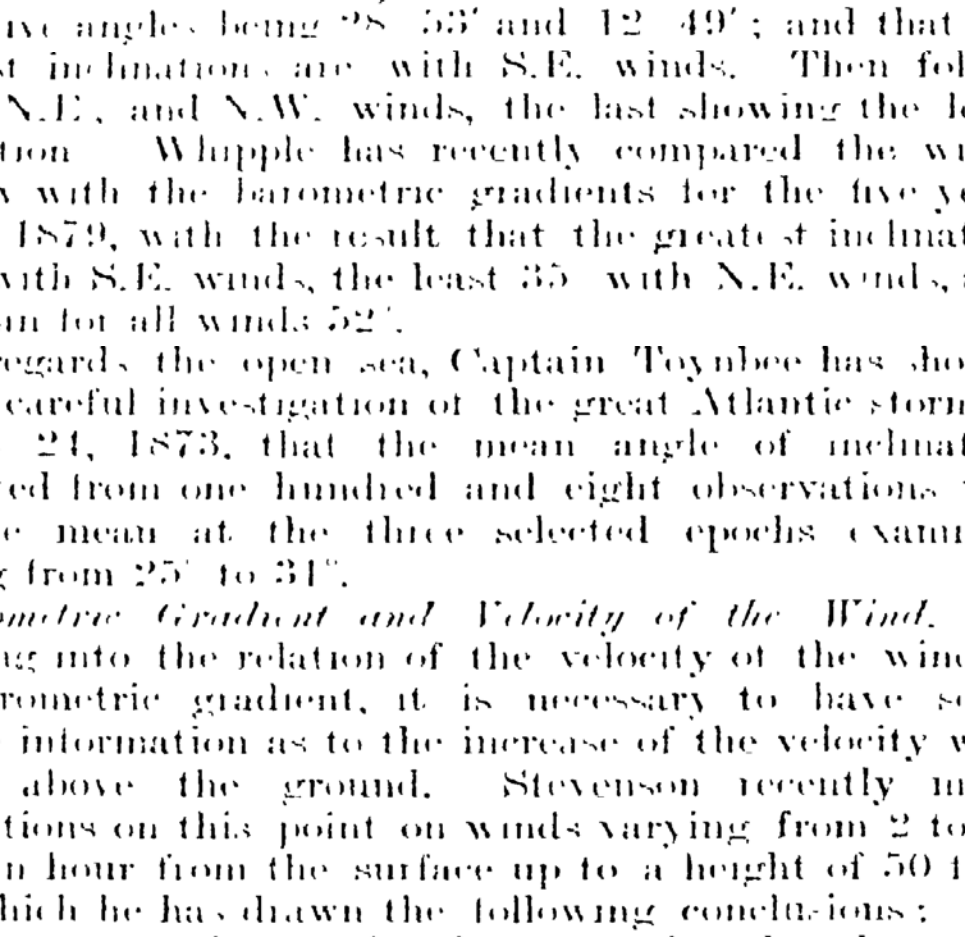


FIG. 20.

their vertices in a horizontal line 72 feet below the ; (3) between 15 feet and the ground there is great ance of the currents, so that the symmetry of the s destroyed; (4) the parameters of these paraboloas directly in the ratio of the squares of the velocities different gales. If v be the velocity of the wind at height H above the ground, the parameter corresponding paraboloa is v^2 (H + 72); and as v va parameter will vary as v^2 or as the square of the of the gale. It follows that, to render wind obser comparable, it is necessary that anemometers be pl one uniform height above the ground, and that st height not lower than 15 feet above the surface. very desirable that the inquiry were prosecuted height of 100 feet; and it is of the utmost importan the variation in the diurnal velocity be at the sam determined at different heights from 15 feet upwar

Stevenson also made wind observations on the Hill, Arthur's Seat, and the Pentland Hills, in the of Edinburgh, up to a height of 1600 feet above se It is from observations made at stations on kno peaks at different heights above the sea, and at d heights above the surfaces of their summits, th problem of the variation of the wind's velocity at d heights with the same barometric gradient can be tained. In carrying the inquiry to considerable h the results cease to be comparable with those o at lower levels, unless in those cases where neighb heights are available for data from which the bar gradient at the observed height can be calculated results of observations as to the velocity of atmo currents at very great elevations in the atmosphere c from the apparent movements of the higher clou altogether incomparable with the winds near the su the earth, for these among other reasons:—the hei the clouds can be at best but imperfectly ascertain motion of the clouds, particularly the higher cloud be only apparent, it being sometimes difficult to dist between the formation and dissolution of clouds an motion; and above all, since the higher clouds are the accompaniments of the greater weather change movements as the result of barometric gradients t a knowledge of which we are absolutely powerless a single step.

As regards surface winds, Clement Ley in 18 Whipple more recently and with greater fulnes calculated the mean wind velocities for twelve gradi the gradients being derived from the daily weather of the Meteorological Office for the five years 1875 at 8 A.M., and the corresponding wind data being o from the hourly readings of the Kew anemograph barometric gradient is for 15 nautical miles, a following are the velocities for the twelve gradients mean of the year:—

Gradient. inch	Velocity.	Gradient. inch.	Velocit miles
0·002		0·017	15·0
0·005		0·020	16·5
0·007		0·022	19·1
0·010	9·2	0·025	22·0
0·012	11·6	0·027	22·0
0·015	12·6	0·030	25·5

The influence of season is very strongly marked velocities for the same gradients in order are—Oct December, 12·5 miles; July to September, 12·6 January to March, 14·8 miles; and April to Jun miles. From those observations of Whipple it that during the six months when the temperature is the velocity for the same gradients is least, while the is greatest during the six months when the tempera rising, and absolutely greatest during the three ending June, when the greater part of the annual i of temperature occurs. It is evident that the ob increase in the velocity of the wind for the same gr is to be referred to the same cause that brings ab diurnal increase in the wind's velocity, viz., th blowing over a warmer surface than itself.

[1] *Journal Scottish Meteorological Society*, vol. ix. p. 66.

ople has also sorted the winds according to the points of the compass, with results of the greatest . If N.W., N., N.E., and E. winds be grouped r as polar, and S.E., S., S.W., and W. winds as rial winds, the mean hourly velocity of the polar for the same gradients, is 1·1 miles in excess of the rial winds. Now, since polar winds pass into lower es, the surface of the earth over which they blow mer, whereas the surface is colder than the equa- winds which blow over it. It follows that the ed velocity of polar winds is referable to the same ons which result in the diurnal increase in the velocity and the greater velocity for the same nts of winds when the annual temperature is rising, n all these cases the winds blow over a surface of er temperature than their own.

evident from these considerations that for the oment of the law of the relation of the wind's y to the barometric gradient with an exactness nt to warrant us in expressing that relation in a l mathematical formula much yet remains to be done. th, as regards the various formulæ submitted by Mohn, Hann, Everett, and others, we have no but to allow the justness of Strachan's criticism *n Meteorology*, p. 98) that the theoretical values ned by the formulæ do not accord with the actual and that therefore a satisfactory formula is yet to nd. Ere such a formula need be looked for, the ions must be fulfilled for the preliminary work of sup- the observational data required. The "Challenger" ations prove that, with gradients substantially the the velocity of the wind is greater on the open sea ear land; and we have seen that the velocity varies he hour of the day, and generally is increased as the rature of the surface rises above that of the air blow- er it, and diminished as the temperature of the surface elow that of the air. It is evident that observations open sea will afford data for the simplest solution of oblem; but on land the diurnal, seasonal, and non- ic changes of temperature greatly complicate the m, and render necessary for its solution observations lly designed for the purpose. It is not easy to see hese can be obtained but by carrying out the plan pro- in 1875 by Stevenson of establishing strings of well- ed meteorological stations planted sufficiently close he barometric gradients may be determined within the of accuracy required. Observations made twelve daily for a year, at stations so arranged, would the observational data for the solution of this funda- l problem in meteorology. Till some such proposal ried out, the problem remains unsolved, for barometric nts based on the widely separated existing stations o uncertain and rough and the wind observations anting in that comparability which alone can satisfy quiry.

ather and Weather Maps.—Weather is the state of r at any time as respects heat, moisture, wind, rain, and electricity; and a change of weather implies a e in one or more of these conditions. Of these es the most important as regards human interests ose which refer to temperature, wind, and rain; and, ese are intimately bound up with the distribution of spheric pressure, the latter truly furnishes the key to her changes.

se relations are well shown by the International Monthly her Maps issued by the United States Signal Service. Of these or December 1878 is a striking example. This month was terized over the globe by unusually abnormal weather. A rawn from Texas to Newfoundland, across the Atlantic, the of France, and Germany, thence round to south-east, through ack Sea, the Caucasus, India, the East India Islands, and Australia to the South Island of New Zealand, passes thr broad and extended region where pressure was throughou siderably below the mean of December, and this low p was still further deepened in various regions along the line other line passing from Australia, through the Philippine I Japan, Manchuria, Behring's Strait, and Alaska, also mar an extensive region where pressure was uninterruptedly bel

On the other hand, pressure was above the average, and ge largely so, over the United States to west of longitude 96 Greenland, Iceland, the Faroes, Shetland, and a large por the Old Continent bounded by a line drawn from Lapland by Lake Balkhash, Canton, Peking, to the upper reaches Lena. Another area of high pressure extended from Syria, t Egypt and East Africa, to the Cape; and part of a third high pressure appeared in the North Island of New Zealan regards North America, the greatest excess of pressure, 0·19 above the mean, occurred in the Columbia Valley, from w gradually fell on proceeding eastward to a defect from the a of 0·146 inch near Lake Champlain and to northward, rising to near the mean on the north of Nova Scotia. To the nor north-east exceedingly high pressures for these regions a season prevailed, being 0·635 inch above the mean in I 0·500 in the south of Greenland and at the three stations r Greenland, proceeding northward, 0·145, 0·402, and 0·346 r

West Greenland being thus on the west side of the re high pressure which occupied the northern part of the At and on the north east side of the area of low pressure in the and Canada, strong south winds set in over that coast, a temperature at the four Greenland stations, proceeding from to north, rose to 1·1, 8·8, 12·1, and 11·4 above the mea the centre of lowest pressure was in the valley of the St La about Montreal, strong northerly and westerly winds predom to westward and southward, where consequently temperatu below the average, the deficiency at Chicago and St Louis 9·5; and, winds being easterly and northerly in California, t perature there was also under the mean. On the other hand New England States, the greater part of the Dominion of Can West Greenland temperature was above the average. Press much higher at St Michael's, Alaska, than to south-westwa Paul's, Behring's Strait, and hence, while temperature at St was 2·9 below the normal, it was 12·0 above it at St Mi where strongly southerly winds ruled. With these strong ce of pressure, America presented contrasts at least as striking distribution of the temperature. Along the south of Lake M the November temperature was 13·7 above the normal, wh December temperature was 9·5 below it, the differen between the two consecutive months being thus 23·2.

As regards Europe, Iceland was on the east side of the p high pressure which overspread the north of the Atlantic, an northerly winds prevailed there and temperature fell 7·2 be mean, presenting thus a marked contrast to the high tem of West Greenland at the time. In Europe, the area of pressure occupied the southern shores of the North Sea, ex thence, though in a less pronounced form, to south-ea Hence over the whole of western Europe winds were N.E., in the south west of Europe W.; and hence everywhere fr North Cape to the north of Italy temperature was bel normal, in some places greatly so, the deficiency being the south of Norway and 12·2 in the south of Scotland. other hand, on the east side of the area of low pressure wi southerly and temperature consequently high. In some l in Russia the excess above the mean was 15·9, and over proportion of European Russia the excess was not less th This region of high temperature extended eastward into Si far as the Irtish, being coterminous with the western hal anticyclone region of high pressure which overspread Siberia. But over the eastern portion of the anticyclone n winds prevailed with the inevitable accompaniment of l peratures over the whole of Eastern Asia, the deficiency tchinsk on the upper Amur being 6·8. Here again, ju America, Greenland, and Iceland, places with atmospheric equally high presented the strongest contrasts of temp Thus at Bogoslovsk, on the Ural Mountains, pressure was 0 and at Nertchinsk 0·154 inch above the normals, but Bo on the west side of the high pressure area had a temperatu above, whilst at Nertchinsk it was 6·8 below the average.

At this time of the year the mean pressure falls to the m in Australia, but during December 1878 the usually low was still further diminished. Pressure at this season also the annual minimum in the North Pacific and North A and it has been seen that the low pressure of these reg likewise still further diminished. But in the case of the it was attended with a most important difference. The lowest pressure, usually located to the south-west of Ice removed some hundreds of miles to the south-east, and an u development of extraordinarily high pressure appeared to t

erspreading the extensive region of Baffin Bay, Greenland, Faroes, and Shetland. It was to the [illegible] high pressure particularly in its relations to the low pressure region to the st of it, that the extreme severity of the weather in the Islands at the time was due. Now the high pressure was intimately connected with, and doubtless occasioned by, upper atmospheric current from the widely extended low pressure to southward, with its [illegible] centres of still pressure in the North Sea and Atlantic and United States, pressures were respectively 30.50, 30.32, and 30.46 inches under mal. Thus, with the most extraordinary distribution of the high-pressure ver Greenland, the most [illegible] pressures which render r 1879 so memorable, and, the whole globe around undation of the earth's atmosphere essentially the one ames at that time of the year, but the usual irregularities he distribution of the pressure appear to be more pronounced

n the all important features of the areas of high pressure and other and climate into consideration, with the abnormal concentration of aqueous vapour to which they imply, it is evident that, he meteorologist will be in a position to forecast, on e ground, the weather of the coming season for Islands, as to the Atlantic he will require to the data on which the forecasts are based

questions, which the International Weather Maps United States enable us to discuss, are of the first nce in meteorology, whether we consider the amplitude the atmospheric changes they disclose (these being vast as to embrace four continents at one time), became profoundly interesting from their direct on the food supplies and commercial intercourse ons) or regard the larger problems they present, ct towards their solution, which underlie physical hy, climatology, and other branches of atmospheric

The discussion presents the great atmospheric as influenced by oceans and continents, no less subordinate but important part played by mountain extensive plateaux, and physically well-defined n as to determine the development, course, and tion of the cyclones.

Storm Forecasts and Storm Warnings.—It is in tropical tropical countries that an isolated observer may, close approximation to certainty, predict the h of cyclones and hurricanes. In these regions atmospheric pressure and the other meteorological conditions constant from day to day that any deviation, even one, from the average of the hour and season in of pressure, the direction and strength of the wind, direction and amount of cloud, implies the presence at no great distance. Dr Meldrum has practically the problem at Mauritius with great success. Royal Alfred Observatory there the mean pressure el in January at 9 A.M. is 29·966 inches, from falls to 29·901 inches at 4 P.M., then rises to inches at 10 P.M., and again falls to 29·927 at 4 the mean direction of the wind and the diurnal variaboth as regards direction and force, have been stated Suppose then that the barometer is observed after 9 A.M. more rapidly than is due to the usual barometric tide, that in the afternoon it does not the second maximum, or that it continues to fall of rising, or appears, in short, any deviation from an daily march, then it is certain that there is ere an atmospheric disturbance near enough to us to influence the pressure. The direction in he disturbance is from Mauritius is readily known e wind, and the distance of the storm closely mated to by noting the rate and amount of the fall barometer, in connexion with the changes of the d the clouds, the rate and progressive motion of m being known chiefly from the veerings of the For a good many years past notifications have been sent to the daily newspapers when observations s that a storm is not far from the island, stating its posi and probable course from day to day. The scheme storm warnings at Mauritius has been entirely success and the result is of great value, since it shows what may done at an isolated station in the ocean, or what may done in ships at sea. In this connexion it is not poss to overestimate the importance to seamen of a knowle of the hourly variations of the barometer and its m monthly heights over the ocean tracks of commerce.

In passing from Mauritius to the British Islands pass from a region where the forecasting of storms weather is simplest and easiest to the region where i most complex and difficult, particularly for the west districts of these islands. The great difficulty lies in fact that the British Islands are immediately bounded the Atlantic to westwards; and, since practically e storm and nearly all weather changes come from direction, no telegraphic communication of their appro can be received. The Meteorological Office in London therefore no choice but to base the forecasts on such of observations telegraphed to the office as experience shown to be the precursors of storms and other wea changes. The more important of these observations the falling and rising of the barometer taken in conne with changes in the direction and force of the wind. S on the north side of the track of the centre of the st winds are northerly and easterly and temperature low, on the south side winds are southerly and westerly temperature high, one of the most important points t ascertained is the probable path the centre of the cyc storm will take. Though a good deal remains to accomplished in the development of this phase of sto yet much has recently been done in this direction by examination of the changes of pressure in the region the anticyclone contiguous to the advancing storm and the changing positions of the rain area near the centr the cyclone.

As regards Europe, the facility of forecasting sto increases as distance from the west coasts is increa Thus to the middle and eastern districts of the Bri Islands, were a day and night watch established in west, forecasts of almost every storm could be issued, exceptions being those small cyclones or satellite cyclo as they are called, originating within the British Isla themselves, which are frequently characterized at once their severity and by the rapidity of their onward cou In the United States, the system of weather forecastin perhaps the best in temperate regions, a result due the admirable system organized and developed under direction of the late General Myer, and adequately s sidized by the Government, but above all to the facili to detect and track the storms in the region where ne all of them have their origin, to west of the Mississi before they advance upon the more thickly peopled Sta

Meteorology sustained a heavy loss by the death in 1 of Leverrier, who was not only the keenest sighted physicists but also the prince of organizers of system meteorological observation. His last great service to science was the establishment of a system of observat by which the propagation of rain, hail, and other weat phenomena could be followed and recorded from comm to commune over France. This scheme for the invest tion of the vitally important bearing on the meteorol of a country of a comprehensive observation of its rain hail, and thunderstorms, through numerous obser assessing sound local information, is not only emine just in science, but is calculated to be attended with greatest benefits to agricultural and other public intere The practical advantages of the scheme, it need scar

ed, can only be reaped after a very large expendi labour and money in organizing a comprehensive al scheme of observation, systematically and per y carried through and discussed

ther details regarding meteorological phenomena found in the articles ATMOSPHERE, BAROMETER, E, HYGROMETRY OZONE, RAIN-GAUGE, SEA, and OMETER. (A. B.)

TERRESTRIAL MAGNETISM

the preceding portion of this article some account has been the influence which the sun and moon exert upon the air, and the ocean, their effect

ly dealt with. The discussion of the influence of the on what *may* be termed the movables of the earth will complete, however, without embracing an account of the which they produce in the earth magnetism. An account other magnetic observations has already been given under ding MAGNETISM and our task will now be to describe the e a description of the best and most recent instruments by the magnetic state of the earth is determined, and to observatory instruments, those adapted for travellers whether or by sea, and differential magnetometer. We shall then port account of the magnetic survey of the earth and of its ervation, and we shall then investigate the changes co- with terrestrial magnetism depending on the sun and moon. mming this task we shall be led to conclude that the ures variable, and we shall therefore examine whether this con- likewise borne out by strictly meteorological observations. we shall venture on remarks embodying a provisional hypothesis, and our object will be gained if this should be suggest certain lines of thought to those interested in the which may lead them to examine and discuss the very great observations at present existing.

INSTRUMENTS FOR DETERMINING THE MAGNETIC STATE OF THE EARTH.

(*a*) *Observatory Instruments.*

Declinometer.—It is that end of the needle which points to h magnetic pole of the earth of which the position is most ted even when the observation is made in the southern re. The difference of this position from true geographical enote what is called the variation or declination for a the needle. East is often reckoned negative and west . The instrument by which this information is obtained is he declinometer. The unifilar magnetometer, which is n of declinometer now used, is described and figured in ETISM, vol. xv. p. 238.

Dip Circle. The instrument by which the magnetic dip or ion is observed contains a thin needle about 3 inches e centre of gravity of which coincides as accurately as with the axis of motion of the needle. The needle has two nsisting of two very fine cylinders of hardened steel carefully gles to the plane of the needle, and great attention must be keep these axles in a state of perfect polish and clean- ns of these the needle can oscillate freely on two horizontal rounded edges, the one always lying on the one edge and the le on the other. If the centre of gravity coincide exactly axis of motion, and if there be no friction on the axles and the agate edges, the needle must settle into position that its magnetic axis lies in the true line of dip. osition of the ends of the needle is read by means of two opes which move round on a cross piece carrying vernier- the position of the lower end of the needle we move round er microscope until the cross wire in its field of view (extend- he line between the two microscopes) symmetrically cuts enity of the needle. The lower vernier is then read. The ocess is repeated for the upper vernier, and the mean of readings is taken. This mean will accurately denote the of the needle if the circle is properly set.

sources of error in a dip observation are (1) a want of ry in mass, the centre of gravity of the needle not being nt with the axis of motion; (2) the vertical circle being sly set; (3) a want of symmetry in magnetism, the mag is not being coincident with the axis of figure; (4) reason the axis of rotation of the needle not passing through the f the circle; (5) friction and adhesion of the axles as they their agate supports. This last source of error is guarded by taking great care of the axles, and by inserting them into a piece of cork before each observation, the agate s ought also to be rubbed with cork. Then, again, when dle has assumed its position, before reading it is gently tri- ns of a lifter, the handle for turning which is shown in the owards the right. It is then gently lowered, and thus pro- cess is repeated until no apparent change of position is p by the operation.

We shall now describe a complete dip observation. T point is to make the needle to swing in the plane of the m meridian. In order to accomplish this, after levelling the ment, the verniers are set for 90°, that is, for a vertical pos the needle. The whole instrument is now turned round h zontal circle until the extremities of the needle are bisected s the two microscopes, and the position of the vernie horizontal circle is then read. The needle is next reversed e microscope shall view its other flat side. It is made ver face, and the position of the horizontal circle read once See the face of the instrument is turned to and 180°, and th two operations repeated. We have thus four readings of th ontal circle, and if we take the mean of the two half-rev sufficient accuracy the position of that plane for ch vertical. Now this plane must be removed 9 magnetic meridian, for in such a plane the horizontal m the earth would have no resolved portion acting the needle's motion so that the needle would pr be neutral to the solicitation of the vertical magnetic force, and therefore perfectly vertical direction. By this means there obtain the magnetic meridian, and thus know the plane we ought to write for needle. The needle must now in the following positions face of instrument, e face of instrument, w needle to face of instrument, face of instrument, w needle to face of instrument, face of instrument, e needle to face of instrument. Finally, the pole of the need be reversed, by subjecting them with powerful bar magnet direction opposite to that in which they were previously and four observations taken corresponding to the above. Th of the eight observations would thus give us the true di

The turning round of the face of the instrument four times is made to counteract any error due to erroneous setting vertical circle. The reversal of the face of the needle is counteract any error due to the centre of gravity of the ne being quite coincident in the direction of the needle. Simil its axis of motion, and likewise any error due to want of sy of the magnetic axis. The correction for eccentricity is reading both ends of the needle. Finally, the reversing of the needle is intended to counteract any error due to the of gravity of the needle not being coincident in the direction needle (as we assume it to be) of figure.

Dr Joule has also constructed a modification of the dip circle the needle is turned on the line on which it rests in read by microscopes upon

Horizontal Force Magnetometer.—The theory of the in for determining the horizontal component of the earth's m force has already been given in the article MAGNETISM, v pp. 248–249, and the instrument is shown in two forms figs. 28 and 29. The corrections necessary for accurate re explained in a paper by G. M. Whipple (*Proc. Roy. Soc.*, 1

(*b*) *Instruments adapted for Travellers by Land.*

6. *Declinometer.* For travellers by land the unifilar mag (fig. 29), mounted on a tripod stand and duly levelled, is perh accurate kind of declinometer.

For this purpose a small fixed telescope with a transit mirror by of which an image of the sun may be thrown into the field of the telescope, and the chronographical position of the s well as the apparent time of the observation being kno azimuth thus determined. In order that such an observati succeed the following points must receive attention.

In the first place the axis of the mirror must be horizon adjustment of this is made by means of a riding level. S the normal to the plane of the mirror must be perpendicula axis. The adjustment for this is made by a screw attached back of the mirror. Take some object sufficiently eleva reflect it into the telescope; turn the object bisected by of the telescope. Then reverse the mirror in its bearing object remains still bisected by the wire no correction req be made; but if not the screw at the back of the mirror must move until the object is exactly the same position observation. Thirdly, the line of collimation of the tele be perpendicular to the plane of the mirror. In order to this there is a collimating eye piece attached to the tel when the sun is bright may be made to illuminate the cro Now turn the transit mirror until the reflexion of the cha cross wires coincides with the wire themselves, in which line of collimation of the telescope must be perpendicular plane of the mirror. When the correction has been once ma the circle reading of a small vernier which moves with the and always set the mirror so as to give this reading.

[1] *Proc. Lit. and Phil. Society, Manchester*, vol. viii. p.

ese means an accurate reading of the sun's bearing may be
and, the position of the place and the time of observation
nown, there are tables which enable the azimuth to be at
ermined.

oyd's Method of Determining the Total Force. While the
le and the horizontal force magnetometer may be used by
rs in addition to their use as observatory instruments, the
Lloyd has de[illegible] a new method of determining the total
The ordinary method of obtaining this is first to find the
the horizontal force, fr[illegible]ch the total force can be at
termined by the equatio[illegible]tal force = horizontal force ×
dip. This method is, h[illegible], open to objection in high
ic latitudes where the h[illegible]l force is very small and the
the No[illegible]L
Anot[illegible]stru[illegible]ethod this objection is over-
nt f[illegible]nder his method peculiarly
m t be kept [illegible], where a traveller's equip
s the a[illegible]the hat it ly
give[illegible]to an ordinary dip circle in
y kept[illegible]ation. These needles must be
ver e[illegible]other magnets, and their poles
as bef[illegible]
ng the[illegible] have two unknown quantities to determine, the
ce of[illegible]ctic moment of the magnet and the other the
[illegible]nth. We must, therefore, obtain two results,
[illegible]mon[illegible] the product of the earth's total force into the
the e[illegible] of the needle, while the other gives the ratio
order[illegible] quantities.
groove[illegible] determine the former of these, let the needle
over[illegible] wheel of radius *r* attached to its axle as in fig.
[illegible] which let an accurately known weight W be

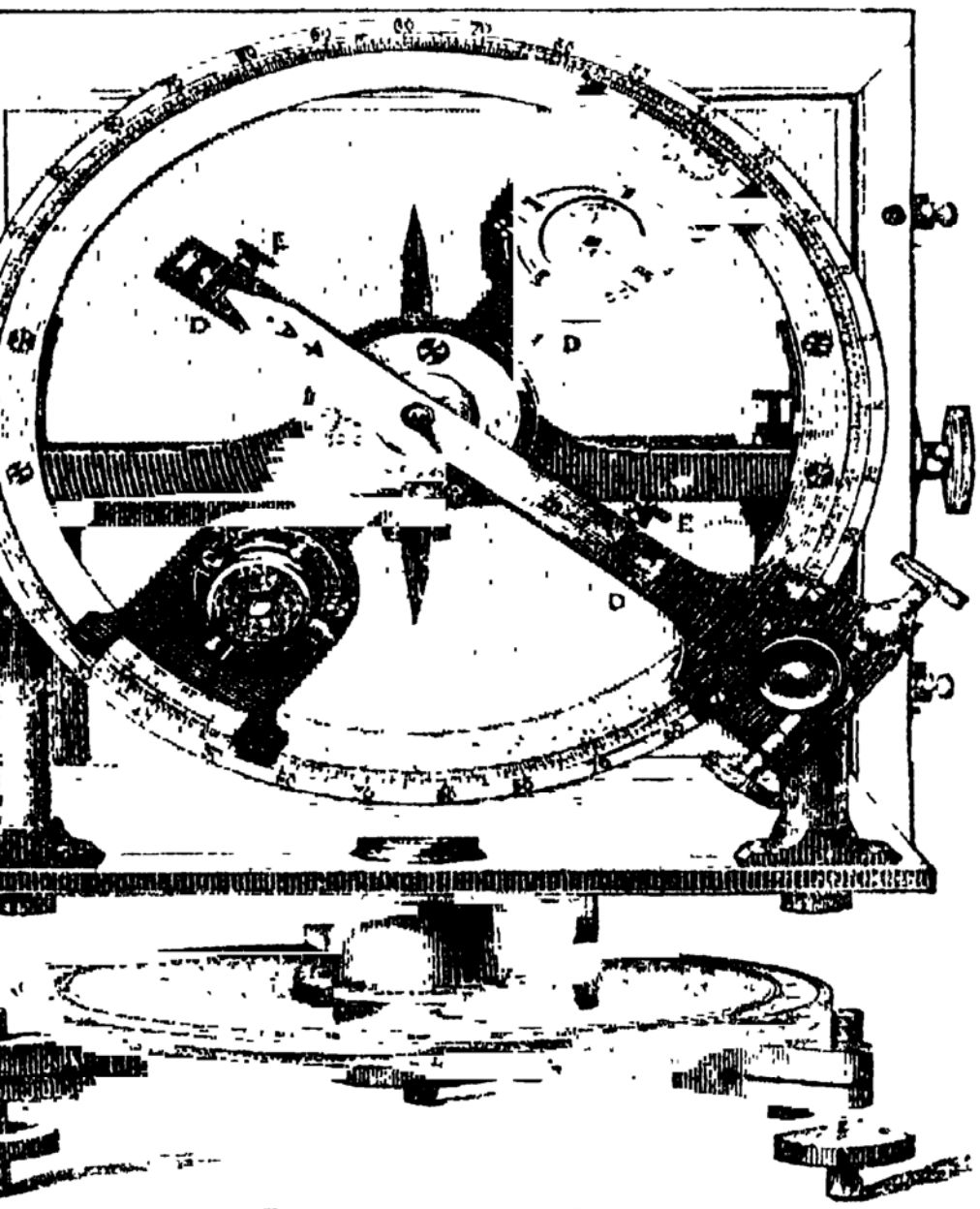


FIG. 21.—Dip Circle.

[illegible]ed by mean[illegible] fine silk thread. The best way of
[illegible]hes is to h[illegible]l with two hooks of precisely equal
[illegible]at each end[illegible]ttach the preponderating weight W
[illegible]of the hooks. W[illegible]ring is done a new position of equili-
will be taken by the needle. If we suppose that *m* denotes
gnetic moment of the needle, that *i* is the angle of dip at the
nd that η denotes the angle which the needle in its deflected
[illegible] makes with the horizon[illegible] sighting being so made
shall be less than *i*, then [illegible] that the needle has been
d out of its position of equilibrium through an angle $i - \eta$.
call this angle u and designate by R the total force
place, we obtain the following equation of equilibrium:—

$$mR\sin u = Wr \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1),$$

supposition (which is very nearly but not strictly correct)
denotes a constant force at all latitudes.
ext, in order to determine the ratio between this needle's
d that of the earth, let it be removed and employed to
another substituted in its place.

When using it thus as a deflector it should be laid in a f
an invariable position as in fig. 21. This frame is at right a
the line between the two microscopes, and as both piece
together the best plan is to turn the whole round until the
needle is visible in the centre of the field of the microscopes, i
position it is of course perpendicular to the deflecting need
always keeping to this arrangement we secure an invariable
between the poles of the two needles. Suppose therefore
have employed the needle as a deflector in the above manner
that the deflected needle has thus been made to assume a
denoting an angle η' with the horizon. It has therefo
deflected from its position of equilibrium by an angle $i - \eta'$ (
ing the dip as before); calling this angle of deflexion u', we
the following equation of equilibrium:—

$$R\sin u' = mU \quad . \quad . \quad . \quad . \quad . \quad . \quad .$$

U being a function depending upon the distance of the nee
on the distribution of free magnetism in them.

10. If we multiply together equations (1) and (2), we ob

$$R^2\sin u\sin u' = UWr \quad . \quad . \quad . \quad . \quad .$$

in which u, u' are determined by observation, while W an
be regarded as constants. U is, as we have said, a funct
pending upon the distance of the two needles and upon th
bution of free magnetism in them.

The magnetic moment of these needles is of course liable t
tion, but if they are carefully guarded from contact with
we may imagine that while their intensity alters, becoming
for instance, this nevertheless does not sensibly affect the
tion of the free magnetism within them, in which case the
U may be regarded as a constant quantity. The results
by this method of Lloyd's fully confirm this hypothesis re
U; but it is essential that the two additional needles, the
and the deflected needle, should have their poles at no tim
reversed or disturbed.

Assuming therefore the constancy of the quantity U, its va
be easily determined at any base station where the total f
been determined independently by the ordinary method.

11. Having thus determined the value of U, or at once
(which we may call *c*), let us carry our instrument to a
station and make the requisite observations. We thus obta

$$R = \sqrt{\frac{c}{\sin u\sin u'}} \quad . \quad . \quad . \quad . \quad .$$

As this method is specially adapted for high latitudes, the d
employed (fig. 21) ought to be one for which the agate supp
horizontal, so as to admit of the needle being visible when
is nearly equal to 90°. It will also be noticed that, if the d
needle have the same temperature when it is used in equa
which it has when used in equation (2), then *m* in the one
strictly equal to *m* in the other, and thus no temperature co
is rendered necessary.

12. A slight modification of the method now described
times adopted. Instead of employing separate weights, wh
be easily lost, two small holes are bored in the deflecting
near each end. The one of these is filled with a suitabl
brass peg when the observations are to be made in the
magnetic latitudes of the northern hemisphere, and the
filled in a similar manner when the observations are to
near the southern pole. In this case therefore we must
the instrument as we pass from the one hemisphere to the o
slight change must be made in the formula when this m
adopted, for it is clear that the weight will not now act al
the same constant leverage. If the weight be called W
leverage when the needle is horizontal *r*, we shall have to
equation (1) as follows:—

$$mR\sin u = Wr\cos\eta \quad . \quad . \quad . \quad . \quad .$$

Equation (2) will, however, remain unaltered, and hence
(3) will become

$$R^2\sin u\sin u' = UWr\cos\eta \quad . \quad . \quad . \quad .$$

If the quantity UW*r* be determined at the base station an
c', we shall have

$$R = \sqrt{\frac{c'\cos\eta}{\sin u\sin u'}} \quad . \quad . \quad . \quad . \quad .$$

(γ) *Instruments adapted for Travellers by Sea.*

13. *Azimuth Compass.*—At sea the declination is
observed by means of an azimuth compass invented b
This is exhibited in fig. 22. It consists of a magnet
graduated compass card attached to it. At the side of th
ment opposite the eye there is a frame which projects
from the plane of the instrument in a nearly vertical direct
this frame contains a wide rectangular slit cut into two
a wire extending lengthwise. The eye-piece is opposite th
and the observer is supposed to point the instrument i

er that the wire above mentioned shall bisect the sun's visible . There is a totally reflecting glass prism which throws into e piece an image of the scale of the graduated card, so that bserver, having first bisected the sun's disk by the wire, next read the division of the scale which is in the middle of ld of view. He thus obtains a reading of the sun's position; call this 100°. From this, ng the geographical posi f his station and the time observation, he may de- n azimuth; let us imagine this is 70° W. Thus a g of 100′ corresponds to ion 70° W. Suppose next he instrument is so ad that when the magnetic t the magnet is between e piece and the wire the g is 0. If a thus clear he magnetic meridian is emoved from the position . Let us imagine that the instrument is so graduated that notes a position 30′ E. We have thus obtained the m declination. If the vessel be at rest the plan generally ed is to take the reading of the sun when it is due and also setting, a mean between the two will give that which cords to a geographical meridian.

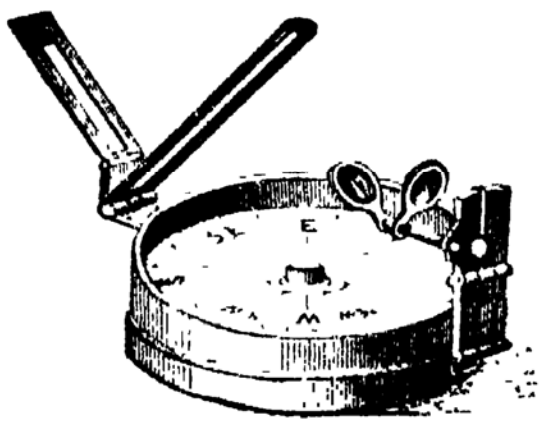


FIG. 22. Azimuth Compass.

Fox's Dip Circle. This instrument, contrived by Robert Fox, is more especially useful for observations at sea. In use it must be placed on a gimbal stand and duly levelled commencing the observation. The following are the peculiarities of this instrument: (1) the needles have two fine pivots or which are inserted into jewelled s; (2) in order to avoid parallax are two graduated circles, the arther from the eye than the and when reading the needle e is to be so placed that precisely the same reading shall be given th circles, the true position of eedle being thus obtained, (3) s a rubber made of bone or ivory ughened, the object of which is a prolongation of the socket on ck of the instrument, the friuch this rubbing causes enabling eedle to find its true position; avoid as much as possible all due to friction and adhesion, tire socked arrangement may be round. The axles of the needle us compelled to be in contact different set of particles. An way of varying the suspension se a magnetic deflecting arrange attached to the back of the atus. Suppose that a reading position of the needle so de- is now taken. Next reverse sition of the deflecting arrangement which is done by turnovable circle attached to this arrangement 180° round; let sition of the needle be again read. On the hypothesis that edle is equally deflected on opposite sides of it, true position se two observations, the mean reading will give the true The principle of the method of observing with this circle is ly the same as that already described for observations on with an ordinary melinometer.

Fox's Intensity Arrangement is merely a modification of that aced by Lloyd, and already described in § 7.[1]

(δ) *Differential Magnetometers and Self Recording Magnetographs.*

In addition to determinations at fixed intervals of time, it is t of much interest and importance to keep a continuous record the magnetic changes which take place at a few selected s. This is accomplished by means of differential magnetos. It is, however, necessary to continue to use absolute ments side by side with differential magnetometers, because tter (with the exception of the declination instrument) are fitted for recording changes of long period, such as the secular es of the horizontal and the vertical force. The reason of this resently be seen.

17. Early in the history of such instruments it was for hourly observations were exceedingly laborious, and attem made to construct a set of self recording magnetometers set of such instruments which were brought into systemat tion were those devised and constructed by the late Charles which have been at continuous work in the Greenwich Ob since 1848. In 1857 John Welch devised a fresh set of s ne instruments, and introduced them into the Kew Obse These, with certain slight modifications, have formed the instruments supplied to a large number of magnetic obse all over the globe.

18. As we cannot conveniently record changes of d differential instrument, changes of vertical force are n stead by a balance or vertical force magnetometer. We h in a differential system, whether adapted to eye observati continuous photographic registration, three instruments, the declination, the horizontal force, and the vertical for netometers or magnetographs as the case may be. T recently constructed instruments are adapted both for phot registration and for eye observation through a telescop advantage of eye observation is that we see what is tak at the very moment of its occurrence, whereas we only ob photographic record some time after the changes to which have actually happened.

We shall therefore describe (α) the three instrument of pattern α adapted to eye observations, (β) the three instrum adapted to continuous registration by photography, (γ) the of determining their scale coefficients, (δ) the [illegible] of de ing the temperature coefficient of the force m

19. *Kew Instruments: The Observations.* In instruments arranged in the relative position Lloyd so as magnetically to interfere with one

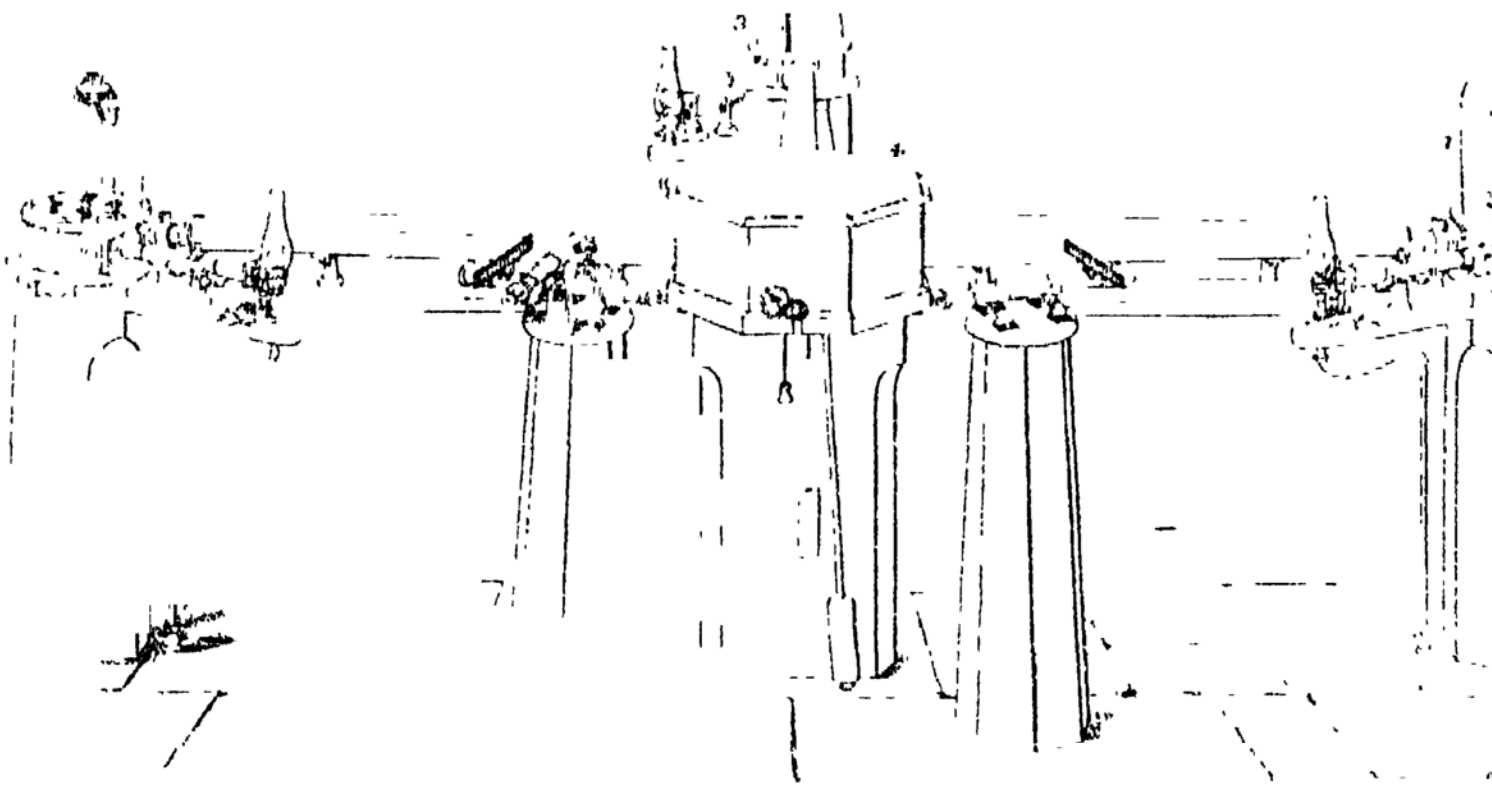


FIG. 23.—Kew I

possible. We are [illegible] No. 1 to the right is the declination instrument, No. 2 the horizontal force, and No. 3 on the distance behind the pillar (No. 1, the vertical force magnetometer. Figs. 2 give us the detail of these three instruments in the same above. Connected with each instrument there is a [illegible] or rather two circular plane mirrors, made of perfectly pla One semicircular half of each mirror is attached to the and moves with it, while the other half is firmly attached marble slab. Each magnet is enclosed in a gun metal windows of perfectly plane glass, each gun metal case is with a dead black shade, and the whole is air tight, and ca exhaustion. Each magnet too is provided with a copper with the view of checking its oscillations. In fig. 23 th two pillars of smaller size. The right-hand pillar carries scope with a scale attached, to record the position of the de magnet. The scale is reflected from the semicircular mirro with the magnet, and the position of this reflected scale a in the telescope indicates the position of the magnet. Th arrangement for the other instruments is similar, except vertical force mirror has a horizontal and not a verti The telescopes for viewing the force instruments are att the left hand pillar of smaller size.

20. The *Declinometer*[2] (fig. 24) consists of a magnet about long suspended by a silk thread freed from torsion as comp

[1] A great deal of detailed information regarding instruments for absolute deter on and the methods of observing with them is to be found in the *Admiralty l of Scientific Inquiry* in an article on "Terrestrial Magnetism," by Sabine elsh. A treatise on *Terrestrial and Cosmical Magnetism*, by E. Walker, kewise be consulted with much advantage.

[2] For a detailed account of the Kew magnetographs, see *British Reports*, 1859.

To keep the state of the thread constant the glass shade rendered air tight, and should contain some substance for moisture, such as chloride of calcium. It is clear that te of the thread remains and if the position of netic axis of the magnet change, this instrument ord faithfully the various f declination

ar Vertical Force Magneto xhibited in fig. 25. Here et H has been twisted round osition at right angles to netic meridian. It is sus y means of two very fine es some little distance d thus the instrument is led the bifilar magneto These wires have the plane through their lower ex- diffe ring very consider n that of their upper. If et should suddenly lose from the whole arrange- ld be twisted round until plane coincided. This of plane gives rise to a ding to twist the magnet one direction while the magnetic force of the onstitutes an nd opposite two couples he magnet m n. The couple upon the ba- gement may resent be re con dant, that on the hori- ce of the earth as variable. If the latter increase or the magnet will be slightly twisted round in one direction er

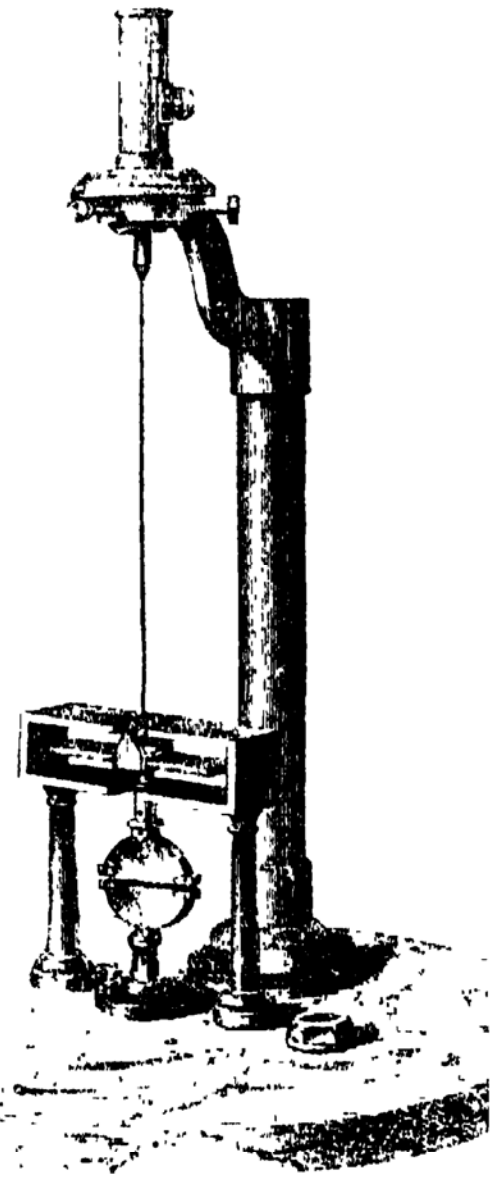
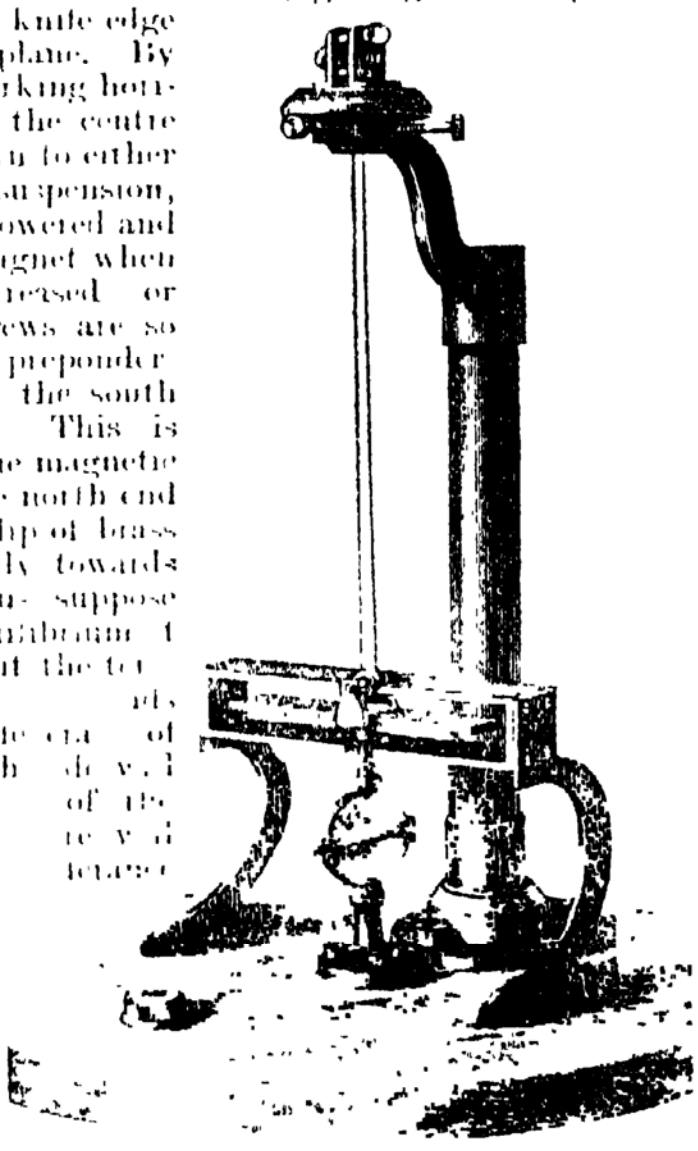


FIG. Declinometer.

Vertical Force Magnetometer (fig. 26), the magnet is y means of a knife edge n an agate plane. By two screws working hori- nd vertically the centre may be thrown to either he point of suspension, be raised or lowered and ility of the magnet when thereby increased or sed. These screws are so hat there is a preponder eight towards the south the magnet. This is ed partly by the magnetic ing to pull the north end partly by a slip of brass ont horizontally towards side. Let us suppose to be in equilibrium t mperature, it the tem ts n to the north of t more than of the the north re vi a slight increase in the north, a be drawn entrally to ent. The the magnet which an in- temperature



agnetographs. FIG. Horizontal Force Magnetometer

rangement by means h these instruments are con- o self recording, be very simple. In fig. 23 ga- flame burning behind a vertical slit and placed end- rder to render its light more intense. The light from nated slit passes through el being reflected mirror of the declination ma the same image of the

slit upon some sensitized paper in the central box. To speak more properly, two images are thrown, one reflected from the upper and movable half and the other from the fixed half of the mirror. The sensitive paper is wrapped round a horizontal cylinder (fig. 27), and the two images are therefore thrown upon different parts of

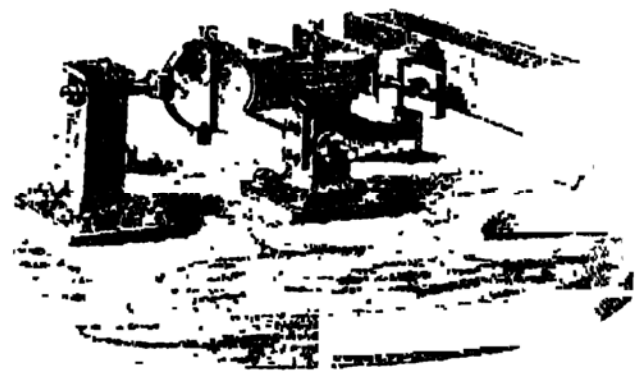


FIG. 26. Vertical Force Magnetometer.

this cylinder. But before reaching the cylinder these two images are by means of a hemicylindrical lens (shown in fig. 27) crushed up into two dots of light. The cylinder moves round regularly by clock-work once in twenty-four hours, and hence the course on the moving paper of the dot of light which comes from the fixed half-mirror will be a straight line, while that of the dot from the moving half mirror will be a curved line depending on the motions of the magnet. When the paper is developed these lines appear black.

The arrangement for the horizontal force instrument is precisely similar to that for the declinometer; for the vertical force it is somewhat different, the illuminated slit being horizontal and not vertical, while the mirror oscillates on a horizontal axis and not on a vertical one, the hemicylindrical lens too and the cylinder are vertical and not horizontal. It was found necessary to put the plane of motion of the vertical force magnet 15° out of the magnetic meridian for the following reason. The axes of the telescopes are respectively 30° inclined to the tubes which go from the magneto-

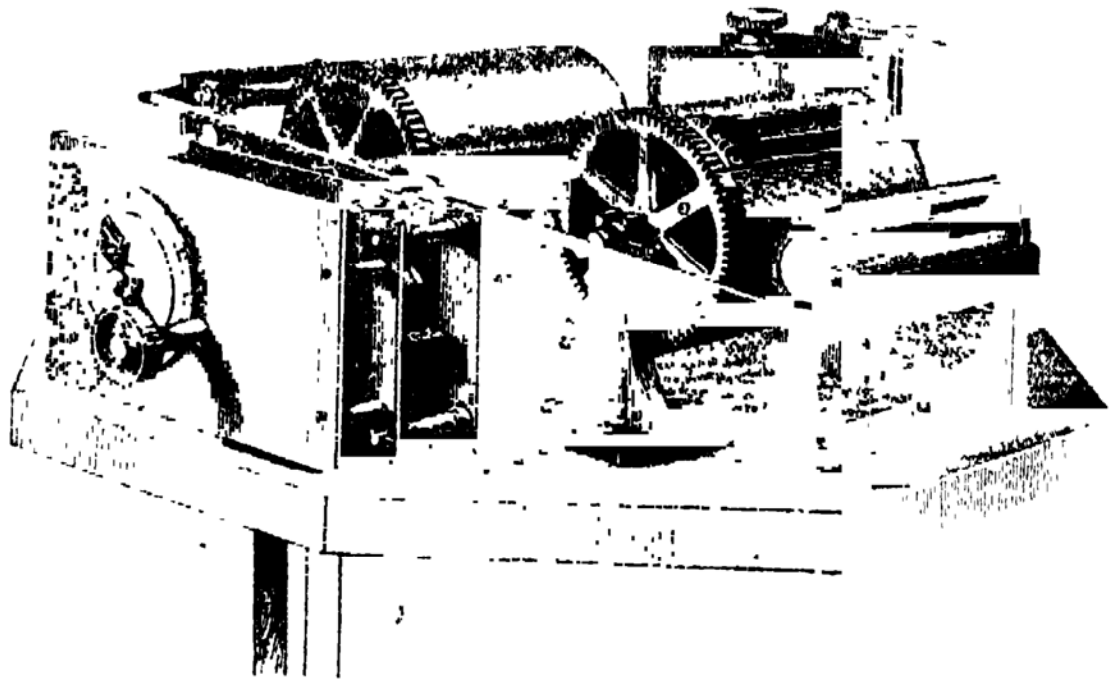


FIG. 27.—Magnetograph.

meters to the central box, and hence had the vertical force magnet swung in the magnetic meridian it would have been necessary to place the mirror inclined at the angle of 15° to the axis of motion of the magnet. This was tried, but it was found that in this position of the mirror the correction for temperature was so excessive that the instrument became a thermometer and not a magnetometer. The mirror was therefore put in a plane passing through the axis of motion of the needle, the needle being made to move in a plane inclined 15° to the magnetic meridian.

22. *Scale Coefficients of Differential Instruments.*—It is necessary to know the value of one division of the scale in the magnetometer or of one inch difference in the ordinate of the curve impressed on the photographic paper in the magnetograph. In the declination instrument it is only necessary to obtain the angular deviation corresponding to one division, and this may be done at once by a series of measurements. In the horizontal and vertical force instruments we wish to obtain the value of one division in parts of force. There is more than one method by which this can be accomplished, but that of John Allan Broun is probably the simplest, and it is, we believe, the one adopted at most of the various observatories possessing self-recording instruments. It is given in the *British Association Reports*, 1859.

23. *Temperature Coefficients of Differential Force Instruments.*—Broun has devoted a great deal of attention to the subject of these coefficients, and has come to the conclusion that the best and most unobjectionable method of determining them is to

e the instrumental readings on days when the tempera
high with the readings on days when the temperature is

By differential instruments the components of a force affect-
magnet are determined in three directions at right angles
h other. It does not, however, follow that this force is
y due to changes in the magnetism of the earth. We know
ertain forces connected with the sun affect the earth's mag-
, and on certain occasions at least these forces manifest them
as currents in the upper regions of the atmosphere and in
st of the earth. Now such currents will have a direct effect
he needle as well as an indirect effect through the changes
they may produce in the magnetism of the earth. The total
ce on the needle will therefore be made up of these two ele-
the one denoting the direct influence on the needle of the
ing force, and the other the indirect influence through the
produced in the earth's magnetism. No attempt has yet
ade to separate the action of these two elements.
Self-recording instruments after the Kew pattern have been
d to observatories at the following places:

atavia.	Mauritius.
oimbra (Portugal).	Kolaba (Bombay).
sbon.	Vienna.
Petersburg.	Zi Ka Wei (China).
orence.	San Fernando (Spain).
onyhurst.	Potsdam.
trecht (declination only).	Brussels.
elbourne.	Nice.

re are also self-recording magnetographs of other patterns at
o, Montsouris (Paris), Greenwich, Wilhelmshaven (?), Cape
and Havana (?).
understand that Professor W. G. Adams is at present
d in making a comparison of simultaneous curves from vari-
tions of these lists.[1]

AGNETIC POLES OF THE EARTH—SECULAR VARIATION.

Magnetic Poles of the Earth. In the article MAGNETISM it
n shown that Dr Gilbert of Colchester had at a very early
grasped the important truth that the earth is a magnet, a
which was afterwards mathematically demonstrated by Gauss.
reserved for Halley, the contemporary of Newton, to show
he earth must be regarded as having two poles in the northern
vo poles also in the southern hemisphere, so that, unlike
ry magnets, its magnetic system has four poles altogether
proceeding further it will be desirable to state what it was
alley actually did and what are the conclusions to be derived
is investigations. It has been remarked by Professor Stokes
while in an ordinary bar magnet we may practically regard
le as having a physical reality and as being the cause of well
attractions and repulsions, we are not entitled *a priori* to
that a point of maximum force in a large spherical magnet
e earth must necessarily be the seat of attractions and repul
fter the same manner as the pole of an ordinary bar magnet.
o be determined by observation to what extent the earth
y preserves an analogy to an ordinary magnet. Now Halley's
sions were derived from the pointing of the declination
since in his day there were no observations possible on total
tic force. He argued that there are two points or poles in
rthern hemisphere to which the needle appears to be attracted,
the upper region of America and one above Siberia. So far
nclusion is hardly anything more than a formal one derived
he grouping together of observations. He asserted that these
be as they are known to be if we imagine two such poles or
force each exercising a causal influence on the magnetic
. And the justification of Halley's way of regarding the earth
d in the fact that when force observations came to be made
ch foci of force were actually found to exist. We do not,
er, mean to imply that these foci have causal properties
y similar to the poles of a bar magnet, for this is not the

rder to exhibit the process of reasoning which led Halley to
nclusion, let us first imagine that the earth has only a single
r force-focus in the northern hemisphere, and that this is
dent with its geographical pole; then, assuming that this
as a catsative influence on the needle's declination, we should
all needles to point everywhere due north. If, however, this
e not coincident with the north pole of the earth, let us draw
dian circle passing through the magnetic pole and complete
nd the earth so as to divide the earth into two halves. At all

points in this meridian circle the needle might be expected
due north, while in the one half of the earth so divided
point to the east and in the other half to the west of tru
In the next place let us imagine that the earth has two no
netic poles or foci of equal strength, both being at the same
while their difference in longitude is 180°, and let us draw
plete circle of meridian passing through these poles (fig. 2
us start from a point in this circle under one of these poles and pursue our journey eastwards along a circle of latitude. At first the needle will point due north. As we move eastwards the needle will point westwards to the pole we are leaving until we come to a region half way between the two poles, where it will be equally solicited by each, and will therefore again point due north. Let us call the space we have travelled over since we set out A. As we proceed the needle will now be under the predominant influence of the second pole to our right, and will therefore point to
until we arrive at the meridian under the second pole. Thi
space which we have travelled over let us call B. As we
we pass through a space C where the needle again points to
until being once more equally influenced by the two poles
point due north. After this we pass through a space D of
variation until we arrive once more at the point from w
started.

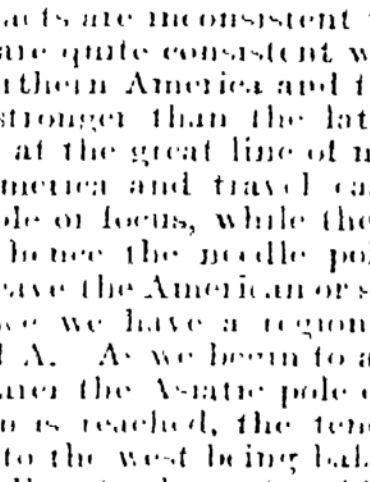


Fig. 28.

Thus there are now four spaces instead of two, and t
shown in fig. 28, where the centre of the circle represents th
geographical pole of the earth, and its circumference the
If pole 2 be inferior in power to pole 1 the spaces B and C
smaller in size than A and D.

27. This fact is an arrangement of things that agrees v
with the results of observation, if we add that the two poles
precisely 180° removed from one another in longitude.
represent lines of equal magnetic variation in 1882. There
lines extending throughout both hemispheres at all points
there is no variation, and also an oval-shaped district
northern hemisphere throughout all points in the circumfe
which we have no variation. These facts are inconsistent
hypothesis of a single pole, but they are quite consistent w
of two poles or foci of force, one in northern America and
in northern Asia, the former being stronger than the lat
order to see this let us take our stand at the great line of n
tion which passes through North America and travel ea
We are just south of the American pole or focus, while the
pole or focus is nearly 180° off, and hence the needle po
north. As we proceed eastwards we leave the American or
pole to the westward of us, and hence we have a region
variation which we have agreed to call A. As we begin to a
the eastern side of Europe we get nearer the Asiatic pole
and at length the line of no variation is reached, the ten
the American pole to pull the needle to the west being bal
the tendency of the Asiatic pole to pull it to the east. A
easterly variation predominates throughout a region B
length we come to a point in the western boundary of the ov
we may imagine ourselves to be directly south of the Asia
while the American pole is nearly 180° distant; once
needle points due north. As we still travel eastwards we
Asiatic pole, which is now the predominant one, to our
hence we have here a region C of westerly declination. A
we come to the eastern boundary of the oval, where the te
the Asiatic pole to pull the needle to the west is balance
tendency of the American or stronger pole (acting now tow
right) to pull it to the east, so that we have once more a
no variation. After this the American pole predominates,
have a large region D of easterly variation until we trav
once more to the point from which we started.

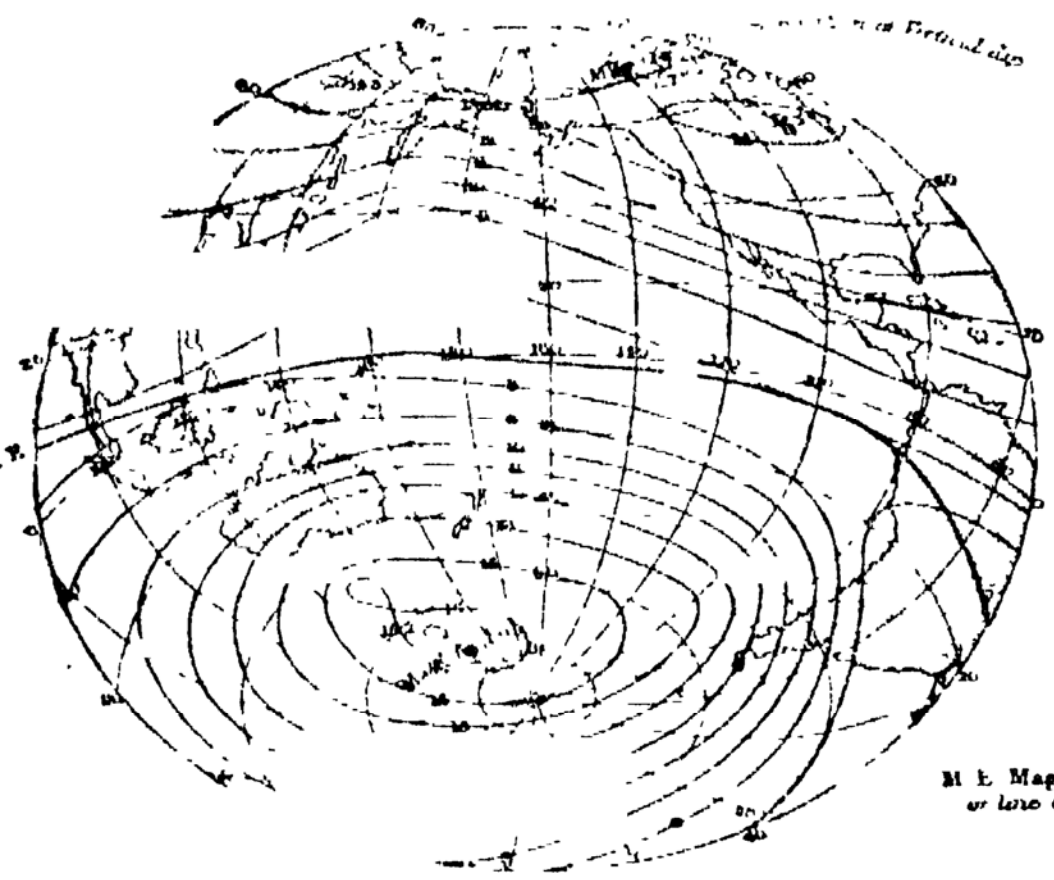
28. This train of argument receives, as we have alre
tioned, corroboration from the fact that in the map of total
power two foci of maximum force, one in northern Am
the other in northern Asia, that in America being the
This evidence was not, however, in existence at the time o
and his hypothesis of two poles does the greater credi
sagacity, inasmuch as he had to deduce it from a compa
small number of observations of declination and dip, those
being altogether wanting.

29. We have hitherto spoken of two poles or, more
foci of maximum force, the positions of which are of co
pointed out in fig. 29; but we have seen that the existenc

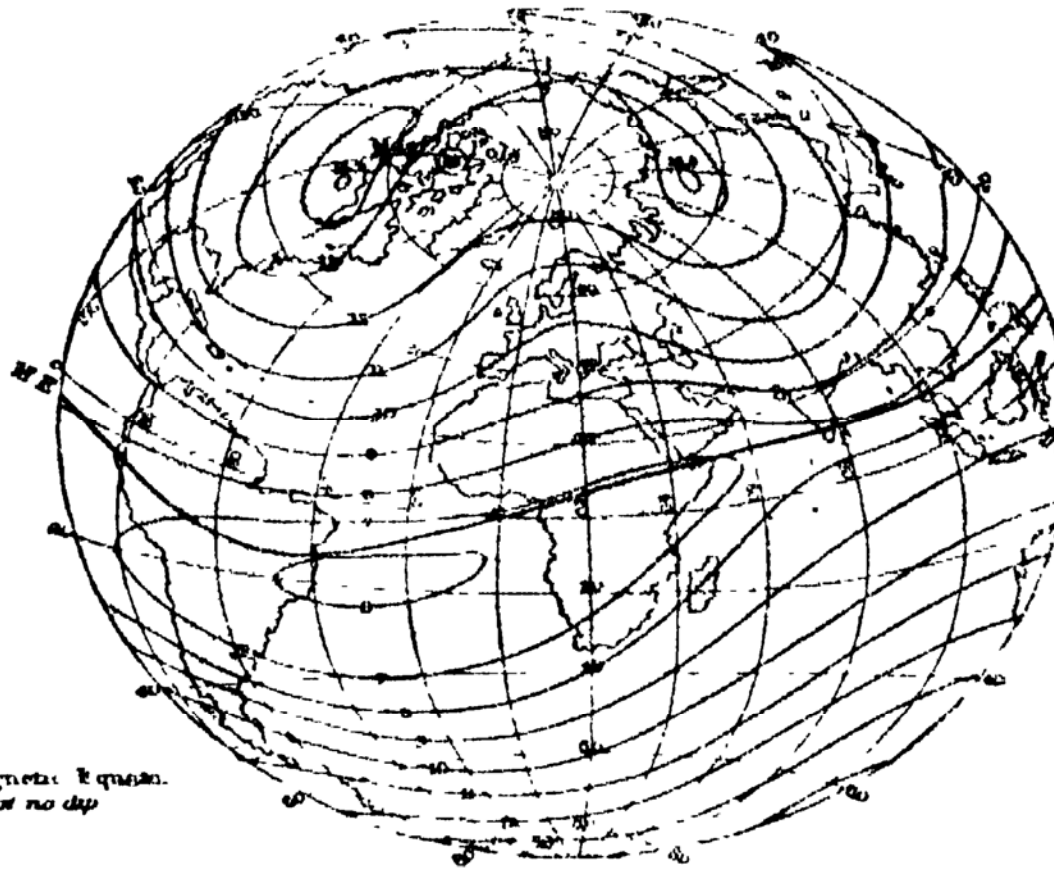
[1] We are indebted for the admirable charts given in figs. 29–32 to the
of the hydrographer Captain Sir Frederick Evans, who, in order to
allowed us to make use of the information he had embodied even be
officially published, and who likewise placed his plates at our disposal.

are indebted to Mr Gordon and to his publishers Messrs Sampson Low & Co
o have obtained them for us—for the sketches of the instruments for
determinations, with the exception of that of Kater's compass, for which
ndebted to Mr J. J. Hicks. For the sketch of the self-recording mag-
phs together and in detail we are indebted to the Kew committee and to
f. Whipple, director of the Kew Observatory

first conjectured from the behaviour of the line of
or declination. Now it will be noticed by looking at the
map (fig. 30) that all the lines of equal magnetic variation
converge to a point in the extreme north of the American
nt. This point is not, however, coincident with the chief
force, which lies decidedly to its south, but it is no doubt
nt with the point denoting a dip of 90°, the locality of
which may be inferred from the map of magnetic dip (fig.
it is likewise no doubt coincident with the position of a
horizontal force which may be inferred from the map of ho
force (fig. 33). Thus we have a point to the extreme
America which has the following properties:—(1) the varie
of declination converge to it; (2) the needle points vertical
wards at it; and (3) the horizontal force vanishes at it.



M. E. Magnetic Equator,
or line of no dip



Earth's Magnetic main flown by the Distribution of Lines of Equal Total Force, in Absolute Measure (British units), w
Positions of the Magnetic Poles and Equators, approximately for 1875.

the ntally balanced r e, ha no hori
tance upon it, with point in my direc
ctly pe ing, the *pole of verti* s, ere
there is only ni in each hemi phere, the e are
hence called the magnetic poles, so that we pe
otte or fo r t maximum force and one pole in each hemi

In the northern hemisphere Sir Frederick Evans[1] assu
stronger or American focus to be in 52° N. and 90° W.,
weaker or Siberian focus in 70° N. and 115° E. In the s
hemisphere he assumes the position of the stronger focus t
S. and 149° E., and of the weaker focus probably 50° S. and
these being thus not far separated from each other or f
magnetic pole. The nearness together of the southern foci

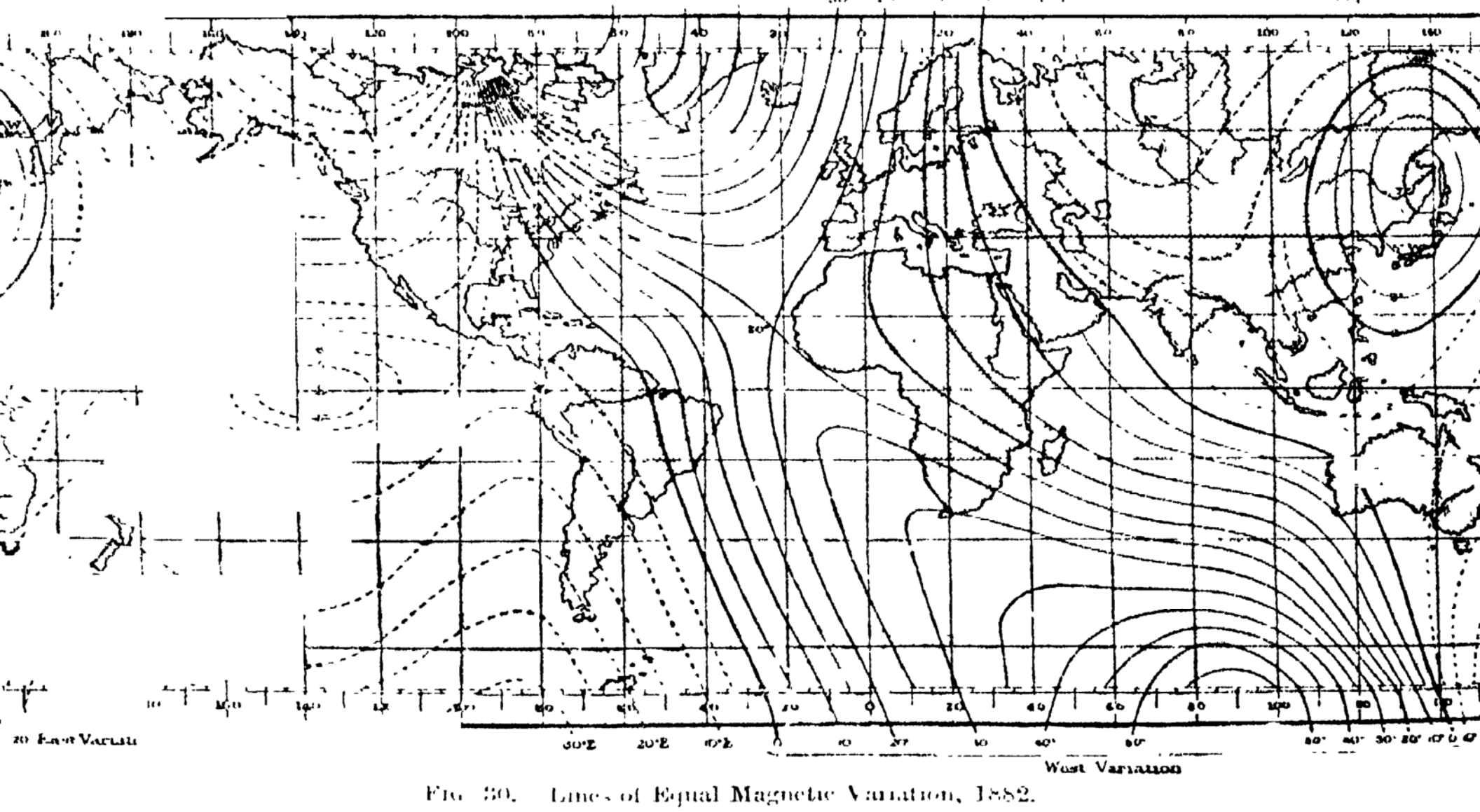


FIG. 30.—Lines of Equal Magnetic Variation, 1882.

reason why the total f ter at the southern than
he northern foci.

agnetic pole (of verticity) in the northern hemisphere was
by Sir James Ross in 1831. The position of vertical dip
rved by him to be 70° 5′ N. and 96° 43′ W. The magnetic
verticity) in the southern hemisphere was nearly attained
by the same navigator in a voyage made in 1839–43. Its
is probably 73½° S. and 147½° E.

The line of no dip is called the *magnetic* or *dip equ*
position is given in figs. 29 and 31. The line connecting

[1] *Elementary Manual for the Deviation of the Compass in Iron Sh*

where the magnetic intensity is least is called the *dynamic*
It coincides very nearly with the dip equator.
ecular Variation.—The earth then as a magnet must be
d to have two sets of centres of force. We shall next
to show that these centres cannot be regarded as constant
position and intensity.
ould be premised that, while there is no well-established

evidence to show that either the pole of verticity or the ce
force to the north of America has perceptibly changed it
ere is, on the other hand, very strong evid to show t
have a change of place on the part of the Siberian focus and
the part of its analogue in the southern hemisphere.
Table I. (p. 166), given by Gilpin (*Phil. Trans.*, 1806),[1]
the change in the position of the needle in Great Britai

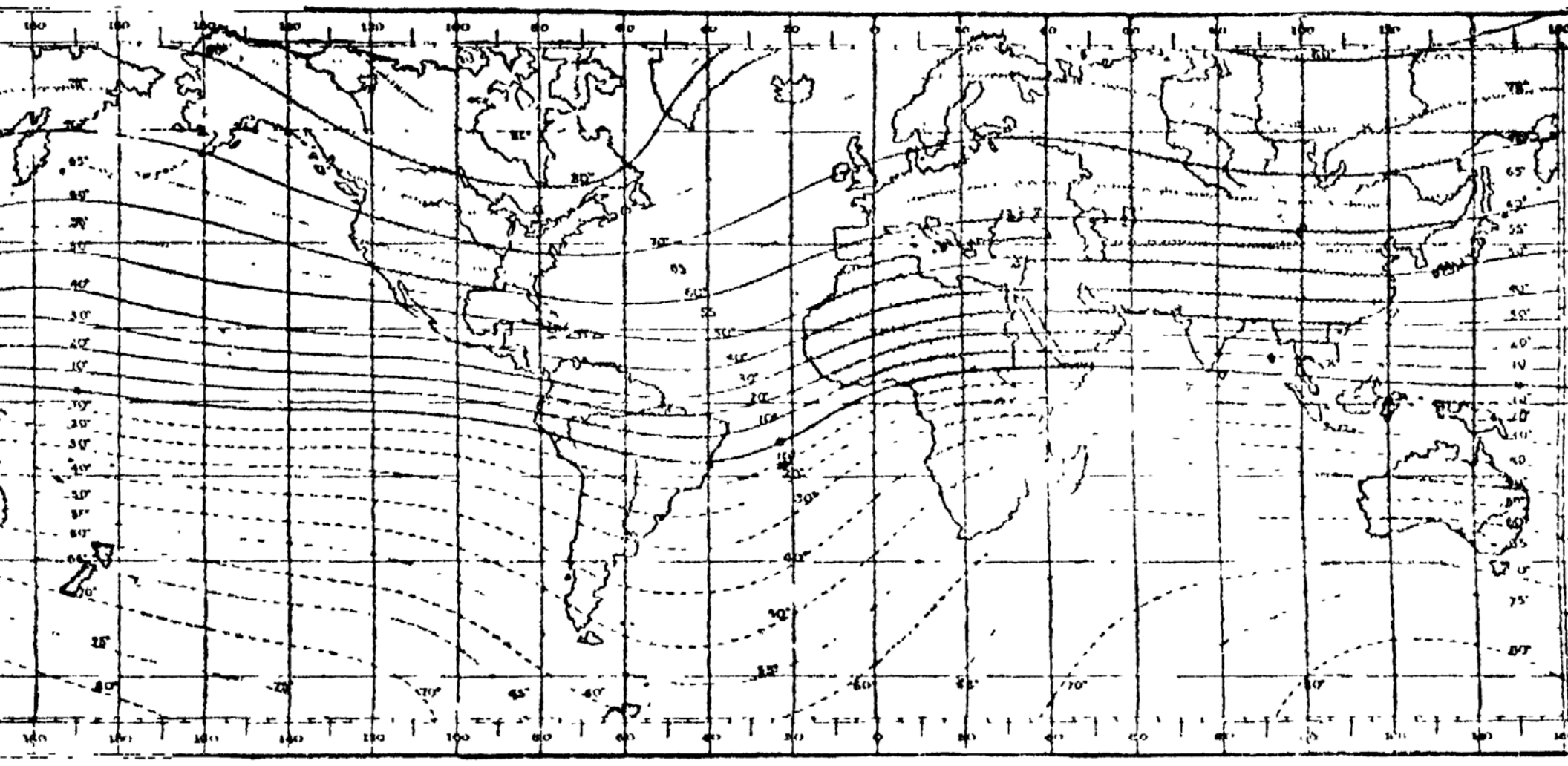


FIG. 31.—Lines of Equal Magnetic Dip, 1882

liest observations up to the beginning of the present

Between the dates recorded in this table the needle has been
g more and more to the west, which implies either a relative
in the power of the American as compared to the Siberian
r a motion of the Siberian focus from west to east. On the
position the lines to the eastward of the Siberian focus

for instance, the line of no variation depending on a balance
it and the American focus should be drawn in towards it,
should travel westwards; but if the latter supposition is
this focus has been moving eastwards while retaining its for
lines to the east of it would be found moving eastwards also.
is strong evidence that the latter is the case, and that
northern hemisphere there has been a long continued proc

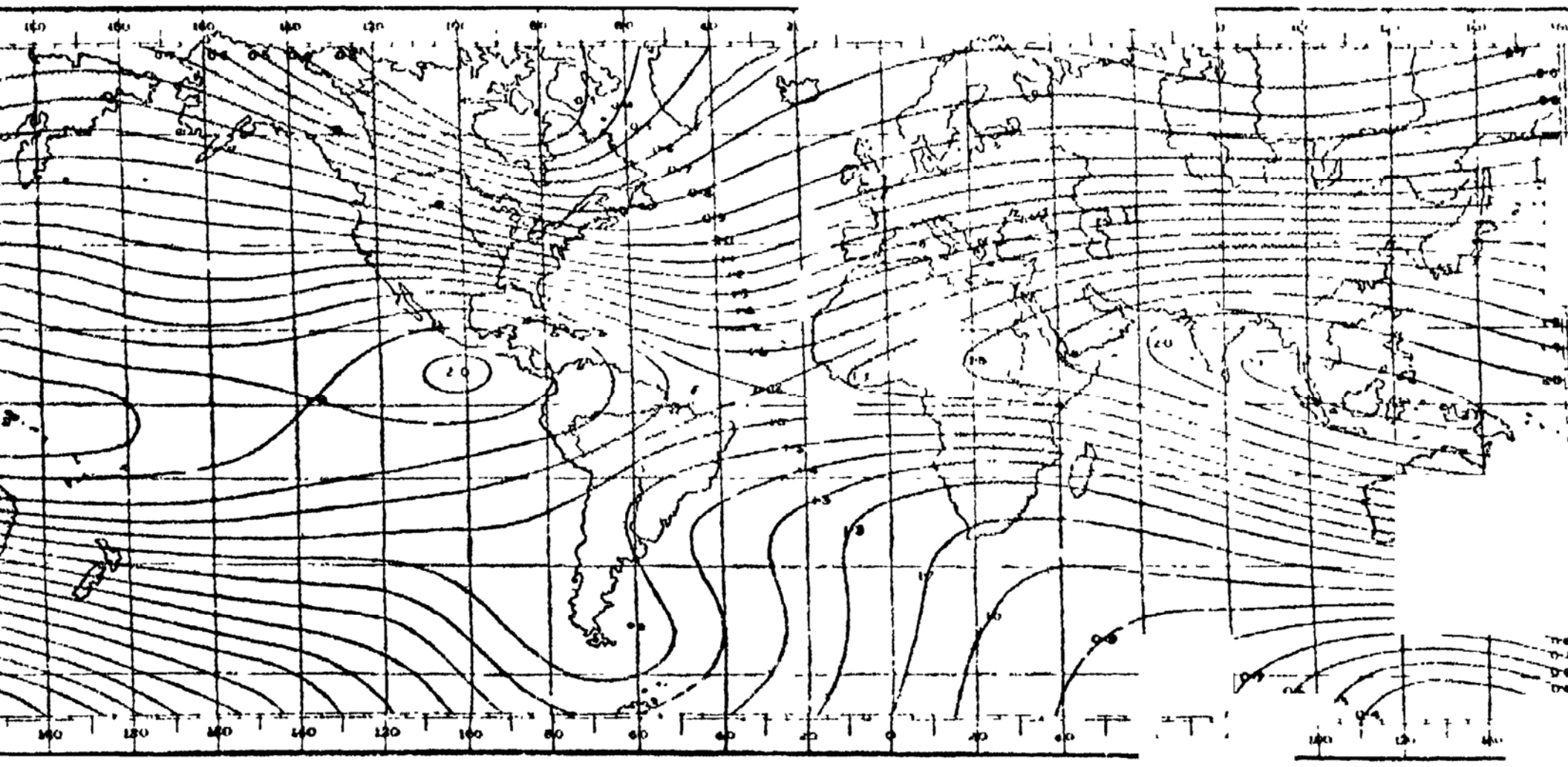


FIG. 32.—Lines of Equal Horizontal Force, 1882.

eastwards of the system of magnetic lines on both sides of
erian focus. In the southern hemisphere also we have proof
e analogous focus has been travelling, not from west to east,
m east to west.
There is some reason to believe that the eastward motion of
erian focus has been recently reversed, and that it is now
from east to west. Table II. shows the declination observed

at Bushey Heath (Herts) during 1817–20, and at Kew fro
to 1882.
It would appear from Table II. that the maximum w
declination was reached in 1818, and that the needle has su
date been travelling eastwards. A similar change has tak

[1] Taken from Walker's *Magnetism*

stations; and, although these changes are not strictly neous at the various stations, they have yet been sufficiently and near together in point of time to indicate that some change has probably taken place in the movement of one s magnetic foci of force.

33. Halley sought to explain the four-pole theory and to

TABLE I. *Secular Change of Variation in Great Britain.*

		Can Annual Westward Change
	11 15 E	
	6 0 E.	7·5
	1 6 E	9·5
	0 0 E.	10·6
	1 22 W.	10·2
	2 30 W	9·7
1692	6 0 W	10·5
	11 17 W	16 0
1748	17 40 W	8·1
	21 9 W	8·4
	23 19 W	9·3
1790	23 57 W	1·7
	24 6 W	1·2
	24 8 W	0·7

TABLE II. *Changes of Declination in England,—at Bush for* 1817-20, *and at Kew from* 1858.

	Declination West.				Declination		
	°	′			°	′	
1817	24	36	4	1869	20	26	
1818	24	38	25	1870	20	18	
1819	24	36	14	1871	20	10	
1820	24	34	30	1872	20	0	
1858	21	54	8	1873	19	57	
1859	21	47	22	1874	19	51	
1860	21	39	51	1875	19	41	
1861	21	31	36	1876	19	31	
1862	21	23	32	1877	19	22	
1863	21	13	16	1878	19	13	
1864	21	3	35	1879	19	6	
1865	20	59	3	1880	18	57	
1866	20	51	10	1881	18	50	
1867	20	40	26	1882	18	44	
1868	20	33	9	...		..	

TABLE III. *Exhibiting certain Years' Values of Declination at Various Places.*

Toronto		Makerstoun		Trevandrum		Cape of Good Hope		Hobart Town	
Declination		Declination		Declination.		Declination		Declina	
°	′		°	′		°	′		°
1	14·3 W	1841	25	33·7 W	1854	0 25·896 E.	1605	0 30·0 E.	1843	9	53·3
1	19·1 W.	1842	25	28·4 W.	1855	0 26·026 E	1609	0 12·0 W	1841	9	54·9
1	29·1 W.	1843	25	22·9 W.	1856	0 26·400 E	1622	2 0·0 W	1845	9	56·4
1	30·8 W	1844	25	17 1 W	1857	0 27·278 E.	1675	8 14·0 W	1846	9	58·4
1	33·2 W.	1845	25	11 3 W.	1858	0 28 769 E.	1691	11 0 0 W.	1847	9	59·2
1	35·1 W.	1846	25	6 0 W.	1859	0 30 406 E.	1751	19 15·0 W.	1848	9	60·6
1	36·9 W.	1847	24	59·6 W.	1860	0 32·034 E.	1775	21 14·0 W.			
1	38 6 W.	1848	24	51·8 W	1861	0 34 318 E.	1788	24 4·0 W.			
1	40·9 W.	1849	24	45·2 W.	1862	0 36·654 E	1792	24 31·0 W.			
1	56 3 W	1850	24	39·0 W.	1863	0 39·125 E.	1818	26 31·0 W.			
2	0 3 W.	1851	24	34·3 W.	1864	0 41·603 E.	1836	28 30·0 W.			
2	4 5 W	1852	24	29 2 W.	1865	0 44·007 E.	1839	29 9 0 W.			
2	7·4 W	1853	24	18 7 W.	1866	0 46·310 E	1841	29 6·2 W.			
2	10 3 W	1854	24	11·8 W.	1867	0 47·590 E.	1842	29 5·9 W.			
2	14 1 W.	1855	24	5·3 W.	1868	0 48·687 E	1843	29 6·0 W.			
2	15·7 W.				1869	0 49·735 E.	1844	29 6·2 W.			
2	19 1 W.						1845	29 7·4 W.			
2	21 9 W.						1846	29 8·7 W.			
2	24 8 W						1847	29 12·4 W.			
2	27 6 W						1848	29 14·9 W.			
2	29 8 W						1849	29 16·2 W.			
2	33 2 W.						1850	29 18·8 W			
2	37·1 W.										
2	41 9 W.										
2	44 9 W.										

TABLE IV. *Exhibiting certain Years' Values of Dip and Horizontal Force at Various Places. The years in this Table are from April to April; thus* 1845 *means the year from* 1st *April* 1845 *to* 31*st March* 1846.

London or Kew			Toronto.			Hobart Town.			Cape of Good
Dip.		Hor. Force	Dip.		Hor. Force	Dip.		Hor. Force.	
			° ′			° ′			°
68 21·84	1857	3·7899	1845 75 15·50	1845	3·5176	1842 70 42·2	1846	4·5054	1841 53
68 22 56	1858	3 7950	1846 75 14 58	1846	3 5419	1843 70 38·2	1847	4·5001	1842 53
68 21 41	1859	3 8007	1847 75 15·30	1847	3 5384	1844 70 33·3	1848	4·4991	1843 53
68 19·29	1860	3 8063	1848 75 18·32	1848	3·5339	1845 70 32·0	1849	4·4997	1844 53
68 17 12	1861	3 8121	1849 75 18·94	1849	3 5367	1846 70 33·0	1850	4·4998	1845 53
68 14·89	1862	3 8165	1850 75 19·98	1850	3·5322	1847 70 34·5			
68 11·71	1863	3 8216	1851 75 20·42	1851	3·5299	1848 70 35·7			
68 9 31	1864	3 8264	1852 75 20 52	1859	3·5154				
68 8·50	1865	3 8306							
68 5·41	1866	3 8334							
68 2 62	1867	3 8367							
68 2·13	1868	3 8393							
68 0·41	1869	3·8451							
67 57·98	1870	3·8485							
67 56·12	1871	3·8510							
67 53·60	1872	3 8542							
67 51·19	1873	3 8577							
67 49 61	1874	3·8625							

e secular change by imagining a solid globe or *terella*,[1] con-
c with the earth but rotating independently of the external
and having a slightly different period of rotation, the shell
g two poles and the terella two others. While continuing to
e Halley's sagacity, we shall not now be disposed to allow such
stitution of the interior of the earth, but will rather be led to
o some external influence as the cause of the secular variation
ile we have strong evidence that the Siberian focus has changed
sition, we cannot assert that the American focus has been
ately stationary, or that neither focus has experienced any
ges of force. On these points we must be content to be guided
servation alone.

It has been supposed by some magnetician that it is possible
mpute with something like certainty the particulars of the
ns of the magnetic foci. Hansteen more especially (1811 19
uted both the geographical positions and probable periods of
ution of this dual system of foci of force round the terrestrial
Sir Frederick Evans has discussed in connexion with the ob-
ll the most recent observations,' and points out two objections
y such theory as that of Hansteen, viz., (1) that, while a mag
turning point has been reached in certain regions, there are
portions of the earth in which this change has not yet been
plished, and (2) that in certain districts of the earth very great
ges in force have taken place. "If we turn," he says, "to the
ent of South America and its adjacent seas, we shall find a
ution of the intensity of the earth's force now going on in a
kable degree. An examination of the [illegible]t observati
by the 'Challenger' officers at Valparaiso and Monte Video,
ared with those made by preceding observers, shows that
n half a century the whole force has respectively diminished
xth and one-seventh, at the Falkland Islands one ninth."
e whole, while there is strong evidence that the Siberian focus
ntil recently been travelling eastwards, and its analogue west
, and evidence less conclusive that recently a turning point in
notion has been reached, we are disposed to think with Sir
rick Evans that a formal theory like that of Hansteen does not
with recent observations. We shall revert to this subject
In Tables III. and IV. certain yearly values of declination,
nd horizontal force are given for various stations.

Inequalities in or connected with Terrestrial Magnetism depending on the Sun.

As there is a marked likeness between the ways in which the
ominates over the two great divisions of terrestrial phenomena,
rology and magnetism, let us endeavour to describe the
effect upon the latter by referring to its influence on the
r, the chief peculiarities of which are well known to all We
hat the temperature of the air at a given station is subject to
rnal fluctuation having its minimum value shortly before sun
nd its maximum early in the afternoon. We find likewise
he mean temperature for the day, as well as the amplitude of
iurnal oscillation, depends upon the season of the year, both
greatest about midsummer and least about midwinter. Now,
s were the only manifestation of solar influence upon this
ular element, it would be possible to predict the temperature
y hour of any day once the mean temperature, the diurnal
ion of temperature, and the modification of these for different
s of the year had been well ascertained. But this amount of
arity is very far from taking place, the march of temperature
frequently interrupted, cloaked, perhaps even reversed, by
dvent of peculiar weather. Thus we may have very cold
er in midsummer and very warm weather in midwinter, or
ay have a very cold afternoon and a very warm early morning,
hich means the ordinary conditions of temperature will be
letely reversed. In like manner weather interferes even to a
r extent with the diurnal oscillation of the atmospheric
ure, so that, in British latitudes at least, it is only possible to
o this correctly by means of a long series of observations.
eather, however, does not consist of a perfectly lawless inter-
re with periodical phenomena, but is subject to laws of its own,
of which we are beginning to discover. Sometimes weather
exalt or depress the diurnal fluctuation of temperature without
wise affecting its character; but sometimes too the turning-
s and the general appearance of this fluctuation are greatly
nced by peculiar weather.

Now it is believed that we have something of the kind in
fluctuations depending on the sun to which the elements of
strial magnetism are subject. Let us take the declination
e most easily studied of the three magnetic elements, and
ose that we are engaged in considering the traces denoting the
uations of declination as derived from a set of self-recording
netographs in Great Britain. Here we shall at once be able to
nize in an unmistakable manner the diurnal variation depend-
upon the position of the sun, in virtue of which a freely-

suspended magnetic needle reaches the easterly extreme of
about eight in the morning, and the westerly about two
afternoon. We shall likewise perceive that the range
diurnal fluctuation is greatest at midsummer and least
winter. In fine, the characteristics of this fluctuation, de
as they do upon the hour of the day and the season of t
are not very different from those exhibited in the diurnal
tion of atmospheric temperature. But, however thoron
may have ascertained the mean declination and its diurnal
tion, as well as the modifications of these depending on th
of the year, we shall nevertheless find it impossible to pre
exact position of a freely-suspended magnet at any mom
particular day. Here then too we have something which
called magnetic weather, and which interferes with the
progress of the systematic fluctuations of the magnet. M
weather has, like its meteorological analogue, a set o
own, some of which we are beginning to find out.
magnetic weather may exalt or depress the diurnal fluctu
declination without affecting its character, but it is imagi
at other times the turning points and general appearance
fluctuation may be greatly influenced by peculiar magnetic

38. There is, however, a kind of magnetic change whi
a- we know at present, is not analogous to anything in mete
and introduces an additional element of complexity in any
to analyse the fluctuations of terrestrial magnetism. We
known magnetic disturbances or storms which occur
only in places very widely apart. Under these circum
it becomes a question how we can best deal in a practical
with this complicated system of things.

We do not think that with our present knowledge an
system can be adopted than that first introduced by Sir
Sabine in his discussion of the results of the colonial
observatories. Suppose that we have hourly magnetic obse
at a station, then first of all we should arrange these into
groups each hour by itself. We should then reject as d
observations all those which differ by mo[illegible]ertain
from their respective normals of the [illegible]th and ho
normals being the hourly means in each month after the
of all the disturbed observations. This method enables u
exclusion of disturbance, to ascertain with much accuracy
form of the solar-diurnal variation of the magnetic elem
given place corresponding to every month of every year,
only that the observations are sufficiently numerous. On t
hand it will probably fail in accurately giving [illegible]e the variati
day to day of the [illegible] of the solar-diurnal fluctuations caus
advent of peculiar magnetic weather, inasmuch as the r
the extreme effects of such weather will probably be cut
the undisturbed observations and reckoned among the distu

For instance, it is known that the solar influence on te
magnetism varies from year to year, and it is suspected th
are also short period fluctuations of solar influence. It wo
however, be a safe proceeding to attempt to estimate num
the last mentioned element of fluctuation by taking the s
diurnal ranges of those observations at any station, rec
undisturbed, by the above process, and plotting them as s
ordinates of a curve, and then supposing that this curve wo
us a true graph[illegible]ors[illegible]entation of solar changes. I
rather p[illegible]y represent such changes with the top and
the [illegible]fluctuations cut off. But if the undisturbed
tion is in this respect we can hardly be wrong in suppo
there has been eliminated from the mean as far as possible, all
due to magnetic storms, and hence that they will afford us
better means of estimating small fluctuations, such, for ins
those due to [illegible]noon, than we could have had without th

Finally, with [illegible]gard to that portion of the observations
as disturbed, we are probably not certain that every such
tion represents a true disturbance, or that the absolute
occurrence of the various observations selected at a disturb
station will be the same as the [illegible]at another. Neverth
Edward Sabine has shown that at the Kew Observatory cer
of disturbance deduced from the whole body of observations
as disturbed are closely reproduced when this selection is
a narrower limit[illegible]ninety five days of prominent disturbar
alone taken. With these prefatory remarks we shall now
to discuss the diurnal inequality of terrestrial magnetism.

39. *Total Diurnal Inequality Defined.* It will be see
on that disturbed as well as undisturbed observations are s
a diurnal variation, but these two variations are different
name *diurnal inequality* is generally given to the compou
tion which is the joint resultant of the two. *Solar
variation* is that portion of the compound inequality wh
to undisturbed observations, while that which refers to
ances has received the name of *disturbance-diurnal varia
would appear that in the United Kingdom, and perhaps
out Europe, the total diurnal inequality is not very
different either in character or range from its most i
component the solar-diurnal variation, at least so fa

[1] See Walker's *Terrestrial and Cosmical Magnetism*, where the subject is well discussed.

[2] His lecture to the Royal Geographical Society, March 11, 1878

ation is concerned. When the diurnal oscillation of a freely-
ded magnet was first observed, the subject of magnetic
ances was not understood, and the early individual deter-
ons which have been handed down to us are not such as to
the expenditure of any very great labour upon them for
rpose of separating the disturbed from the undisturbed observ-
s. Inasmuch, however, as the total diurnal inequality of
ation (which is in reality the element given by these early
ation) does not greatly differ from the solar diurnal varia-
may with much justice and little risk of error give the
of these early observations in connection with that of the
diurnal variation of declination which is by far the best
and perhaps the most trustworthy of all the various magnetic
produced by solar influence.

Solar Diurnal Declination Curve.—Graham, an instrument
maker of London, found in 1722 that a freely suspended
magnetic needle subject to the ordinary oscillation of definite char-
The next observer was Canton, who in 1759 became acquainted
with four thousand observations which he communicated to the
Society on December 10, 1761, and from which he concludes
the range of the diurnal variation is greater in summer than in
Macdonald observed at Fort Marlborough in Sumatra
(*Phil. Trans.* 1820), and Duperrey in the tropics in 1822–
perhaps the first that might lead us to conclude that the
ude of the diurnal oscillations of the needle is less in the
than in middle latitudes, and that the motion of the needle
southern hemisphere is in the opposite direction to that in
it moves in the northern hemisphere at the same hour.

Solar Annual Inequality.—The existence of these early
ations had long been pointed prematurely to conjecture
ere must be a time somewhere near the equator when
no horizontal variation in declination. In 1847 Sabine com-
nicated to the Royal Society the results of five years' observations
Ireland, showing that at that station for the half of the year
ning at the vernal and reckoning at the autumnal equinox the
of the needle corresponded nearly to that in the northern
sphere, while for the other half it corresponded nearly to that in
the southern hemisphere. Sabine's views confirmed and extended
been used to reduce the annual inequality by discovering the
ntation of the various colonial magnetic observatories. More
y, the result of twelve years' observations at Trevandrum,
servatory established by the Rajah of Travancore, John
Broun gave in a very complete form the law of change
the diurnal variation of magnetic declination near the
, showing the extinction of the mean movement near the

Perhaps the best way of contributing what really takes place is
examine which is that adopted by Sabine.
the annual value of the solar diurnal variation is of what
calls the northerly type in place of middle latitude in the
n hemisphere, and of what may be called the southerly type
of middle latitude in the southern hemisphere. Now let
a northern station, and consider the mean form of its solar
variation for the six months beginning with the vernal
Here we shall have an oscillation of the northerly type
more greater than the annual range. For the other six months,
, we may imagine that the annual range is supplied
by the superposition upon it of a variation with a type similar
with. At the same station during the other six months, the
nual variations will be taken from the mean of the year, as if the
variation had been depressed by the superposition on it of a
on with a type the opposite of its own, that is to say, with a
ly type. At a station in the southern hemisphere, again,
an annual form of the solar diurnal oscillation is of the
ly type, we have during the six months beginning with the
approximately by the superposition of a variation of northerly
ype upon it during the other six months it is depressed by the super-
position of a southerly type. Thus when the sun is
of the equator we have superposed variation of the northerly
on both hemispheres with the effect of increasing the range
northern hemisphere and diminishing it in the southern;
the sun is south of the equator we may superpose a varia-
the southern type upon both hemispheres with the effect of
ishing the range in the northern and increasing it in the
n hemisphere.

the equator, as at Trevandrum where Broun made his
ions, we find the mean annual value of the solar diurnal
n to be extremely small, if not altogether evanescent.
the six months beginning with the vernal equinox the type
ly northerly, while for the remaining six months of the year
rely southerly in character. In fine, at this station the
rnal variation changes its character at the equinoxes, at
me we have, as already observed, an extinction of the mean
nt, not indeed in absence of all variation, but rather a

alker, *Terrestrial and Cosmical Magnetism*.
s the name used by Sabine, but its appropriateness may perhaps be
d.

variation having an undecided character, which for a few da
be of one type and then of the very opposite. There is mov
but no mean movement.

43. In the following table (V.) the solar-diurnal varia
given for Kew, Trevandrum, and Hobart Town. Of
places the first denotes a station in middle latitude (n
hemisphere), the second an equatorial station, and the
station in middle latitude (southern hemisphere).

	Trevandrum				Hobart Tow	
—	April to Sept.	Oct. to March.	Year	April to Sept	Oct. to March.
		+1·5	-1·30	+0·07	0·61	+2·35
		+1·9	-1·74		-0·45	+2·15 +4·85
	6·94		0·84		1·5	+3·15 +5·95
	5·21		0·33	+0·61	+0·13	+3·30 +5·50
			0·03	+0·28	+0·24	+2·40 +4·30
			+0·15	+0·35	+0·24	+1·30 +2·70
			+0·06	+0·22	+0·13	+0·75 +1·55
		0·21	0·1	0·23	+0·04	+0·90 +0·80
		0·05		+0·19	−0·05	0·30 +0·30
		+1·1		+0·13	0·08	0·85 0·25
		+1·77		+0·09	0·06	1·10 −0·70
		+1·81		+0·10	+0·01	1·15 −0·85
		+1·66				+1·10 −0·80
+1·1		+1·4	+1·29		0·08	+0·15 −0·75 −0·75
+1·1		+1·3	+1·39		0·02	0·15 0·10 −0·70
1·5		+1·09	1·1		0·11	+0·09
		+1·17	+1·88	1·31	0·28	+0·02 −0·02 −0·78
		+1·13	+2·21	1·18	0·15	+0·01 0·10 −1·40
	1·56	1·51			0·66	+0·18 −0·23 −2·37
	2·31	+1·85			0·81	+0·32 −0·50 3·80
				+1·20	−0	0·21 −1·25 −5·25
				+0·17	0·56	+0·06 2·10 5·30
	·1	0·16			0·11	0·22 2·20 −3·80
+1·8	2·18	−2·68	−0·91	−0·07	−0·50	−1·10 −0·80

this table a... te reckoned positive, d...
ds magnetic ...st negative. The scale is in minutes of arc.

Also in fig. 33 we have a graphical representation of the
diurnal variation for the whole year at these three station
which it will be seen that the range at Trevandrum is ext
small, and that the curve for Hobart Town is opposite in appe
to that at Kew.

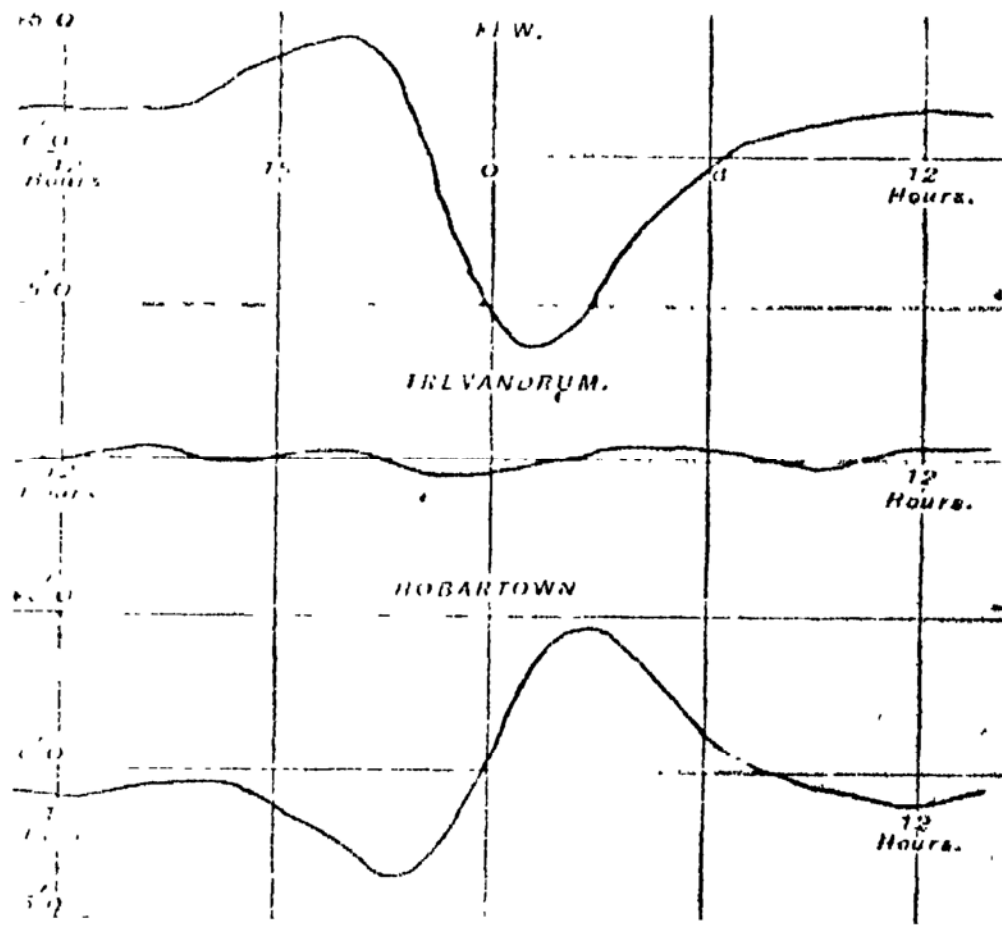


Fig. 33.

Finally, in fig. 34 we have a graphical representation of the
annual inequality or difference from the whole year's mean of t
half yearly means of Table V., the one half-year (that with
lines) commencing at the vernal and the other at the aut
equinox. It will be seen from this figure that the semi
inequality is of the same character in both hemispheres, the li
extending even to its minor peculiarities.

44. *Change from Month to Month.*—Charles Chambers, di
of the Kolaba Observatory, Bombay, remarks (*Trans. Roy.*
December 10, 1868) that "the regular progression from
to month in the diurnal variation is so distinctly shown i
Bombay observations as to lead, on a first inspection, t
supposition that the law of variation is identical throughou
year, the extent only (including a reversal of direction) varying
month to month. But in this respect a different exposition
character of the variation in different months shows tha
first thought would be inaccurate." He then proceeds to d

h the monthly val of the solar diurnal variation at
. Broun for Trevandrum observations discuss
the solar diurnal variation at the Trevandrum Observa
t would hardly be of service to reproduce here the result
discussions, but when such analyses become sufficiently

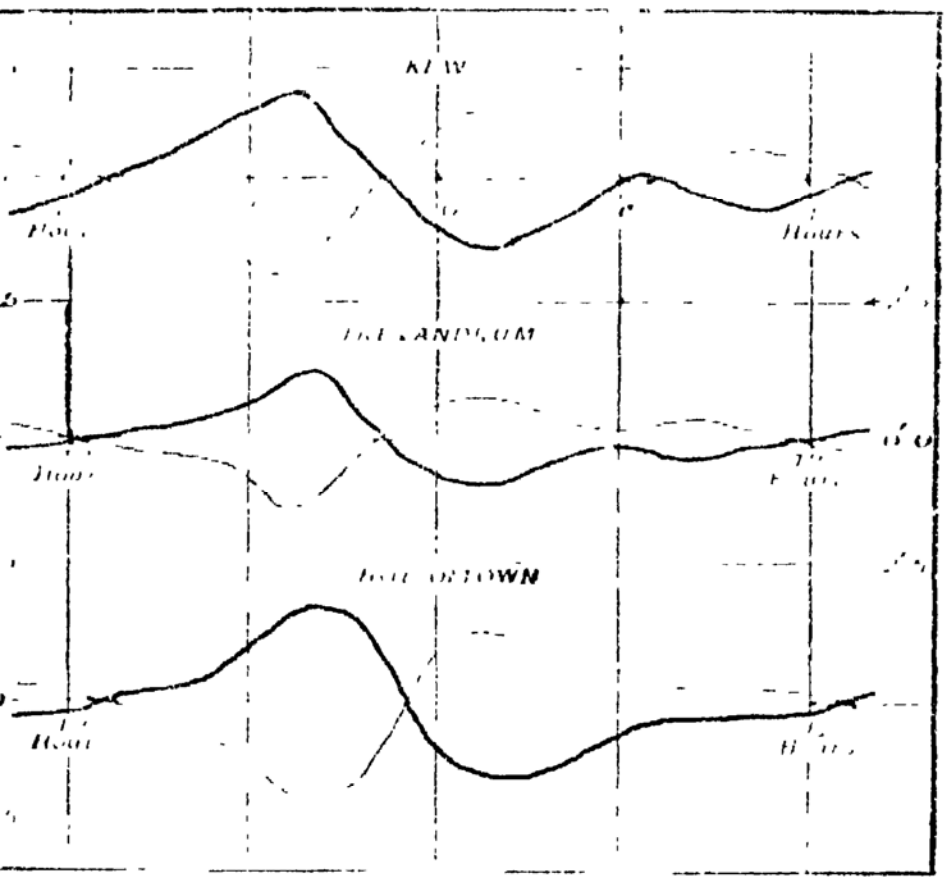


FIG. 31.

hey may be expected to throw light upon the cau
diurnal variation

following we have mean monthly values of the declin
ns at the Kew Observ corrections to forty eight
the year derived from ten year observations

VI. *Greenwich Monthly Means reduced to 22 01 for Epoch
Papers of the Years of the Kew Solar Diurnal Declination
The Amount, Progression and Epoch in which the
the date of the year commencement of the mean, January* (1)
for one year after the commencement and so

Mean Value		Mean Value		Mean Value
			Sept (0)	594
			(1)	574
	(2)		(2)	554
	(3)		(3)	537
	June		Oct (0)	514
491	(1)		(1)	496
418	(2)	519	(2)	478
458	(3)	501	(3)	463
467	July (0)	501	Nov (0)	41
508	(1)	507	(1)	415
		94	(2)	384
587	(3)	507	(3)	66
615	Aug. (0)	594	Dec (0)	540
663	(1)	601	(1)	58
639	(2)	611	(2)	598
670	(3)	606	(3)	598

be seen from this table that, while we have a maximum
e summer and a minimum about the winter solstice, we
mistakable indications of maxima at or about the commence
not take place at a tropical station such as Trevandrum.
harbour near the Magnetic Pole. Figs. 33 and 34 exhibit
prominent feature of the solar diurnal variation of declina
he extra tropical regions of the northern hemisphere. If
ver stand over the centre of the needle and look towards
ed end, or that which points to the north, he will perceive
towards his right hand which will reach its
nd a deflexion towards his left hand which will reach its
about 2 P.M. But are these deflexions to the right and
l of geographical or of magnetical north? The question
answered by Sabine in his discussion of the results of hourly
ions of the magnetic declination at Port Kennedy (*Phil.
1863, p. 660*). This station is 72° 6′ 49″ W. Lat. and 94° 19′
, and here the marked end of the needle, while it points
the magnetic pole points in reality about 35° to the west of
Now the marked end of the needle when viewed at S.A.M.
Port Kennedy is seen to have moved to the geographical west
he magnetical east. It would thus seem that throughout
a-tropical regions of the northern hemisphere the S.A.M.
of the needle is always towards the magnetic east but not
owards the geographical east, while the deflexion at 2 P.M.
ays tend towards the magnetical west but not always
the geographical west. In time the oscillations have
refe the pe l and
north geographical pole. No observations o tained
made in the southern hemisphere.

16. *Long Period Inequalities at Declination Kew.*—It w
observed by Lamont that the yearly values of the diurnal
in the declination at Munich presented signs of a per
variation. In 1852 Sabine (*Phil. Trans.*, 1852, p. 103)
that this inequality corresponded in period with the
cies of black the surface of the s

The existence of black-spots or the dark of the sun w
known to the Chinese. In Europe they were but rarely
observed after the invention of the telescope, and it was
from their behaviour that the sun revolved about its axi
twenty-six days. Hofrath Schwabe of Dessau, from a long
forty year observations of the sun was the first to show
state of the sun's surface as to the spots was not uniform,
their frequency was subject to an inequality the average p
which was about eleven years. Other inequalities both
and shorter periods have been supposed to exist, but the
yearly period is the most prominent and is to be carefully
the sun spot catalogue of Schwabe is the best with respect
completeness, yet Professor Rudolf Wolf has endeavoured t
observations of sun spots made at different times and by
observers compare with each other, and by forming what
ing approximately the relative number of sun spots for ea
The list extends back into the 17th century, and is of gr
in confirming past all doubt the existence of the eleven yea
It will appear below that the sun is probably to be reg
viewed most light and heat at those times when sun
most frequent. The most accurate and now universally
method of estimating sun spots is to take the spotted area
millionths of the visible hemisphere.

To return from this digression, the correspondence betw
spots and declination range as detected by Sabine was of such
that years of large declination range accord with those of m
spots, and *vice versâ*. In the same year with Sabine (1
Rudolf Wolf and M. Gautier independently remarked the ex
cidence. Subsequent discussions have entirely confirmed
of the connexion, and in May 1872 William Ellis (*Phil.
1880, p. 419*) showed that the observations made at the G
Observatory during the years 1841–77 indicated a relation
nature between the diurnal range of horizontal force as well
of magnetic declination on the one hand and the amount of
frequency on the other. The general character of this con
between sun-spot frequency and declination range is s
graphically in fig. 39 below.

17. *Ratios of Range in Years of Maximum and Years
mum Sun-Spot Frequency.*—Broun (*Trans. Roy. Soc. of Ed
xxvi. p. 1*) has shown that the ratio of the diurnal range of de
in years of maximum to that in years of minimum
frequency for places widely apart on the surface of the earth
nearly alike. This will be seen from the following table:

TABLE VII. *Ratios of Declination Range in Years of M
and of Minimum Sun-Spot Frequency*

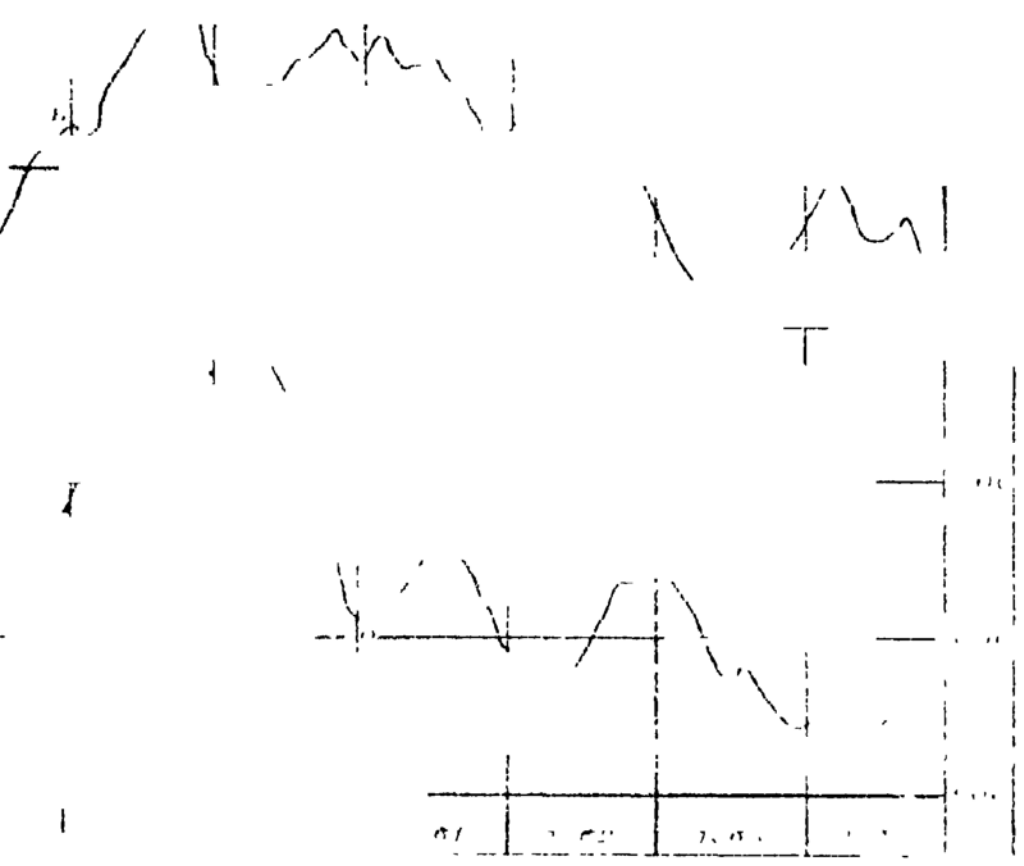
Place	Mean Ratio (1)	
Paris	1·71	Capocci and Arago.
Gottingen	1·74	Gauss.
Munich	1·66	Lamont.
Dublin	1·57	Lloyd.
Hobart Town.		
Toronto	1·51	Youngchu Land and L
Trevandrum		

18. *Closeness of Correspondence. Lagging behind of
Stewart has shown (in addition to the declination r
Kew, Trevandrum and Pekin (*Proc. Roy. Soc.*, March 5
February 5, 1874; May 16, 1878) that the correspondence
the rate of the sun's surface and the diurnal range of de
extends to inequalities of short periods as well as to that
the period approximately eleven years, but that a portion
of the surface precedes in point of time that of the de
range. Dr. Lamont pointed out, in time, that the solar cau
the terrestrial effect which latter lags behind to an extent
sometimes considerable. The above conclusions have been cont
Lit. *ut supra*), and have likewise been extended by him
horizontal force. The close nature of the correspondence
and the lagging behind of the terrestrial magnetic effect, wi
from fig. 35.

There are indications that this lagging behind of the
effect is greater for sun-spot inequalities of long than for
short period, a method of behaviour quite similar to what
in meteorological phenomena.

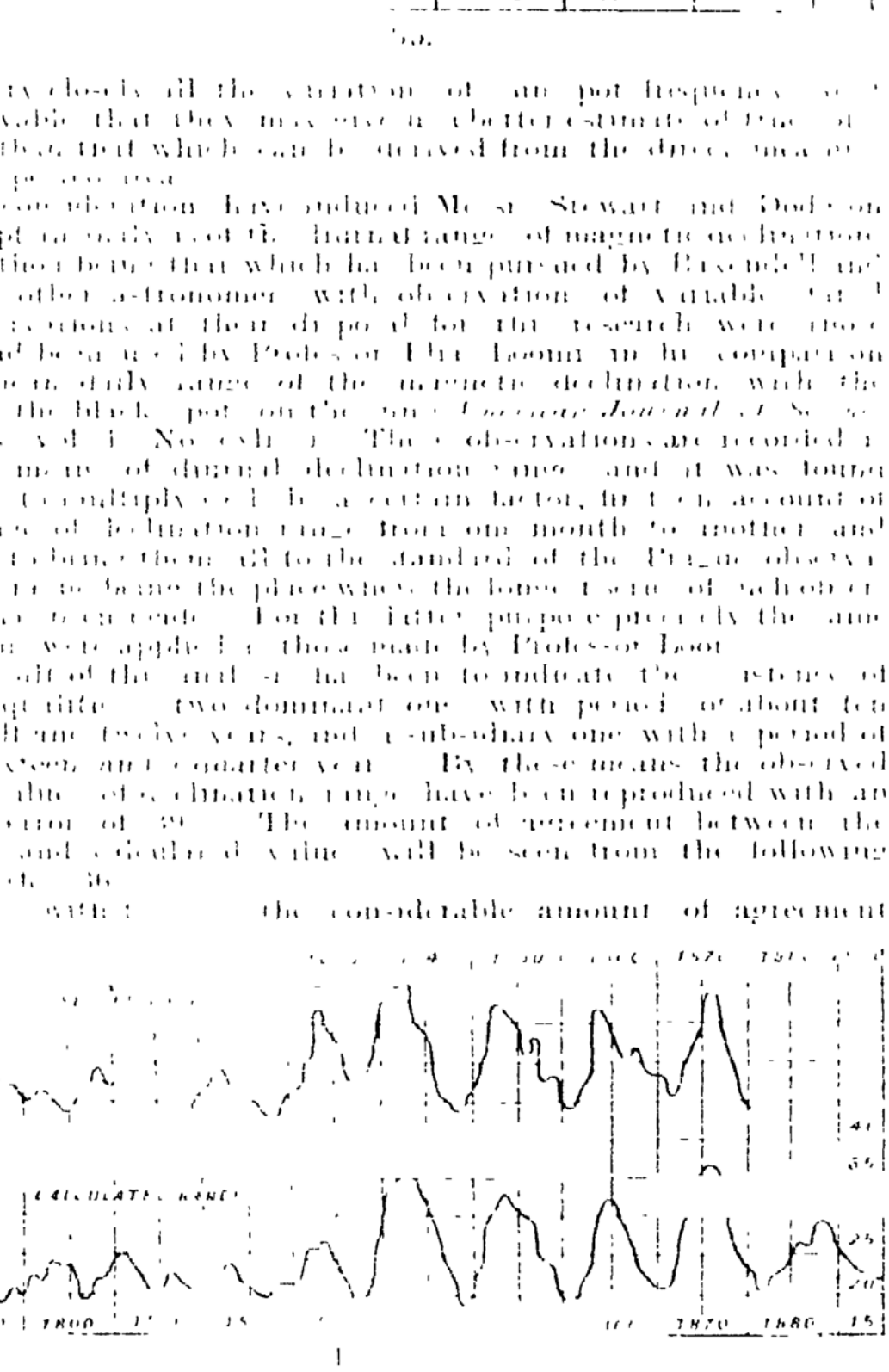
19. *Analysis of Long-Period Inequalities.*—We possess no

recently accurate for a discussion, or a complete account of
relating to solar periodicity before the time when Schwabe
his method the system of solar observations which was
the year 1 . We have, however, a much longer series
annual range of magnetic declination which we have access to



closely all the variations of our present
able that they may give a better estimate of true
than that which can be derived from the direct means
present

consideration have induced Messrs Stewart and Dodson
to carefully reduce the diurnal range of magnetic declination
this being that which has been pursued by Ellicott and
other astronomers with observations of variable
stations at their disposal for the research were more
be surpassed by Professor Elias Loomis in his comparison
yearly range of the magnetic declination with the
the black spots on the sun (*American Journal of Sc*
vol i November) The observations are recorded
means of diurnal declination ranges and it was found
to multiply each by a certain factor, in each account of
of declination range from one month to another and
to bring them all to the standard of the Prague observ
to be the place where the longest series of observ
extended For the latter purpose precisely the same
were applied as those made by Professor Loomis
all of the analysis has been to indicate the existence of
quite two dominant ones with periods of about ten
nine twelve years, and a subordinate one with a period of
seven and a quarter years By these means the observed
diurnal declination ranges have been reproduced with an
error of 3 The amount of agreement between the
and calculated values will be seen from the following
table 36



with the considerable amount of agreement
the results of observ
hardness, it would
obtainable is too short to render the analysis a very
one It will certainly not be necessary carrying back forty
years beyond its starting point, which was in 1784, and
be very hazardous to carry it forward any considerable length into the future It will be seen that cal
indicate a maximum of declination range about 1884, bu
pronounced a maximum as that of 1871 Here then we
prediction which observation will either fulfil or contradict
a practical test of the value of the analysis

51 The remark now made would seem at first sight t
that we are not yet furnished with sufficient yearly records
declination range or of accurate and not observations too
to unravel the long period solar inequality with such comp
as to carry out calculations more than a very short distan
the future with any chance of success and that we may
wait for another hundred years observations before we are
do so On reflection, however, it would seem that lon
inequalities may be caused by the superposition of those
period and that the results of the latter may lead to
the former It would relieve us if this were found to be t
for the observations at our disposal may be sufficient to e
completely a short period the position, amplitude
have in each the elements of a true periodicity

A remark made by the author of the above analysis wou
to indicate that a connection of the returns between long a
period does in all probability exist It is a well known f
the so called eleven yearly variation of declination range
certain time later and at other than mean Thus, for
they have been later for the last forty years but they we
about the earlier part of the present century Now it is cl
an inspection of the observations so far as to trace a corre
oscillations accompanied with an acceleration of the long
time between successive phases, what seems to small os

compared with the dependence of the same The res
long period curve of the sun's spot period, so to
the eleven yearly inequality

Now a phenomenon precisely in the connexi
longer period It we take inequalities in period of thre
month we find that such are often developed or
ten and badly developed or of small range, and that
ence of such accompanied with an alteration of the bas
a of average efficiency, while a small range is accompani
a deficiency of the same The result is a curve of the base
which the period is roughly speaking eleven years May
therefore imagine that the so called eleven yearly period, or,
more correctly, the ten and a half and twelve yearly perio
which the eleven yearly period may perhaps be analysed
more duly beat period for longer disturbance Is it no
more possible that a study of these longer periods may
information regarding the nature of the eleven yearly
whether for sun spots or declination ranges, which the sma
of actual observations is incompetent to afford

52 *Declination Range Weather* Although has alread
reference to magnetical weather is perhaps having laws similar
to, yet not to those which regulate meteorological weather.
diurnal range of magnetic declination and those of atm
temperature present us with elements of the two weathers
used Again there is strong evidence for si
that an element of meteorological weather such for inst
temperature range, travels as a rule from west to east,
peculiar rule of temperature range might be expected to
first in America and some days afterwards in Great Brit
becomes therefore a question for inquiry whether this r
from west to east applies also to magnetical weather as evide
the diurnal declination range Stewart is of opinion that
of travelling applies to both, but that magnetical weathe
later than meteorological (see *Proc Roy Soc* January 10,
23 1879, and June 9, 1881) From the preliminary discussi
by him it would appear that Kew lags behind Toronto as
phase of magnetical weather by 1 6 days, that Prague lag
Kew 0 days, and that Trevandrum lags behind Kew by
The conclusion cannot, however, be regarded as establish
it is confirmed by a more complete discussion of observatio

53 *Disturbance Day and Duration of Declination* M
storm (1 38) were so named by Baron Humboldt, one of
observers of such phenomena From observations at Paris
Freiburg he found that very frequently, though not un
these three stations were simultaneously affected by such
The observation of magnetic disturbances was afterwards
more systematic manner by Gauss and Weber of Gottingen
days were instituted for this purpose by these observers, t
say, periods each of twenty four hours length during which
tions were simultaneously made at intervals of five mi
Gottingen and about twenty other stations distributed g
over the continent of Europe Finally, the establishmen
British Government of the colonial magnetic observatories,
energy and sagacity of their director, Sir E Sabine, ha
greatly increased our knowledge of these remarkable phen
Sabine has not merely separated the disturbed from th
turbed observations as explained in § 38, but he has div
former into two categories —(1) those tending to increase

† *Phil Society of Manchester*, March 8 1881

ion and either element of force, and (2) those tending to
the same. He finds that these two categories obey
laws, from which he argues that there are at least two ex
ing forces. In fact if we have to give up the idea of a sim
constant type, it is natural to ask if the phenomena of dis
can be approximately represented as due to the united
two independent types of force. It was probably some
a that led Sabine to separate disturbances into the two
s above mentioned. Here there is no attempt to treat
se two types represent an ultimate and complete analysis
ter concerned. We merely use the separation as the most
ent method at our disposal in the present state of our knowl
to ascertaining whether there be indications of a similar

sults in the Northern Hemisphere.—Sabine's method of
the phenomena has enabled him to obtain the disturbance
variation for the following stations:

...	...	...

bove stations have been ... at Kew may be
a on one ... and Peking and Nertchinsk a position on
e side of the ... the pole while Toronto may be counted
e side and ... Nertchinsk and Point Barrow on the other
the American ... (3) The question is to what
if any, these ... owe their disturbance diurnal
of declination; thus one which may be observed by
ne the result obtained at the observation stations. For the
n-stead of recording the average disturbance of the
hours, the resultant expressed in ratio ... the mean hourly
the day being taken as unity, or in other words
disturbance for the twenty-four hours being
our. The results of the method are graphically represented
e, where in the left-hand curves Kew time is used, and
ght-hand curves local time, each starting at 0°

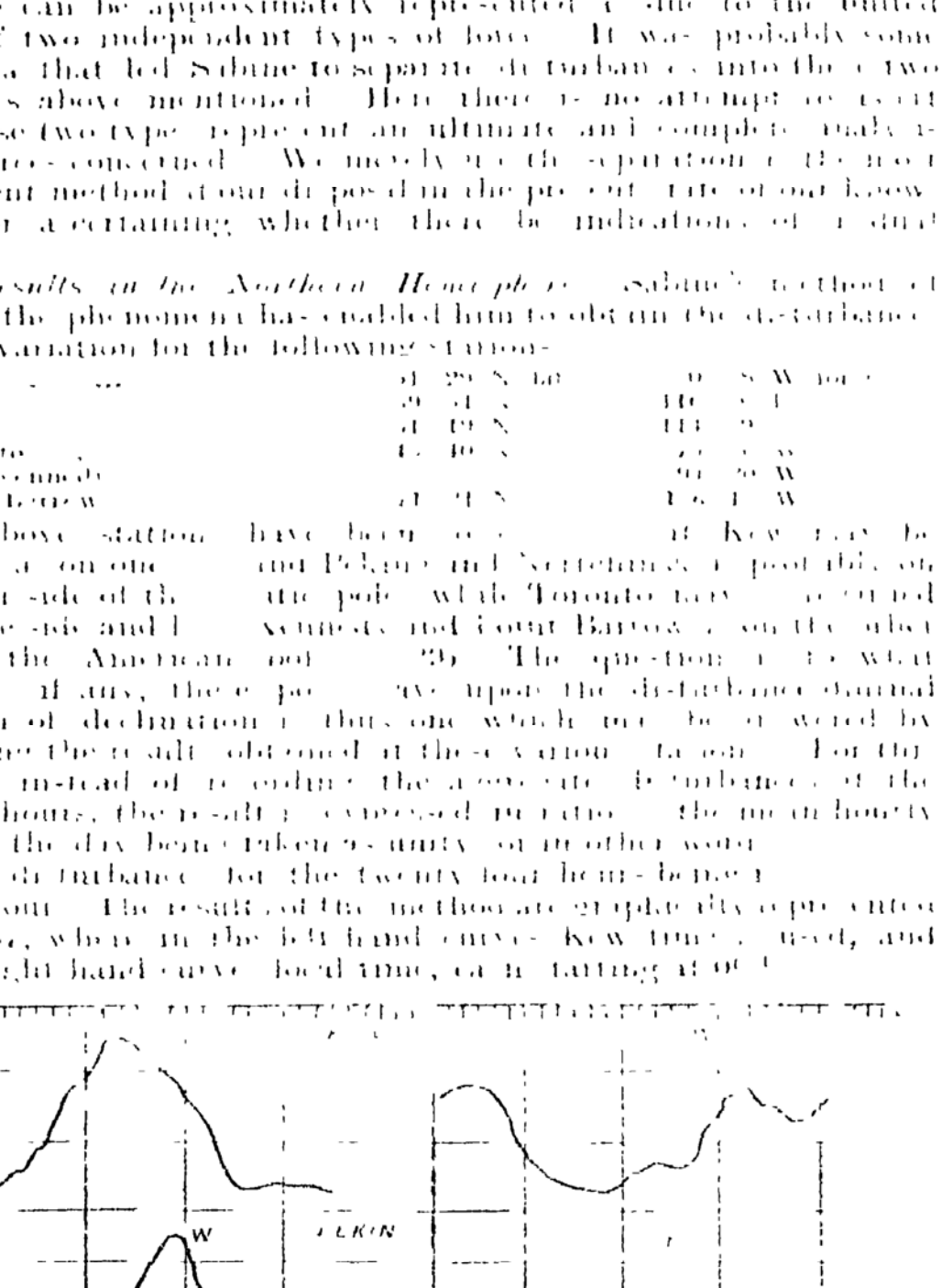


FIG. 37.

t all the various stations one curve exhibits unmistakably
progression while the other exhibits more or less dis
a double progression. At Kew, Toronto, Port Kennedy,

ferred to a paper by C. Chambers, director of Bombay Observatory

same characteristic ... ry at Pekin or Nertchinsk the maximum
out twenty-two or twenty-three hours Bombay astronomical time.

and Point Barrow it is the easterly disturbance which
the single progression, while, on the other hand, at Pekin
Nertchinsk, stations which are oppositely related to the
magnetic centre, it is the westerly disturbance which is
mined by Sabine and others that this peculiarity is due
to the fact that Kew and the associated stations may be re
on one side, and Pekin and Nertchinsk on the other, of the
the movable magnetic system.

Sabine has likewise remarked that the rapid progression
which is denoting easterly disturbances, exhibited
which take place not far from the one o'clock time. W
observations plotted all the left-hand curves accurately to Ke
but the curves readily, on account of small irregularities w
curve pendulum-like exhibit. It will be noticed that there
marked resemblance between the maximum at Kew, Toronto
at Nertchinsk, but that the maximum at Port Kennedy and
Barrow, which both occur nearly about the same time, fall a
accurately if not very greatly different from that of the
maximum. Indeed the time of maximum for Port Kenne
Point Barrow is not far from the time of minimum for th
station. Now it has been noticed by Sabine that Port K
and Point Barrow may be regarded as on one side of the M
magnetic centre of rotation, while Toronto and the as
associated stations are on the other side. It seems therefore pro
to connect this fact together with the latter, as the time of ma
Sabine has likewise remarked that the ... mounts
disturbance is much greater at Point Barrow than at
stations. Now from Barrow's observations that perturb
maximum. This and the phenomena above described
that somewhat corresponds to Asiatic perturb
somewhat, perhaps, of the Asiatic pole, and
the centre of minor activity. Sabine, who
appears to have very well appreciated the
these phenomena to the Asiatic pole. He
that of the two magnetic systems which
mobile to the magnetic of the globe one
the other a magnetic equator, and that it
two systems which by their progression over
phenomena of regular change and to those irregular cycle
owe their origin to the operation of the regular change
current with the conclusion of Walker that "the
influence at any point of the globe is the result of two
magnetic system the principal of which has its magnetic
of the close by the northern portion of present
the north of the American continent while the weaker
is that which is felt from the magnetic meridian
by tropical action and of which the northern point of
attraction appears to be north of the Asiatic continent
the direction of the magnet at any point to all three
portion of the three-system the magnetic pole being
dominant over the more remote (Phil. Trans., 1860). W
prone to think that something of the nature both
as a working hypothesis we would however point out
Asiatic pole cannot be regarded as accounting for all
magnetic disturbance, but that the location of
near the locus of aurora than it is to either of the
magnetic interests.

The right-hand curves represent the ... variations
variation which have two maxima except for Port K
and Point Barrow, decided exceptions. Sabine remarks
marked as having reference to Greenwich time, like those
previous ones, their occurrences rather to be ... time. We have
plotted all the curves according to local time, and the
reference to ... not come out with very great distinctness
must be ascribed, in our opinion, to instrumental
and we think also to the time of ... when
new interpretation is to be ... and
56. *Localities in the Southern Hemisphere.*—Table VIII
the occurrence of a maximum of declination expressed
Helena, 15 ... S. lat., ... W. long.; Cape of Good
... S. lat., ... W. long.; Hobart Town, ...
lat., 147 ... E. long.

At St Helena and the Cape the easterly disturbance ...
appearance of a ... process, while the ... mum
... to the ... easterly disturbance at Hobart Town
the time of ... for St Helena and the Cape
local ... while Hobart Town, which we may
situated on the opposite side of the chief southern ...
from St Helena and the Cape, has a maximum nearly
absolute time with the occurrence of the other two ...
would thus seem that the chief magnetic centre of the
similar manifestations regard the ... pole to the ...
as the centre of the north. As in the case of the time of ...
mum for the south is determined by St Helena and the
about twelve hours different from the corresponding time
north as determined by Kew, Toronto, Pekin, ... Ner...
All this is in favour of the working hypothesis already ...

TABLE VIII

Easterly Range	Westerly Range	Westerly Range

tions of short period hitherto discussed are not necessarily accompanied by a permanent change of mean position of the needle. We have now to inquire whether there be any fluctuation of long period (besides the secular change discussed in §§ 30-33) tending

us at once to the annual variation, for one must look to the later made and more accurate observations in which all possible sources of error have been carefully eliminated. Broun has made an exhaustive experimental inquiry into the several sources of error which could possibly influence his declination needle at Trevandrum. His conclusion was that the variations of torsion of a well-made thread are not sufficient to produce a sensible effect upon the position of a powerful magnet. In fact Grubb's magnet, weighing 6000 grains, and Adie's, weighing 1100 grains, give almost identical results. We may extend the conclusions to other observatories where well-devised instruments have been established, and look with much confidence to such instruments registering correctly the secular as well as the annual change of declination that may be taking place at each locality.

65. The following table (XIII.), borrowed, with the exception of the Trevandrum and Bombay results, from E. Wallen's *Terrestrial Magnetism*, shows the annual variation of declination:

	Declination, Secular Change	Annual Change	Observations Year
Kew	21° 29′ W.	+ 9′·00	1858
Hobart Town	9° 36′ E.	+ 1° 23′·30 W.	1841-45
St. Helena	24° 25′ W.	+ 7′·00 W.	1841-49
The Cape	29° 1′ W.	+ 0° 2′·30 W.	1841-46
	1° 0′ W.	+ 1′·42 W.	1845-?
	0° 22′ E.	+ 1′·?	1841-?
	0° 31′ E.	+ 3′·16 E.	1857-6

PLATE XIV. *Showing the Mean Diurnal Curve for Month of the Year at Seven Stations.*

May	11·8	9				3·7	16·3
June	20·6	17·4	1	6·4	24·1	3·2	9·8
July	7·3	12·6	+ 8·4	3·9	5·6	3·9	1·4
August	20·7	1	5	+ 6·8	1·3	2	1·6
September	9·2	+ 17·1	19·8	13·2	4·1	10·3	+ 0·1
October	19·6	+ 6·0	1·8	1·8	+ 1·6	8·0	11·1	8
November	3·8	+ 9·6	3·3	+ 3·2	2·6	1·2	2·0	1
December	+ 9·6	+ 19·8	+ 2·3	+ 12·6	+ 3·3		4·3	1·8
January	+ 9·6	+ 4·2	3·0	+ 2·9·1	+ 2·2·9	7·1	+ 3·2	1·0
February	+ 34·2	+ 0·6	+ 18·0	6·3	+ 7·9	+ 3·5	2·6	+
March		5	1·0		16·2	1·9	1·2	

Here + indicates that the mean of pole of the needle is to the west and − that it is to the east of its mean position for the year.

66. To cancel the irregularities of the table let us take the means from April to September and from October to March, the former embracing the months around the June solstice and the latter those around the December solstice (Table XV.):

	Mean from April to September	Mean from October to March
Kew		+ 4·5
Toronto	+ 4·?	+ 17·1
St. Helena		+ 6·3
Cape of Good Hope		+ 3·9
Hobart Town	+ 18·7	+ 17·3
Trevandrum	+ 0·1	− 1·6
Bombay		6·?

It will be seen from the above that the means for Trevandrum and Bombay present opposite signs to those for the other stations. The whole amount for Trevandrum is no doubt very small, but Chambers does not regard the evidence for Bombay as conclusive, but on the whole it would appear that two observatories near one another present evidence of a similar behaviour in declination, and we are therefore disposed to regard it as a reality.

67. *Semi-annual Variation of Declination.* If we look at the numbers of Table XIV., we shall see that there are traces of turning points at the equinoxes. Let us, in order to exhibit this, compare together the sums for the six months grouped around the two equinoxes with those for the six months grouped around the two solstices, that is to say, compare the sums for February, March, April, August, September, October, with those for November, December, January, May, June, July; and we thus obtain the following table (XVI.):

	Sums around Equinoctial Months	
		101·2
		96·4
Hobart Town		0·?
Trevandrum		19·0
Bombay		6·2

68. *Diurnal Variation of the Horizontal and Vertical Components of Magnetic Force.* Although self-recording magnetographs have been established in many observatories throughout the world, owing to the peculiar difficulties of the task, and the labour of reduction, very little has been done towards investigating the solar diurnal variation of the horizontal and vertical components of the earth's magnetic force. Señor Capello of the Lisbon Observatory has, however, made progress with his reductions, but already published valuable information regarding the mean diurnal fluctuation of the two force elements at his observatory.

In his attempt to eliminate the disturbance of horizontal and vertical force by the method of Sir E. Sabine, Señor Capello experienced considerable difficulty, more particularly with the curves of the vertical force magnetograph. The instrumental bifilar has very often been found by him to change the zero of equilibrium after some perturbation. As in the case of the hourly variation of the horizontal and vertical forces, so in the case of the diurnal variation, Señor Capello found it necessary to reject from the discussion the days of great magnetic disturbance, and also those days which, though free from great disturbance, indicated a considerable amount of disturbance, estimated according to a general scale. In the reduction of many thousands of photo-

PLATE XVII. *Monthly Mean Diurnal Range of Force at Royal Observatory, Greenwich.*

Year	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean

Plate III. the declination range of 13′, the horizontal force a preponderance in summer and minimum in winter, a tendency towards two maxima and two minima in winter, and two maxima and one minimum in summer.

69. *Diurnal Inequalities of Horizontal Force at Different Periods of the Year.* Ellis has compared the hourly values of the horizontal force as well as that of the declination at Greenwich with the period of sun-spot frequency. He compares the years from 1847 to 1877, and he has deduced the following conclusions:

[1] See also Ellis, *Observations at Hong-Kong*, Introduction, p. 6, first to point out the relation between the state of the sun's surface and variation in the horizontal force.

e diurnal range of the magnetic element- of declination
rizontal force are subject to a periodical variation, the
of which is equal to that of the known eleven year sun
od.

e epochs of minimum and maximum of magnetic and sun
t are nearly coincident the magnetic epochs on the whole
g somewhat later than the corresponding sun spot epochs
ation- of duration in different periods appear to be similar
phenomena

e occasional more sudden outbreaks of magnetic and sun-
ces, extending sometimes over a period of several months,
o occur nearly simultaneously and progress collaterally

Disturbance Diurnal Inequalities and Force Components. We
ive the following conclusions on the results obtained by
on the observations at Toronto St Helena and
ment there are two categories namely, those disturbance
ency to increase and those which tend to diminish th
magnetism

Toronto the disturbance increasing both elements of force
ore or less progressively with maxima occurring for both
or 5 hours local time Again the disturbance decreasing
ment represented by
ma
e for both at about 11 or 12 hours local time

Kew the disturbance increase both elements represent
ly progression with maxima occurring for both about 5
l time On the other hand, the disturbance decrease in
rizontal force represents more of a double progression in
turning the vertical force seems of a simple progression the
to be the latter falling between the two maxima for the
and occurring at 11 hours local time

ere is not the same close correspondence between the
of the disturbances which tend to increase both elements
ect the presence of those which tend to decrease both
at St Helena there is for the other stations a
ble difference between the numbers for St Helena and those of
or Kew is there a difference between the numbers for Toronto and
Kew

he fact that the disturbance diurnal variations of the two
ments at Kew are very like each other while neither of
very like the corresponding declination variation is
confirmation from a visual inspection of the Kew curves
Philosophical Transactions for 1861 Stewart thus describes
lt of an inspection of the disturbances of these curves for
1858 60 disturbance

see two
the force
d only exceed
in which the
or lowered
description
or lowered
the vertical force and only eleven cases of an opposite description
es are here one case in which both forces are raised or lowered
and only two cases of an opposite description There is therefore a
ot may in the curves of all the elements to be raised or lowered simul
but the tendency from a between the horizontal and vertical force
no between either of these and the declination It may of the mo
ll noted that with the exception of the disturbance of August to Septem
here is never a movement curve in which the three elements do not co
other

s and Hollows. The are certain small but abrupt mag-
ments which from the fact that they generally fall within
ctuation value are not usually regarded as disturbances. The
ments only be brought to light where there is continuous
of magnetic phenomena such as that derived from self
magnetograph They were first studied at the Kew
ory by Stewart *Phil. Trans.* 1862 We have seen that
the one type of force must be concerned in producing
disturbance This is confirmed by the appearance of the
ves in which it may be seen that no disturbance of any
ble is due to the action of a single force varying merely in
and not in direction For if there were only one type of
force at any moment at a point in the curve of one
ion of normal position would bear throughout a
ple to portion to the distance of corresponding
at the ordinary position of the elements from its normals,
ld be seen in their
ven if several independent forces are at work it may be
and only there is the
ement a sudden change should
ce in all there is the
robability that sudden changes
s exhibited peak
hollow are changes in one of
entary force
ver if the changes not a very
ne, provided
ne our eyes to such peaks and
as present a similar appearance in all the curves, we may
that we have observed one or more only of the elementary
ng forces, for it is found by that two or more independent
dently would
ne similar appearances
ree curves

ure, it is probable that similarity of appearance in the
uctuations of the three elements denotes a simplicity in the
force, Stewart has discussed all such peaks and hollows
extending over the first two years of their production, and
the result which is embodied in the following table

TABLE XVIII *Hourly Ratios and Frequency of the Ke
and Hollows, the Vertical Force Disturbance being t
Unity*[1]

Hour	Declination	Hor Force	Number of Observations	Ho	Declination	Hor Force	Nu Obse
0 1	2·11	2·06	7	12 13	1·16	2·63	
1 2	1·94	2·16	7	13 14	2·00	2·04	
2 3	1·86	1·99	11	14 15	2·10	2·14	
3 4	1·81	2·05	7	15 16	2·05	2·11	
4 5	1·55	1·75	4	16 17	3·18	2·16	
5 6	1·57	1·51	1	17 18	3·80	2·11	
6 7			0	18 19	2·91	2·18	
7 8	1·83	1·91	2	19 20	·97	2·25	
8 9	1·69	2·70	4	20 21	1·11	2·21	
				21 22			
10 11	1·33			22 23			
11 12	1·10			23 24			

71 It will be seen from this table that the ratio between
maxima peaks and hollows of the two components of the force
nearly constant, the horizontal force disturbance being about
that of the vertical force, so far as can be seen on the curve i
It will also be seen that there is a very marked diurnal
the ratio which the declination peak or hollow bears to the
vertical force, this ratio being greatest about 7 A.M. Also
here we have almost peaks and hollows, while in the even
early morning hours there is so great an absence of these phe
that the ratios are doubtful

75 A preliminary comparison between the peaks and
at Lisbon and at Kew has been made by Capello and
(*Proc. Roy. Soc.*, January 28, 1864) with the following conc
(1) The Kew peaks and hollows are simultaneously proc
Lisbon in all the elements, but to a smaller extent than at
(2) The direction is the same at both stations for the dec
and horizontal force peaks and hollows, but it is reversed in
of the vertical force, so that a sudden small increase of verti
at Kew corresponds to a diminution of the same at Lisbon
It would be manifestly impossible to discuss with any ac
the nature and origin of these peculiar changes until mor
ive observations of them have been made. As the p
hollow force is probably of a simple nature, a further know
its character may be of much importance to the theory of te
magnetism.

It is interesting to remark that we have in peak and hol
the close relation between the variations of the two forces
that we find in the larger disturbances

It is believed too that during violent disturbances a
change of type is produced in the peak and hollow force, a
especially this remarkable in the great disturbance in Aug
September 1859, where the declination would seem to mar
opposite direction from the two components of the force.
seen that the same peculiarity characterized on this occa
larger and more apparent magnetic changes. We shall af
refer to a circumstance which may perhaps throw light u
peculiarity (§ 93), meanwhile we conclude by again remark
during comparative magnetic calms the peak and hollow for
signs of remaining constant in type, and that it is the
great importance that the directors of observatories possess
recording magnetographs should take united action to obse
force

76 *Other Inequalities of the Disturbance-Diurnal Variati
Force Components.* Sabine has shown that disturbances of
components present a distribution over the various month
very similar on the whole to that which is exhibited
turbances of declination. He has likewise shown that distu
of the force components present a distribution over vario
similar to that exhibited by disturbances of declination
we may probably conclude that disturbances of the force com
are smallest at those portions of the earth's surface where
ances of the declination are smallest, and largest at those
where such disturbances are largest.

77 *Annual and Semiannual Variation of Horizontal F
Rep.* Broun (*Trans. Roy. Soc. Edin.* for 1861) has discus
results obtained by Sabine at his magnetical stations, and ha
that differential and absolute observations agree in telling
the horizontal force is smallest at the equinoxes and gre
the solstices Whipple has recently obtained the same res
the Kew observations

We have deduced the following table (XIX.) from the
absolute determinations that have been made at sundry pla
at the annual and semiannual variations of declination, ho
force, and dip are exhibited, "increase" denoting a push
west, and "decrease" a push to the east. The method of o
these has already been indicated in §§ 66, 67.

[1] We ought to mention that, with the exception of the one occasio
alluded to, a peak of one element always corresponds to a peak of an
ment, and a hollow of one element to a hollow of another

	Effect on Declination		Effect on Horizontal Force.		Effect on Dip	
	At Equinoxes compared to Solstices	At June Solstice compared to December Solstice	At Equinoxes compared to Solstices	At June Solstice compared to December Solstice.	At Equinoxes compared to Solstices	At June sol compared December So
stown or Kew	Increase	Decrease	Decrease.	Inappreciable	Increase.	Decreas
	Increase.	Decrease	Decrease	Increase	Inappreciable	Decreas
f Good Hope	Increase	Decrease	Decrease.	Increase.		
Town	Decrease	Decrease.	Decrease.	Decrease.	Decrease.	Decreas
dium	Decrease	Increase.				
y	Undecided	Increase				
na	Undecided	Decrease.				

discussing the results of the table we shall assume that acts, and in all probability acts indirectly, upon the system of the earth. This point will afterwards be examined. Meanwhile, assuming this indirect action of the assuming, to fix our thought, that it is in close alliance convection system of the earth's atmosphere, we can readily that such solar action would act most strongly on the magnetic poles at the solstices, and that in the June solstice or poles in the northern hemisphere and in the December those in the southern hemisphere would be most affected. trong action on this kind upon either pole may be assumed to decrease the general magnetism of the earth, or that portion of it which is most readily affected by external that is to say, the induction system. Again, if the solar influence is connected with the convection current of he can readily imagine that the influence in the northern ere where there is much land should exceed that in the hemisphere where there is much water.

these views be reasonable, we might expect two things to the earth's induction system should be strongest at the than at the equinoxes, and (2) it should be more especially the June solstice, when the forces in the northern hemis-

We must bear in mind, however, that a vast increase at a time applied to its particles most susceptible of may not be instantaneously propagated throughout but that time may enter as an element of the question, case, inasmuch as the action of the sun at the June solstice northern hemisphere, a station near the south pole may not take of the magnetic effects of this action.

hypothesis of this nature would appear to be consistent results of Table XIX.

first place, if the earth should become stronger as a magnet in both of its magnetic systems this would show itself by ase of horizontal force at least in all such stations as those absolute observations are made. An influence which the horizontal force at these various stations is therefore regarded, and was regarded by Broun as one meaning gth of one or both of the magnetic systems of the earth. of one or of both will presently appear. We may therefore from our observations that one or both of the earth's mag stems are strongest at the solstices.

next place we may imagine that the changes of declination which the table exhibits as occurring at the solstices are changes which would be wrought in these elements by an of power in the earth. For we see very well that an of horizontal force at the various stations may be regarded ing an increase of the earth's magnetic power. We cannot, see with equal facility what changes would be produced in nation and dip by an increase in power of one or both of netic systems, but we may well imagine that such change elements as are found to accompany an increase of horizon are those that denote an increase of the earth's power.

have thus ascertained the probable nature of those changes of e elements which denote an increase of power. Now it will ed from the table that the effect at the June as compared at at the December solstice is of the opposite nature to the the equinoxes as compared with the solstices, that is to earth is more powerfully affected in June than in December, well-established exception to this being Hobart Town in the h. But, assuming that time is an element in the develop this preponderating influence acting in the north, it is easy hy Hobart Town should not exhibit its full effect.

pains to determine from the observations themselves which magnetic systems it is that exhibits the observations would of course point to the induction system, but it is e to determine this from the observations themselves.

51, when discussing the disturbance diurnal variation of ion, it was found that Toronto and Kew may be regarded as side of the Siberian pole, while Peking, Nertchinsk, and are on the other. Now, if it be this pole that is influenced oscillations under discussion, we might expect that the influ declination at Toronto and Kew should be the opposite of Trevandrum and Bombay. We find by the table that this ase, and we are thus inclined to attribute these changes to erian instead of the American pole. It would thus appear that the observations of Table XIX bear out the provisional hypothesis which we have ventured to introduce. It is quite able that the above remarks may not stand the test of more inquiry, but they are here introduced rather as denoting a of looking at the subject which ought we think to be pursued embodying conclusions of a final nature.

80. *Effect of the State of the Sun's Surface upon the Magnetism of the Earth.*—We have now to consider whether state of the sun's surface permanently influences the magnetism the earth. It will at once be seen that any such action will ently manifest itself as an oscillation in the secular change. We however, carefully guard ourselves against prematurely concluding that it implies a variation in the amount of true secular change. There may be two distinct things: true secular change due cause, and action depending on sun-spots due to another. from the nature of the case, as necessarily mixed up together the yearly changes which we examine, it does not, however, follow there is any real identity between them. We shall now consider example of the method to be pursued in the attempt to detect influence of this nature. Let us turn to Table III., and take the nation yearly values at Toronto from 1856 to 1871. Subtracting value for 1856 from that for 1871, we find that the westerly declination had increased in fifteen years 51′·6, that is to say, at the rate of 3′·44 per annum. Again, the average declination for sixteen years 1856·71 is 2° 20′·8, corresponding to the end of the commencement of the year 1861. Taking the average value for this epoch, and also the average yearly increase above given, we proceed to construct the following table XX., in which calculated and observed values at Toronto are compared together.

1856	1 56·50	1 55·00	+1 30
1857	2 0·50	1 55·11	+2 06
1858	2 4·50	2 1·58	+2 6
1859	2 7·40	2 5·19	+2 05
1860	2 10·60	2 8·76	+1 51
1861	2 11·40	2 12·20	−0 20
1862	2 15·70	2 15·61	+0 06
1863	2 19·10	2 19·08	+0 02
1864	2 21·90	2 22·52	−0 62
1865	2 24·80	2 23·96	+0 84
1866	2 25·60	2 29·40	−1 80
1867	2 29·80	2 32·84	−3 04
1868	2 35·50	2 36·98	−1 48
1869	2 37·10	2 39·77	−2 67
1870	2 41·90	2 43·16	−1 26
1871	2 47·90	2 46·69	+1 21

may be gathered from this table that years which correspond to minimum sun-spots have on the whole a negative or lower positive sign than those which correspond to maximum sun-spots, and hence we may conclude that at Toronto tendency of many sun-spots is to increase the westerly declination.

81. Performing a similar operation for all those cases in which we have a sufficiently extensive series of observations to work upon, we obtain the following table:

TABLE XXI.—*Effect of Numerous Sun-Spots on the Magnetic Elements.*

Station	Declination	Horizontal Force	
Kew	Increase	Inappreciable	Inc
Toronto	Increase.	Increase	Inc
Hobart Town	Increase (?).	Uncertain.	Inc
Cape of Good Hope			
Trevandrum			

82. We have good grounds for supposing that the sun is powerful when there are numerous spots on its surface, and that the above table represents a state of things which we may expect to be caused in one way or another by increased solar power. The most natural hypothesis is to imagine that an increase acts in producing an increase of disturbances, and that from stations at which the disturbances tend on the whole to affect the elements in a definite direction there will be left behind a permanent effect in this direction. A comparison of Table XXI. with XII. will, however, show that this explanation is not valid. For instance at Toronto and Kew disturbances tend rather to

increase the westerly declination, while the effect of numerous spots is to increase it. Again, at the Cape the tendency of disturbances is to increase the westerly declination, while that of the sun-spots is to decrease it. At Trevandrum it would appear that the effect of disturbances will be to increase the westerly declination, while that of sun-spots is to decrease it. It is believed that at Kew and Toronto the supposed disturbance will act on the diurnal inequality in character with the sun-spot effect. On the whole, therefore, there is no definite relation between the two.

If we take Hobart Town, the Cape, and Trevandrum in the order, we find from Table XIV. that these stations seem to indicate that the magnetic state of the earth's most powerful hemisphere is one of maximum for sun-spots. Kew and Toronto, however, in declination and dip are not concerned appear to go the other way. If, however, we suppose that during the period of maximum sun-spots the American pole is well as the earth is affected, and that in such a position of long continuance as that the former is more influenced than the latter, we shall be able to bring out results with the hypothesis of increased solar action. It must be borne in mind that time must be an important element in the consideration of the effect of the American pole, and that, although its influence may not be apparent at Toronto and Kew, which are relatively near the pole, it would not be apparent at the other stations of Table XXI. We shall recur to this subject when discussing the secular changes.

Solar Phenomena connected with the Sun and with Terrestrial Magnetism.

Loomis's "Uniformity and Connexion between Solar Changes and Magnetic Disturbances." Loomis's "Increase Journal of ... [illegible]

He has tabulated the extent of sun-spots for the six days preceding and following each of the great magnetic disturbances at Greenwich, and has compared these values with that for the very day of the disturbance. In the manner he has treated all the days of the magnetic disturbance at Greenwich for a period of twenty years, with the exception of those cases in which very few or no sun-spots were made. The cases of disturbance thus treated amount to one hundred and thirty-five, and the following result has been obtained.

TABLE XXII. *Effect of Spotted Solar Surface.*

Day before Storm					Storm	Days after Storm				
6	5	4	3	2	1	1	2	3	4	5
47·9	50·1	51·4	[illegible]	48·4	9	49·0	45·1	40·3	45·6	45·2

From this result Loomis draws the following conclusions: "1. Disturbances of the earth's magnetism are accompanied by similar disturbances of the sun's surface on the very day of the magnetic storm. (2) The great disturbance of the sun's surface which accompanies terrestrial magnetic storms is generally heralded by smaller disturbances three or four days previous, succeeded by a comparative calm which immediately precedes the magnetic storm."

There is one instance on record of a sudden solar change which was practically simultaneous with a magnetic disturbance. On September 1, 1859, a little before noon, R. C. Carrington was viewing by means of a telescope a large sun-spot when, to use his own words:

> "the area of the [illegible] of which had previously been somewhat diminished, became covered with two patches of intensely bright light which broke out before I could fetch the time by the chronometer, and, scarcely crediting my own eyesight, I supposed that some optical effect had been produced by the brightness of the sun-spot. Running to the door of the equatorial room, I directed Hodgson, who happened to be sitting there, to watch the sun-spot carefully, and to call me if any change should occur, while I hastened to the position micrometer to obtain more exact measures of the two unexpected objects. On my return with the micrometer, Hodgson, who had seen the whole appearance, confirmed my impression that the two bodies had both moved rapidly forwards in company before they disappeared. Not more than five minutes could have elapsed between the first observation and my return to the room, and I was surprised to find that the sun-spot had entirely disappeared. In this short interval of time, which was taken for the time of disappearance, the whole area of the sun-spot, which had been covered with a multitude of minute spots, had travelled forwards in the direction of its own proper motion, and had become a single mass of light, of an oval figure, and of a uniform brightness throughout. Its boundary was well defined, and free from penumbra. Its area was about 10 millionths of the sun's visible hemisphere, or nearly equal to the area of the great sun-spot of November 9, 1847. Its light was estimated by Hodgson and myself to be fully equal to that of the photosphere in contact with it, and therefore much more than sufficient to fill up the deficiency of light due to the dark spots. Its motion was also determined by measures taken with the micrometer, and proved to be at the rate of 35·4 miles per second, or 1° 16′ 30″ per day. The two bodies preserved their distance unaltered during the whole time of observation. Their observed motion was in parallels to the solar equator, and in direct advance of the motion of the spots. Their positions were as follows:
>
> | | Sun's Centre | Distance | Position |
> |---|---|---|---|
> | | h. m. s. | | |
> | First body | 11 18 19 | 23·8 | 44·5 |
> | Second body | 11 18 19 | 23·8 | 44·5 |
> | First body | 11 22 30 | 23·8 | 44·5 |
> | Second body | 11 22 30 | 23·8 | 44·5 |
>
> "Before I could complete the micrometrical measures, the first body had entirely disappeared, and the second was fast following it.

e nearly twenty-six days. This assumes that the meridian
hat power is fixed on the solar surface. It does not, however,
npossible to imagine that such a meridian may have a proper
of its own, and indeed the planetary hypotheses of the origin
spots would rather lead to this conclusion. But if this be
e we shall be unable to deduce from recurrent magnetic dis-
es the true value of the period of solar rotation.

Repetitions of Magnetic Changes.—J. E. Capello, of the Lisbon observatory
Roy. Soc., October
has remarked
periods of dis-
e there are
synchronous
ents of the de-
on needle during
onding hours for
hree, or more
He thus describes
henomena:

ome cases the re-
s only in two or
nalled movements,
s there are true
t repetition of some
n duration. The
periods are not
similar then phases
modified that in
es then identity can
recognized by a
nute investigation.
e periods when re-
have not always
total duration, nor
commence at the
ecise hour, but
es earlier and some-
er, the differences
from a few minutes
three hours. We
that the greatest
of repetitions be-
the night hours,
o say, those hours
movements of the
re easterly. In the
hours there do not
to be any well
repetitions. There
nty-four examples
n, fifteen of which
epetition on two
ht on three days,
y one where the
pears repeated for
s. It appears that
facts exhibited in
amples agree with
nical theory, the
xisting in the sun
ce) appears to con-
metimes during two,
several days with-
ergoing remarkable
nations. The re-
being sometimes
sometimes later,
so to indicate that
possesses a proper
t; the cause per-
only comes again
ration when the
, its diurnal rota-
ced in a similar
or conjunction to
e preceding days."

art, having com-
Capello's curves
e corresponding
of the declina-
Kew, found that
nshon disturb-
ure almost in-
y reproduced at
the same time,
a greater ex-
d also that the
mount of simi-
hich the various

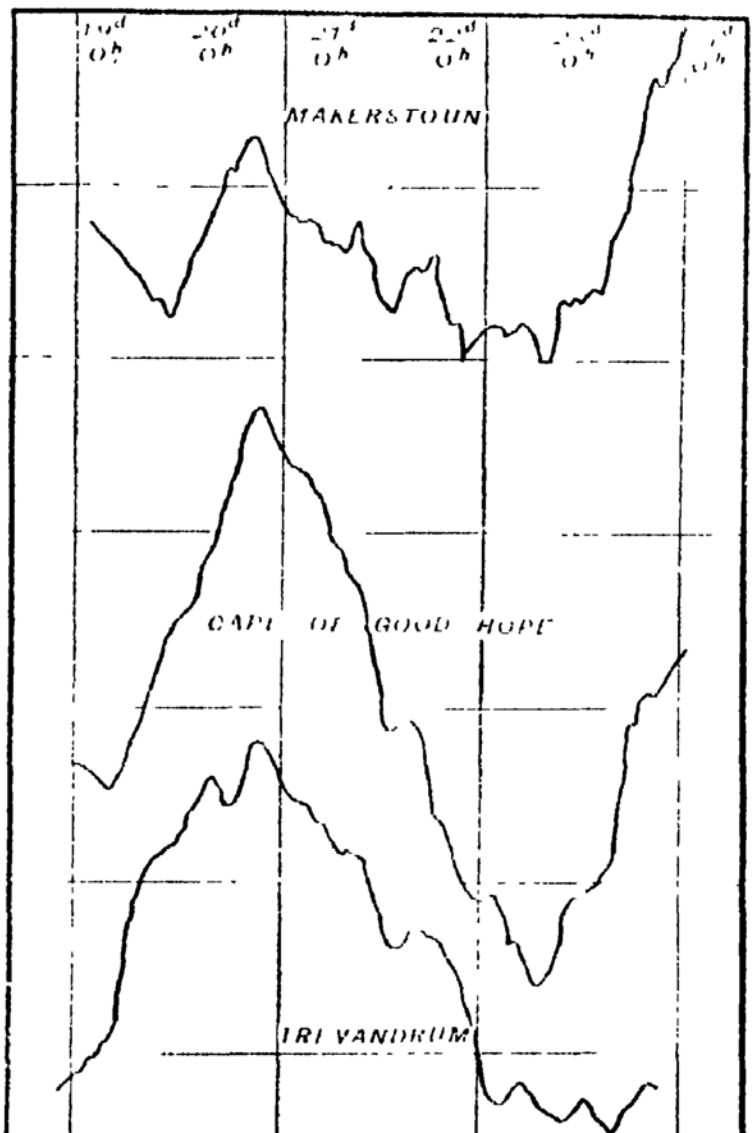


Fig. 28.

curves exhibited in the corresponding Kew curves.
ongest point in favour of the hypothesis is, he thinks, "not
h the repetition of a single disturbance as the repetition
nplicated disturbance in most if not all of its sinuosities."
examples of this occur in the diagrams. It would seem
mething of the above nature was suspected by Humboldt,
iest investigator of disturbances. Humboldt was astonished
over the frequency with which nocturnal perturbations
d, sometimes recurring at the same hour on several successive

TABLE XXIV. *Cases in which the Earth's Magnetic Force*
ished One-thousandth of its Value or more in 1841-15

No. of Case	Date (Jan. 1, 1841 = 0)	Change of Force in Hundredthousandths	Solar Meridian
	1 to 89		
	110 to 116	104	11 to 12
	141 to 145	107	11 to 12
	189 to 190	116	
	211 to 214	177	
	221 to 222	110	1 to 14
	267 to 270	−115	1 to 10
	274	104	1 to 14
	291	−268	
10	325	150	13 to 14
11	361	164	
12			11
13		164	
14	416 to 417	148	
15	467 to 469	150	
16		110	
17		154	
18		102	
		101	
	634 to 635		
	646 to 648	126	
		118	
		100	
		100	
	696 to 698	110	
	709 to 710	201	
	740 to 742	142	

nights (Walker's *Magnetism*, p. 80). We would make t
gestions before dismissing the subject.

(1) It is imaginable that these changes are caused by
influence acting vertically on some susceptible region of th
then, inasmuch as they occur at the evening or early nigh
this region must be considerably to the west.

(2) The region must also have a proper motion of its
Capello's remarks. Is it possible that this proper motio
the whole from west to east, a motion which we know is
by meteorological weather, and in which it is imagined th
magnetical weather as defined by us likewise participates?

88. *Comparison of Declination Curves at Stations n*
other.—Messrs. Sidgreaves and Stewart (*Proc. Roy. Soc.*, Octob
have compared together certain curves of the Kew and Sto
declination magnetographs. These magnetographs are of
pattern and it was found that on ordinary occasions the de
traces at both stations were precisely alike. This was c
by placing the curves the one over the other, when they wo
to coincide even in their most minute features. In time
turbance, however, it was found that the motions exhibite
Stonyhurst curves were greater than those at Kew, and th
of Stonyhurst over Kew depended not so much on the
size of the disturbance as on its abruptness.

This feature of the comparison is exhibited in the f
table (XXV.), in which the excess of Stonyhurst over Kew
divisions is compared with the abruptness of the disturba
element being measured by the change occurring in that o

Excess (under 5)	Abrupt	Abrupt nes	Exc cep 2	Abrupt	
		12	1		
		26	1		
		9	1		
		5	1		
0	31	4	1		21
1	29	5	1		21
1	12				
4	5				

It is very desirable that further comparisons of this natur
be made.

89. *Auroral Displays.*—The auroræ are very frequent not co
near the magnetic poles, while in middle latitudes they a
variable accompaniments of all considerable magnetic dis
the equator they hardly ever occur.

There is a considerable variety in the forms of auro
displays, and it is possible that there may be more th
variety in the cause or causes which give rise to them.

Loomis (*Smithsonian Report* for 1866) describes th
varieties: (1) a horizontal light like the morning twilight
of day; (2) an arch of light which frequently extends
across the heavens from east to west, and cuts the magnetic

right angles, in the polar region have each to be have
at once, the lender luminous beam or column with
and often of a bright belt, of the corona, the centre of
invariably near the magnetic south but not always
coincident with it, and of wave- or flashes of light
auroræ exhibit the same annual variation of magnetic dis
and are most frequent about the equinoxes effect first
by Mairan. Kreutz in his *Meteorologie* gives the follow
which is applicable to European auroræ

ble XXVI. *Monthly Frequency of European Auroræ*

Mar.	April	May	June
110	47	151	4

...ormation ... bu-
...Americ... ... four months derived from one
...ntifuls ... ...ion at New Haven and Boston
...ly years ... ... New York, and two years' obser
...in Canada ... are represented in the following

ble XXVII. *Monthly Frequency of*

...	...
...	100
...	124

...ar- from t
...ance exist ... out the equinoxes
...ance exist ... disturbances go together, it is
...to make me that we should have great auroral displays in
...nevertheless are not. That is found to be the case, and in
...with table XXVIII. Wolf's proportional number of sun-
...spot frequency are compared with the number of auroræ
...d in Europe and America compiled by Loomis. It will
...from the table that ... of maximum auroræ coincide
...l with years of ... in the spot

Sun-Spot Number	Auroral Number		Sun Spot Number	Auroral Number
4	11	1707	136·9	4
24	7	1708	101·1	6
16	3	1709	81·1	6
6	1	1710	61·5	8
4	4	1711	38·1	6
	6	1712	14·1	
	6	1713	9·1	
	11	1714	13·1	
	15	1715	9·5	
	1	1716	6·1	
	2	1717	4·3	
	1	1718	3·1	
	1	1719	2·1	
11	10	1754	21·1	
40	1	1755	4	
	1	1756		
	1	1757		
15	15			
	5	1760	31·8	
	11	1761	74·1	
	10	1762	84·9	
	8	1763	41·1	
	4	1764	14·1	
			31·4	31
	1	1766	111·1	51
	1	1767	114·5	27
	1	1768	86·5	32
			68·6	
	14	1770	131·8	
	21	1771	111·8	
1				
1				
			114·7	
			111·1	

...graphical representation is given of the likeness
...subsist between the progress of auroral frequency, spot
...and declination

92. While the results now given leave little doubt as to t
of a connexion of some sort subsisting between sun spots
one hand and mag-
netic disturbances
and auroræ on the
other, yet it is
doubtful to obtain
evidence as to the
closeness of the
connexion between
aurora and sun
spots similar to
that which was
exhibited in § 82,
and which showed
the close connexion
as to amount of time
between sun spots
and disturbances.
Loomis has with
this view treated
auroræ in precisely the same way in which he treated distur
and has obtained the following table:-

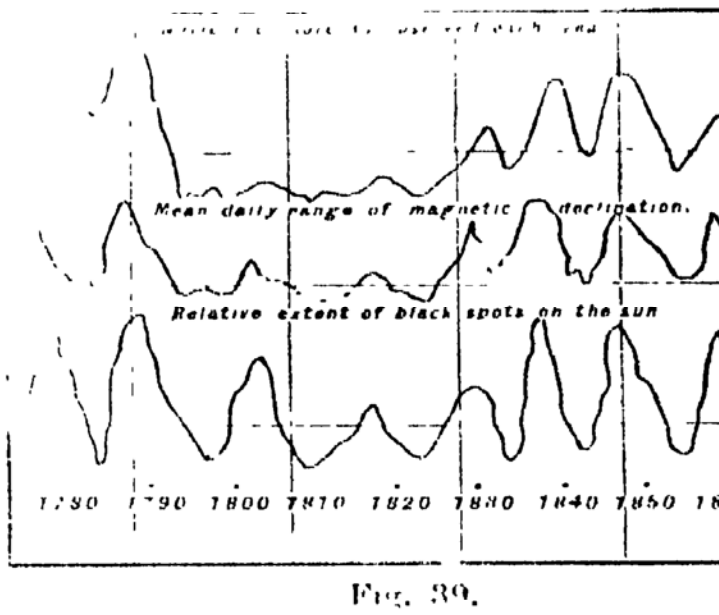


Fig. 39.

TABLE XXIX. *Extent of Spotted Solar Surface*

Days before Aurora.	Days after Aurora.
4	1
3	2
2	3
1	4

...of Days.

From which he concludes that "auroral observations in the
latitudes of America are generally accompanied by a ma
disturbance of the sun's surface on the very day of the auror

93. *Earth Currents.* These are electrical currents whic
place in the crust of the earth, and were first dete
W. H. Barlow (*Phil. Trans.*, 1849). At a later period the
and studied by C. V. Walker
Trans., 1862). They are now continuously recorded by photo
at the Royal Observatory, Greenwich. Earth currents are p
larly strong during magnetic disturbances. Sir George A
graphically compared together certain magnetic disturba
recorded by the Greenwich self-recording magnetographs a
simultaneous earth currents recorded by appropriate galvano
(*Phil. Trans.*, 1868), and find it almost impossible to avoid t
clusion that the magnetic disturbances are produced by ter
galvanic currents below the magnets. The like ness between
system of graphical representations is unquestionably very
ing. But, while there is no doubt an intimate connexion b
earth currents and magnetic disturbances, there is one
sideration which should make us pause before assigning the
as the complete and efficient cause of the latter. It
indicated by Lloyd:-

"When we examine the curves in which Mr Barlow has represented th
of the galvanometric deflections caused by the earth currents we observe
peculiarity of that course, continually interrupted by rapid reciprocatin
ments in which the needle oscillates from one side to the other of
alternately. These movements are similar to those of the magnetome
which we are familiar, but they are much more rapid and bear a large
tion to the regular changes. I have selected for calculation th
version made during the six hours commencing at 3 P.M. on May 29, 1
being a period of comparative disturbance. The sum of the change
division-scale needle during that period, on the Derby and Rugby
corresponded to 571 divisions of the instrument, the mean daily range
entire week being 114 divisions and the ratio 50. The sum
changes of the Greenwich declinometer during the same period was
minutes, the mean daily range being 14·1 minutes. In like manner th
the changes of the horizontal force was 0158 and the mean daily ran
The ratios according to the sum for the two magnetic elements, and it
remarkable that one tenth of the corresponding ratio in the case of the
magnetical change. We learn therefore that the rapid changes of t
currents are much greater in proportion to the regular daily changes
corresponding movements of the magnetometers."

We shall return to this subject in a subsequent part of this

94. *Incandescence as Terrestrial Magnetism caused by the M*
Kreil in 1841 was the first to point out that the moon has
influence on the position of the declination needle, and
afterwards the same fact was independently discovered b
Allan Broun. The more recent observations of Sabine
Broun, but especially those of the latter, have thrown mu
upon the nature of this action. As the lunar influence
generally large, it is necessary to free the observations fr
results of other inequalities, and this has been done by
observers above mentioned. The results given in Table
have been obtained by Sabine (see Walker's *Magnetism*).

95. Thus (1) the mean effect of the moon upon the
tion needle is to cause in each lunar day a double oscillati
Sabine has shown that the lunar influence upon the other m
elements is of a similar type. (2) The turning points f
hemispheres are in all cases not far removed from the luna

XXX. *Mean Lunar-Diurnal Variation in Declination*

r	Kew	Toronto	Peking	St Helena	Cape	Hobart Town
	62	18 9	4 2			5 9
	96	−16 1	3			8
−	84	− 9 1	−1 5			4
+	20	+ 0 4	+0 7			1
	06	+ 0 2	+2 6			
+	40	+15 9	+3 7			
+	90	+18 1	+3 9		7 5	4
+	113	+15 3	+3 0		4 9	3
+	96	+ 8 2	+1 3			1
+	47	0 4	0 6			
−	01	−10 7	−2 2			1
	55	−14 3	−3 1			1
	96	−19 1	−2 9			
−	113	− 16 3	− 1 7			2 1
−	54	+ 1 0	+ 0 3			
	06	+10 8	+1 0			
+	51	+17 8	+4 0		10 3	
+	85	+20 2	+4 8		10 1	
+	98	+17 4	+3 3			1
+	88	+19 2	+4 5			
	74	4				
	24					

table + indicates that the north end of the magnet the east and is to the west of its mean position

18. (3) In the northern station we have a maximum deflexion about the hours 0 and 12 and a minimum easterly about the hours 6 and 18, while in the southern stations on is the reverse of this. (4) The oscillations would appear ost decided at those stations, such as Toronto and Hobart hat are far removed from the equator.

unual Variation of Lunar Effect. Broun has recently with much success the peculiarities of the lunar influence at um, and has obtained some very unexpected results. His lt was that the nature of the lunar influence upon the de n needle at Trevandrum depends upon the time of the year, the southern type of lunar action predominates at Trevan ring the winter and the northern type during the summer. If we take the mean of the whole year, then probably hern type will be found to predominate.

ean Lunar-Diurnal Variation during the Day and during Nt.—Broun has shown that the action of the moon on the on needle at Trevandrum is greater in every month of the ring the day than during the night. The following table) gives the day and night ranges for the various months ir ratios.

0·82	0·47	0·49	0·41	0·24	0·36	0·40	0·29	0·31	0·23	0·41	0·69
0·24	0·26	0·23	0·22	0·11	0·11	0·22	0·18	0·21	0·21	0·20	0·24
3·6	1·8	2·1	1·8	1·6	3·2	1·9	2·1	1·5	1·1	0·1	1·0

uld appear from Broun's observations that there is a e of type as well as a difference of range.

unar Diurnal Variation with Reference to the Moon's .—Both Sabine and Broun have shown that the variation er for perigee than for apogee. Broun has found that the tio of the apogee effect to the perigee effect is as 1 to 1·21. He remarks that "the ratio of the moon's mean distance earth in the half orbit about apogee is to that in the half out perigee nearly as 1·07 is to 1, as the cube of 1·07 is rly, we see that the mean ranges of the curves for the two s are in the approximate ratios of the inverse cubes of the distance from the earth, as in the theory of the tides.

unar Diurnal Variation with Reference to the State of s Surface.—Kreil in a memoir presented to the Imperial y of Science in 1852 considers that the observations at and Milan tend to show the existence of a solar period in variations. Sabine (*Phil. Trans.*, 1856) has discussed the observations and also (*Phil. Trans.*, 1857) the Hobart Town ions with the view of deciding this important point, and has the conclusion that there is no systematic difference in the ration corresponding to the decennial period of the solar variation, but merely such casual fluctuations as might onably expected, considering the shortness of the period ney represent.

ve made a preliminary discussion of Broun's Trevandrum ions with the view of throwing a little more light on this. For this purpose we have taken the ranges of the lunar variations recorded by him for each month of each year. e in the first place grouped these ranges together into representing quarterly results, and have then compared these quarterly results for years of small and for years of great sun spot frequency,—assuming the years 1854 56 and represent the former, and the years 1857 62 to repre latter. We have thus obtained the following result:

TABLE XXXII. *Relation between Lunar-Diurnal-Ran Declination at Trevandrum and Sun Spot Frequenc*

	Great Sun-Spot Frequency.	Small Freq
February, March, April	0·501	0
May, June, July	·464	
August, September, October	·501	
November, December, January	·641	

It would appear from this table that such ranges are gr year of maximum than at year of minimum sun spot fr Nevertheless the proof is not conclusive inasmuch as with such lunar ranges we may have remnants of solar dist the tendency of which might possibly be to increase the ranges. Now such disturbances are more frequent at maximum sun-spots, and it might therefore be contend this tendency would be to increase the apparent lunar such times above the range corresponding to year of m sun-spots. On the whole we are not disposed to think evidence already adduced is sufficient to decide this as a matter of fact either in the one direction or in the othe

100. *Variation in the Diurnal Range of Declination upon the Age of the Moon.* Chambers (*Annals of Trivandrum*, 1876) and Stewart (*Proc. Roy. Soc.*, 1877) have found that the range of declination is greatest about th of new and full moon, a result recently confirmed by C. C of Bombay. The following are the results recorded by derived from 19½ lunations at the Kew Observatory.

TABLE XXXIII. *Variation of Diurnal Range of Decli with Moon's Age*, (0) *denoting New and* (4) *Full Moo*

Phase of n	(0)	(1)	(2)	(3)	(4)
Value of n	519	512	499	499	508

101. *Earth Currents caused by Lunar Influence.* Mr A J. S. Adams (*Nature*, March 3, 1881) has made use of a t wire the ends of which were connected with the earth, th Cardiff and the other at London. He observed the current wire every quarter of an hour from March 28 to April 2 He believes that such are earth currents, and that they lunar diurnal variation. There are during the lunar day a to this observer, four electrical maxima, two positive and tw tive, each maximum being bisected from the next by a point of no current. His results likewise exhibit a regular tion of la of the earth current variations behind th to the extent of nearly three but these require confirmation from further observations.

THE EFFECT OF SOLAR VARIABILITY ON THE METEOROL OF THE EARTH.

102. We may learn from the preceding paragraphs t sun exerts a more powerful influence upon the magne the earth at times of maximum than at times of minimu spots. It remains now to find whether a similar v obtains in the phenomena of terrestrial meteorology. I purpose we may divide the meteorological elements into divisions of pressure, rainfall, wind, and temperature, inqu what manner the are affected by solar inequalities.

103. *Pressure.* In 1871 Blanchet (*Memoirs of the Lit Society of Manchester*, 1871–72), from an analysis of eleve of the Radcliffe observations, Oxford, came to the conclu ars of maximum sun spots the maximum barometric occurred under north west wind and the minimum under west, while in years of minimum sun spots the maxim minimum pressure took place respectively under north an east winds. He came in error to the conclusion that, be difference in distribution of the convection currents of th the forces which give rise to the movements of the air appear to be greater in years of maximum than in minimum sun spots.

104. A study of the isobaric lines would appear to be method of obtaining information upon this important point well known that during summer the interior of large c have a peculiarly low and the surrounding ocean a pe high atmospheric pressure, while a different r reverse obtains during the winter months. May this be due to solar action, and we might therefore infer that w sun is peculiarly powerful the peculiar meteorological distribution found to be increased in prominence, while this will be di at times of comparatively weak solar influence.

The distribution of pressure has been traced with much ex by Indian meteorologists, including Messrs Archibald, H

Charles and Frederick Chambers, Eliot, and Hill and the
g conclusions is the result of their labours We may assume
Indo-Malayan region bri for the mean of the year a
re pressure probably below the general average of the
We might therefore imagine that during years of powerful
fluence the peculiarity would be increased Now these
s have found that in the Indo Malayan region the
r t abnormally low during time of maximum sun
Verkn, western Siberia r district which in the winter
t pre are decidedly above the average and we should
mine me that during years of powerful solar influence this
pre sure should be pec ecek But this is what
hi found in his discu the Russian stations to
nd with year of maximum ot
, Frederick Chambers hi ted the following laws as
g from his discussion of various meteor gical records:
mation of the sun pe ea are cu ded one months
le in the Indo Malay re ion by cor ponding abnormal
re variation, a inch barometer corresponds to mini
um-spo
n becomes below average for easterly than for westerly
In other words, the like other meteorological phenomena,
to try I prove we t to exist
ey therefore conclude that the barometric evidence is as
s in favour of the hypothesis that the sun is most powerful
of maximum sun pot

Rainfall Records of Rivers and Lakes In 1874 Mel
the Mauritius Observatory brought forward evidence
that the rainfalls at Mauritius, Adelaide, and Brisbane
the whole greater in years of maximum than in years
mum sun-spots Shortly afterwards it was shown by
(*Nature* December 17, 1874) that the same law we
le in the rainfall at the Cape of Good Hope and Madras
mo has since found that the law holds for a great num
ations, including eighteen out of twenty two European
ons with an average of thirty years observations for each
lts are exhibited in the following table (XXXIV):

		Inches
ter I	11	+ 13·08
stan	31	+ 19·65
burg	51	
( )	19	
n	11	+ 10·95
ht	11	+ 0·41
ter	19	
nwich		
m		+ 49·90
		+ 8·90
el		+ 13·84
ne		+ 2·57
		+ 38·46
o		+ 9·94
ton		1·55
land		+ 6·44
)		6·46
		11·80
		18
m		5·05
ano		1·77
n		16·86

l, I ppe r from t bservation or Gover
that th ntfi in Barba has an exception to
ne t about the times of minimum sun pot
We s in 1873 showed that the recorded dep
es f the Rhine, Oder, Danube, and Vistula fo
od from 1800 to 1867 was greater at the
t times of maximum sun pot frequency
e been confirmed by Prof Sor Brit
Sun Lat and Past Sc or Manchester,
evidence given by Fritz as regards the Elbe
one examined He divides each sun period,
ever h th, into twelve portions, and put
t r t he hts corresponding in time to
is He finds by this
ver repe cutting the same
that we take the whole or either half of all the recorded
ion , and whether we take the Lthe or the Seine The
ay ne ts ea ma ima ab the time of
m sun spot ater maxima about the
minimum sun spot T e ne to on too to think
Nile and Thame are ex those rivers in exhibiting a
m about the time of ma m pot and a subsidiary
m about the time of m m pot , only their sub-
ax mum greater than for Lthe and Seine.

November 25 and December 30
March 18, 1880
Nature vol ix, 1873.
Die Beziehungen der Sonnenflecken Periode zu den Magnetischen und Barometrischen Oscillationen Haarlem, 1878.

107. In 1874 G M. Dawson came to the conclusion
levels of the great American lakes were highest about
maximum sun spots In this investigation the value
evidence derived from rivers and lakes is no doubt great
that derived from any single rainfall station, inasmuch a
former case the rainfall of a large district is integrated and
larities due to local influence thus greatly avoided.

108 Dr Hunter, director general of statistics in India, has
shown (*Nature* November 1877) that the recorded
have been most frequent at Madras about the years of m
sun spots years likewise associated with a diminished rai

109. *Winds and Storms* Meldrum of the Mauritius
vatory found in 1872, as result of about thirty years'
tions, that there are more cyclones in the Indian Ocean
years th during years of minimum sun-spots
connexion between the two is exhibited in following ta

TABLE XXXV *Comparison of the Yearly Number of
occurrences in the Indian Ocean with the Yearly Nu
Spots on the Sun*

Cha ter as gards	Number of Storm	Number of Whole	Number of Strong Gales	Total Number of Cyclo
Max	1847			9
	1848			
	1849			10
	1850			
	1851			
	1852			
	1853			
Min.	1854		0	4
	1855		0	5
	1856		1	4
	1857		0	4
	1858		2	9
Max	1859		4	15
	1860		0	13
	1861		2	11
	1862		2	10
	1863		1	9
	1864		0	5
Min.	1865		0	7
	1866		1	8
	1867		0	6
	1868		0	7
Max	1869		2	9
	1870		3	11
	1871		3	11
	1872	1	1	13
			0	12

* Up to May 31

In 1873 M. Poey[6] found a similar connexion between th
canes of the West Indies and the years of maximum su
He enumerated three hundred and fifty seven hurricanes
1750 and 1873, and stated that out of twelve maxima ten
110 In 1877 Mr Henry Jenla, of Lloyd's, and Dr Hunt
that the casualties on the registered vessels of the United K
were 17½ per cent greater during the two years about m
than during the two years about minimum in the solar cy
111 *Temperature* — Baxendell, in a memoir already que
the first to conclude that the distribution of temperatur
different winds, like that of barometric pressure, is sens
fluenced by the changes which take place in solar activ
1870 Piazzi Smyth published the results of an importa
of observations made from 1837 to 1869 with thermomet
in the rock at the Royal Observatory, Edinburgh.
cluded from these that a heat wave occurs about every eleve
its maximum being not far from the minimum of the sun-sp
Sir G. B Airy has obtained similar results from the Green
servations In 1871 E. J Stone examined the temperatu
vations recorded during thirty years at the Cape of Goo
and came to the conclusion that the same cause which lea
excess of mean annual temperature at the Cape leads equ
operation of sun spot Dr W Koppen in 1873 discussed
lation to the connexion between sun spots and terrestrial temp
and found that in the tropics the maximum temperatur
follows a year before the minimum of sun-spots, while in t
beyond the tropics it occurs two years after the minimu
regularity and magnitude of the temperature wave are most
marked in the tropics.
112 The evidence now given appears at first sight to be
nistic to that derived from the other elements both of ma
and meteorology and to lead us to conclude that the sun
most when there are fewest spots on its surface. This co
will not, however be strengthened if we examine the subj
greater minuteness.

[5] *Brit Assoc Reports*, 1872.
[6] A Poëy *Sur les Rapports entre les Taches Solaires et les Ouragans de
de l'Atlantique Nord, et de l'Ocean Indien Sud.*

ifically we may regard the earth as an engine, of which is the furnace, the equatorial regions the boiler, and the gions the condenser. Now this engine may be supposed to the following manner. Hot air and vapour are carried e upper regions of the atmosphere from the equator to the means of the anti trade winds, while in return the cold is carried along the surface of the earth from the poles to ator, forming what is known as the trade winds. When sun's heat is most powerful both trades and anti trades- e most powerful likewise. But we live in the trades rather the anti trades in the surface currents, and not in the urrents of the earth's atmosphere. When, therefore, the ost powerful is it not possible that we might have a part strong and cold polar current blowing about us? The same ould happen in the case of a furnace fire: the stronger the more powerful the hot draught up the chimney, the more also the cold draught from without along the floor of the It might thus follow that a man standing in the furnace- ar the door might be chilled rather than heated when the itself was roaring loudest. In fact temperature is a phe no- due to many causes. Thus a low temperature may be due deficiency in solar power, (2) to a clouded sky, (3) to cold to cold winds, (5) to cold water and ice, (6) to cold pro evaporation, (7) to cold produced by radiation into space ord has recently shown that at certain Indian stations ean temperature occurs when there is an unusually large and a great amount of clouds, a result in accordance with lusions previously enunciated by Professor Piazzi Smyth. of maximum and minimum temperature must not there too closely associated with a maximum and minimum of wer.

Considerations of have induced Stewart to (*Nature*, June 16, 1881) that the true connexion between s and terrestrial temperature is more likely to be discovered dy of short period inequalities of sun spots than by that of en-year period in which there is time enough to change the etric state of the atmosphere and the whole convection of the earth. He has accordingly discussed at some length innent sun spot inequalities of short period (about twenty- rs), and endeavoured to see in what way they affect terres- mperature. From this it appears that a rapid increase of s is followed in a day or two by an increase of the diurnal ture range at Toronto. Now an increase of diurnal tempera- ge most probably denotes an increase of solar energy, and has led to associate an increase of solar heat with a large ment of spots. This, however, is a point which requires nvestigation.

General Conclusion.—On whole we may conclude that eorological motions and pre of the rth are probably tive at times of maximum sun-spots, and that they agr gnetical phenomena in representi g the ra- most power uch occasions, although the evidence derived from meteor- not so conclusive as that derived from magnetism.

ETICAL VIEWS REGARDING THE CONNEXION BETWEEN THE TE OF THE SUN AND TERRESTRIAL MAGNETISM

Principles of Discussion. In the following discussion we ly to advance a working hypothesis, with the view of sug- further inquiries into the subject of terrestrial magnetism. s therefore desirable that we should limit ourselves to such or possible causes as are known to exist and to operate on h. These various agents or causes will be described, and endeavour to show that converging lines of evidence point al cases to certain of these as being most likely to produc rticular type of effect which is exhibited in terrestrial sm. This course will in our view most readily suggest inquiries with the view of confirming or disproving the points of this working hypothesis. Believing that the tion of any unknown cause can only be justified when auses have been found insufficient to account for the pheno- question, we have not advocated any direct magnetic action un upon the earth. We have refrained from this for two —first, because from what we now know of the sun it to us unlikely that it should exercise an influence of this pon the earth, since a body at a high temperature possess- y strong magnetic properties is unknown to us; and, , we shall see further on that such an influence will not the best-understood magnetic changes, nor is there in our any magnetic phenomenon for the explanation of which it absolutely necessary to resort to this hypothesis. In fine, presuming to deny the possibility of unknown influences nature, it does not appear to us that the time has yet arrived e are called upon to resort to such as necessary aids to the y of further truth.

Nature of Solar Variations.—It is quite certain that there ability in the visible appearance of the sun's disk, which sometimes a comparatively large amount of spotted area while on other occasions it is entirely free from spots. No been remarked by Thomson that were the sun an incandesce its surface would become cool in a few minutes. The act property which our luminary possesses of pouring out conti a vast amount of radiant energy must unquestionably depe machinery of great power by means of which fresh hot are rapidly brought from the interior to the surface, whi particles which have given out their light and heat are hurried downwards to be recruited from the great store heat in the sun's centre. In fine, a gigantic system of co currents of this nature forms the essential condition witho the sun would not be able to continue shining as it does.

The mottled appearance of the sun's disk as seen through scope denotes no doubt the existence of a vast system of as and descending currents, the hot matter rising from be neat denoted by the brighter portions and the cold matter des from above by the darker portions of the structure. On occasions and in certain regions of the sun the scale of these ments is greatly increased, and we have a huge uprush o and a corresponding down-rush of black matter. In fine, t known sun spot with its bright faculous appendages. W sun-spots are very frequent we should therefore expect the co system of the sun to be particularly powerful, and the great and size of the red flames on the higher portions of the co system observed around the sun's limb on such occasions us in this supposition. And if the convection system of be particularly powerful when there are most spots on its it would seem to follow that the radiation from our luminary on such occasions be particularly powerful also. The spec leads us to the same conclusion. It would appear from th vations of Lockyer and others that at times of maximum s certain definite regions of the sun when examined spectros pres appearances of a very high temperat

We are unable to confirm these conclusions by direct obse of the sun's heating power. Actinometrical determinatio not yet been made with su ent accuracy and pe this point experimentally. We have, he direct nature derived from terrestrial magnetism and met all tending to make us think that the sun is most powerfu times of maximum sun spots. We have seen that on such the solar influence upon the magnetism of the earth is pe powerful in more than one way, and that its influence on logy is then peculiarly powerful also, although we are not s of this latter fact as of the former.

We may therefore take it to be most probable that the most powerful at times of maximum sun-spots, and proce this basis to propound the two following questions: in place, what is the the solar influence upon te magnetism? and, secondly, why is this influence so much mo perceived than certain forms of solar influe pon meteo

117. *Diurnal Magnetic Variations. Hypotheses regarding* The various speculations on the cause of these phenomen ranged over the whole field of likely explanations. (1) It supposed that the sun acts directly as a magnet upon the ma of the earth. (2) It has been imagined that convection established by the sun's heating influence in the upper re the atmosphere are to be regarded as conductors moving acr of magnetic force, and are thus the vehicle of electric which act upon the magnet. (3) Faraday, reasoning f discovery that oxy paramagnetic ld become weak power when heated, and stronger wh cold, supposed sun by heating certain portions of the atmosphere rende less magnetic while others, not subjected to any heating i are rendered more magnetic. The action is equivalent t placement by means of the sun of the magnetic matter of th and involves a displacement of the lines of force. Here solar action is associated with the great mass of the atm (4) It has been supposed by Christie and by De la Rive heat of the sun produces in the atmosphere and in the earth electric currents which produce the daily magnetic varia ti is not easy to perceive how we could have thermo-electric in the upper regions of the atmosphere but there is no objection to the generation of such currents in the crust of th Thus the first hypothesis has no reference to the atmo phe ever, the second deals with the upper atmosphere in con tact with the great body of the atmosphere, while the fourt have ventured to modify it, has reference to the crust of th

118. *Discussion of these Hypotheses.*—Dr Lloyd and Chambers[1] have both shown that direct solar magnetic ac not account for the peculiarities of the diurnal magnetic va Again (§ 48) we have strong evidence that changes in the the daily magnetic variation lag behind corresponding solar in point of time. Now this kind of behaviour is inconsist direct magnetic action, and points rather to an indirect effect caused by the radiant energy of the sun.

[1] *Proc. Royal Irish Academy*, February 22, 1858, *Phil. Trans.*, 18

Let us therefore dismiss the hypothesis of direct action and that of Faraday. We know both from observations of the ion and horizontal force (*Proc. Roy. Soc.*, March 22, 1877, *Phil. Trans.*, 1880, p. 341) that the action of the sun in pro diurnal variations of the declination is one and a half times erful at epochs of maximum as it is at epochs of minimum t frequency. It is hardly credible that there should be great differe in heating effect he great bulk of the atmosphere. Moreover there seems to have never d such a difference nor is there any marked corresponding ity of diurnal temperature range. Meteorological evidence garding the diurnal var due to the upply the sun of the great of oxygen which constitutes gnetic portion of the earth phere. Again, as there is ondensation of hot ocean va southern hemisphere during ne and in the southern hemisphere during the December there ought according to this theory to be a well marked variation of the magnetic meet the earth, the northern hemi be one at the one time differently affected from the southern ne no trace of such phenomenon, the annual and semi variation which we have already described (§§ 64–67) being confined to land and none of them very large.

Precisely the same objections apply with even greater force earth by other ... It seems impossible to allow that any effect on the earth caused by the sun can be one and time a great at epoch of maximum and at epochs minimum spot frequency.

We are thus driven by the method of exhaustion to look ... on of the earth's atmosphere probable ... solar influence in producing diurnal magnetic chang...

It need hardly be said that the only conceivable magnetic cause of operations in such regions must be an electric current ... know from our study of the matter that there are such ... in these regions. ... continuous near the pole and occasional ... latitude. A good deal has been said about the difficulty ...ining a daily set of current to be generated in regions of ...perfect conductivity; but we shall see by and by (§ 134) ...re is good ground for imagining that their conductivity may ...e greater than has hitherto been supposed.

Analogies between Meteorological and Magnetical Systems of the Earth. We have in the first place a zone of maximum ter... temperature, the middle line of which is nearly coincident ... with the geographical but likewise with the magnetical

Again, there are probably in the northern hemisphere ...es of greatest cold, which possibly do not greatly differ in ... from those spots which we have called magnetic.

About the southern hemisphere we have no information ... Furthermore, we believe that the hot air is carried from the zone ...est heat to the place or places of greatest cold by means, no ... of the return trade which blow in the upper atmosphere.

The hot air diverges at this zone, one part blowing northe... in the northern and another southwards in the southern ...here. Now this zone, from which the anti trades divide, ...annual motion of its own, being found farthest north at the ...stice and farthest south at that of December. Probably too ...thern system is strongest in June and the southern system ...ember. If we now turn to the solar diurnal variation of ... declination, we find here also a northern and a southern (§ 11), the type of the one being antagonistic to that of the ... We find also that the northern system is strongest in June ... southern system in December.

... it seems probable from what we have now said that the ... , strictly speaking, have reference not to the geographical ... and poles but to the zone of maximum and the poles of ...e temperature. Now, turning once more to the diurnal ...on of the declination needle, it seems probable that the ...ance last we must be interpreted as having a reference ...the geographical but to the magnetical pole (§ 15).

... analogies must be taken for what they are worth. Our ...n into discussing them has reference to the previous discussion, ...hich we expect that the magnetic influence of the sun is ...ly due to currents in the upper region of the atmosphere—...se of which we were content to leave in abeyance. Now ...nalogies we are led to suggest that this cause whatever ...y perhaps be found to be related to the convection system ...earth on the one hand and to the magnetic system on the ...

Analogies between Meteorological and Magnetical Weather. — ...marks are borne out by the further analogy which appears ...st between what we have called meteorological and mag... weather. Let us take the solar-diurnal variation of declina... Not only is the variation similar in form to the diurnal ...n of atmospheric temperature (§ ...), but the ranges of the ...ve a similar annual variation. And, as the element of ...ological weather affects the orderly march of the temperature ...must be element... etical weather affects the orderly ...f the declination range.

Furthermore, just as temperature-range weather progress... west to east (§ 52), so declination range weather would seem ...gress in the same direction as the other (§ 52) although at a ...rate. It will doubtless require a more extended investiga... make us quite sure of this latter point; nevertheless we ... perceive the validity of the objection that is sometimes made ... hypothesis of progress in magnetic weather on the groun... magnetic influences are known to affect all portions of th... simultaneously. It will, we think, be perceived that in th... statement no supposition whatever is made with respect to t... of propagation of a magnetic influence through the earth, th... be instantaneous or it may not. It is supposed that we ha... a travelling cause of excitement, say a travelling cause of e... in the upper regions of the atmosphere which progresses from ... east and always ... its greatest marked effect above those ... where it passes just as the sun itself in passing from east ... produces a magnetic effect the various phases of which trav... east to west with the sun which causes them. We think too t... hypothesis of travelling causes of magnetic change is streng... by the fact observed by Capello and described in § 97.

124. If, however, the objection made to this hypothesis ... the fact disclosed by Broun (§ 80) that changes of horizont... appear to take place simultaneously at distant parts of the ...urface, then we think that analogy should lead us not to d... possibility of a travelling magnetic excitement, but rather to ... the possibility of there being some meteorological influence ... like the magnetical one above mentioned, may be found ... place simultaneously at different parts of the earth's surface. Broun (*Proc. Roy. Soc.*, May 11, 1876) has given us prel... evidence for supposing that there are simultaneous barometri... tions. For instance, there was a barometric maximum at ... Town, Peking, the Cape, St Helena, Makerstoun, Su... Madras, Simla, Ekaterinburg, and Bogoslovsk about the ... March or first day of April 1845. There appears to have ... simultaneous increase of the horizontal force of the earth at ...stations much about the same time, and there also appears ... been a short period maximum of spots on the solar surface. ... has likewise registered simultaneous barometric variations a... pore, Madras, and Simla, for the first three months of 1845 ... these it would seem that simultaneous barometric maxi... possibly coincident with rapidly increasing sun-spot areas.

Again is it not absolutely certain that if there is a sudden ... of solar power this must mean an increase of heat comm... to the earth, although it may be difficult or even impos... tain experimental evidence of such a fact? All these a... ts which require further investigation.

125. *Further Remarks on the Solar-Diurnal Variation of Declination.* In § 24 we have asked how far the action of t... diurnal force upon a freely suspended magnet is due to ... acting directly upon the magnet and how far to a change p... in the magnetism of the earth. Some light appears to be ... on this point by the behaviour of the needle at places ... magnetic pole where the dipping needle is nearly vertic... opposite sides of this locality the declination needle points ... side directions. Now suppose that we have a set of such ... placed all round this region. It seems a legitimate genera... from the observations described by Sabine (§ 45) to conclu... if we place ourselves above the centre of any of these ne... S A M., and look towards its marked pole, we shall find it ... case deflected towards the right, while if we look towards t... pole at 2 P.M. we shall find it deflected to the left. No... imagine that at 8 A.M. there are above these magnets (in th... atmospheric regions) electrical currents of which the ho... components form a set of positive currents flowing from the... all sides, then by the known laws of such currents the mark... of all these needles will be deflected towards the right. A... P.M. the resolved portions of such currents should be ... towards the pole, then the marked poles of all these needles ... deflected towards the left. It thus appears that this ... magnetic behaviour might easily be explained by a hypo... distribution of currents. And in fact in such regions we h... dubitable evidence of the existence of currents in the upper ... of the atmosphere. On the other hand this behaviour co... easily be explained by the hypothesis of some definite ter... magnetic system set up by the solar influence in the earth ... such a case we should imagine that similar poles of all the ... ought to be deflected towards the pole of this temporary ... which is not the case.

126. Another point for consideration is the possible con... of the solar-diurnal variation. For we may imagine (1) t... sun acts in such a manner as to produce a diurnal variation ... may also act like the moon (§ 91) and produce a semidiurna... tion; (3) these possible actions may be accompanied by ... currents in the upper regions of the atmosphere and in the ... the earth; (4) it is possible that the sun's rays may affe... variations or some of them in the way in which Broun fou... the lunar variation at Trevandrum was affected by the s...

d by him that the lunar action was considerably increased
e sun was above the horizon of the place.

We have pointed out (§ 119) that, while there is a marked
in many respects between the diurnal variation of declina
l that of atmospheric temperature, we have yet no long
netuation of the diurnal range of temperature at all com
in magnitude to the magnetic fluctuations. It does not,
, seem difficult to account for this difference if we imagine
magnetic fluctuations take their origin in the upper atmos
regions, while the temperature fluctuations are due to the
gions of the earth's atmosphere. For, as the sun increases
t from times of minimum to times of maximum more pot
ey, we may imagine that a continuously increasing amount
ous vapour will be taken into the earth's atmosphere.
the experiments of Tyndall and others induce us to think
air would under such circumstances become more and more
or certain rays of the sun, and thus continuously elect
portion of the sun's heat would be able to penetrate into
er atmospheric regions. This latter influence would there
rate to cloak perhaps to a considerable extent, the effect of
's increasing power; and this may very well be the reason
temperature range at the earth's surface does not exhibit
e eleven yearly inequality as the declination range.

There seems, however, reason to believe that if we go from
short period inequalities there is a much greater similarity
range of the magnetical and the meteorological changes.
The explanation seems to be that in the short-period changes
has not time to alter sensibly the constitution of the atmo
and hence the proportional increase of effect experienced in
per atmospheric regions is more nearly the same as that
ced near the surface of the earth.

Magnetic Disturbance.—There is strong evidence that the
portant disturbances break out very nearly simultaneously
ly different parts of the earth, and that they even affect both
heres at the same time. Very little, however, is known
e *modus operandi* of the forces concerned in producing such
nances. For instance, it is not known whether a disturbance
ently affects the magnetic state of the earth, *e.g.*, whether
he magnetic elements before a disturbance become sensibly
t in value from what they were after the disturbance has ceased.
On the other hand we know (1) that disturbances break
the very day when there are rapid changes taking place
sun's surface (§ 83), (2) that [illegible] ly begin by
tarily increasing the horizontal force, but that the
changes, so that during most disturbances the horizontal
diminished (§ 86); (3) that large disturbances take place
rticularly about the equinoxes, when, we have reason to
the horizontal force of the earth is at a minimum (§ 77).
not possibly conclude from these habits of action that at
f disturbance the earth is magnetically in a delicate state of
rium, perhaps having more magnetism than its surroundings
strictly warrant, and being therefore inclined to part with
nd that a sudden increase of solar activity tending, as such
probably do, at first to exalt the magnetism of the earth,
eless destroys its magnetic balance and gives it ultimately
ortunity of parting with some of its magnetism? This can
regarded as a speculation, inasmuch as we do not know
r or not a disturbance produces any permanent influence
e magnetism of the earth.

Auroras and Earth Currents.—There is no doubt that these
ena denote electric currents in the upper regions of the
here and in the most conducting crust of the earth. The
dispute is with respect to the origin of such currents.
re inclined to regard auroras as peculiar manifestations of
herical electricity in high latitudes, while others imagine that
splays are rather of the nature of induced currents generated
ll but abrupt changes taking place in the magnetism of the
The advocates of the first view do not deny that currents
place somehow in the upper atmospheric regions will have their
ons modified, to some extent at least, by the inducing influence
netic changes. Nor will the advocates of the induction hypo
e disposed to deny the possibility or even the certainty that
s due to atmospherical electricity and not dissimilar to some
aurora take place in some region of the atmosphere. But the
ty regard auroras rather as the cause than as the effect of mag
anges, whereas the advocates of induction regard such displays
as the effect than as the cause of changes somehow produced
nagnetism of the earth. And here it is desirable to remark
e advocates of the induction hypothesis take for granted the
ism of the earth and the changes thereof as phenomena for
they do not profess to account, whereas unless we go to some
ely unknown cause (and this is against our present pro
e) we must look to atmospherical electricity as likely to throw
on the origin of terrestrial magnetism. We cannot therefore
e with regarding atmospherical electricity as an agent which
ve played an important part in the development of the
magnetical condition of the earth, but we are yet of opinion
that, under the present state of things, the theory which be
atmospheric electricity must largely be supplemented by the
tion hypothesis if it is to explain the peculiarities in type
of the phenomena which observation brings before us.

131. Professor Tait in his essay on thunderstorms attribu
kind of aurora to atmospherical electricity. Such an auro
believes, the manifestation of almost continuous discharg
those given by a Holtz machine in a vacuum tube. The
condensation of vapour going on very slowly in very large
es. The electricity is due to previous contact of particle
and vapour. The result is that the air particles in the nay
time acquire a definite difference of potential from those of ve
so that, when the latter aggregate, a nimbus region well charge
sult, and this discha[illegible] to the oppositely elect[illegible]

132. Again, Professor Stokes, without attempting to ac
the origin of atmospherical electricity, has produced an hy
with the view of explaining the intimate connexion w
between auroral displays, earth currents, and magnetic cha
the one hand and outbursts of sun-spots on the othe
clears that two somewhat distant atmospheric regions A an
charged, let us say, with positive and negative electricity
tively. A induces in the ground below it a charge of negat
charge of positive electricity. At first things are held in thi
A cannot discharge either through the upper atmospheric
to B or through the lower regions to the ground beneath
B in a portion precisely similar. Presently, however, in
of the radiative power of the air produced. Such an
would probably imply not merely an increase in general a
but a particular increase in such a time rays as are absorbed
upper regions of the earth's atmosphere. The layer of air
between A and B will therefore speedily absorb such ra
perature will rise, and as is known to be the case for ga
electrical conductivity of the stratum will be in
charge will therefore ultimately take place in the upper
between A and B; this will relieve the charge of negat
positive in the ground immediately beneath A and B an
charges will therefore rush together through the ground, pr
an earth current. This earth current will be in the oppos
tion from the atmospheric current, and the two will com
represent, virtually at least, if not absolutely, a closed circu
will of course affect the earth's magnetism and produce a di

133. This hypothesis certainly affords a good explanatio
promptness with which disturbances follow increased solar
[illegible] to resort to some unkn
cult to think of any other possible explanation of the fact
an explanation appears too to receive corroboration from
(§ 97) [illegible] lunar influenc[illegible] rth's magnetism a
at Trevandrum is greater during [illegible] day than during the
greater possibly too at times of maximum than at time of m
sun-spots. We are therefore dispo[illegible] in
the way in which increased solar activity produces ge
turbance are the best that have been brought forward.

134. This does not, however, decide the disputed point
these elevated currents are due to atmospheric electricity
lar to induction. The argument against the possibility of
currents in these regions is derived from experiments with
tubes, such as those recorded by Messrs. De la Rue and Muller
would seem to indicate that enormous differences of potenti
be required to produce electrical currents in elevated region
the atmosphere is very rare.

Indeed, on account of these experiments, the measure
the old observers, who sometimes assigned a height of mo
100 miles to the aurora, have been called in question, and
been supposed against direct observation that these phenome
always occur in regions [illegible] elevated. It would ap
that such reasons were influential in determining Professo
to regard the aurora as produced by atmospherical electricit
as we know from ordinary lightning, presents us with
differences of potential [illegible] but it is to be remarked that he
fully guarded himself against the possibility of laboratory
ments with vacuum tubes not being strictly analogous to th
takes place in the upper atmospheric regions. Now it would
that recent experiments by Hittorf throw some doubt u
strictness of this analogy. The high difference of potential
to force the current through vacuum tubes is, according
observer, due in great part if not entirely to the pass
from the terminal to the residual air of the tube, so that th
tial requisite to pass a current through a tube of double l
not sensibly greater than that required for a tube of single
The whole subject is one which demands further investi
meanwhile we are not disposed to accept the [illegible] auro
tion currents taking place in the upper atmospheric region

135. Let us now consider whether the form and type of t
currents observed during disturbances favour the presence
tion to any sensible extent. The remarks of Dr Lloyd
quoted (§ 93), which are confirmed by the [illegible] observ
seem to be decisive in this respect. These may be interp

owing manner In a magnetic disturbance we have fre- a general displacement of the various elements the hori ce, for instance, now on the curve which represents this considerable displacement a large number of comparatively t very abrupt changes are superimposed These latter es are invariably accompanied by quick strong alter from positive to negative of the earth currents, while the low motion, although it may be of large range, hardly to have any galvanic equivalent or no The would appear the induction hypothesis, according to which small but magnetic changes should give rise to strong earth currents ly positive and negative without reference to the position magnet above or below the horizon at the time

Another fact bearing upon the hypothesis mentioned From the it would appear that on ordinary occasions the ording the process of the declination needle at Kew and r traces as nearly as possible identical but on occasions of ge the range at Stonyhurst is greater than that at Kew by ut not apparently in dependence in any way on the magnitude of turbance at the time of disturbance The introduction of the of abruptness would appear to be in favour of the mix n of earth currents with the phenomena n

surface Airy has not been able to detect any resemblance between the diurnal progress of the magnet and that earth currents It seems, however possible that the peaks dotted lines 7 7 may form an important integral ne daily magnetic movement and there even appears to be dence that the annual progress of the earth currents bears resemblance to that of the peaks and hollows than it does progress of the monthly curve which is usually held to the diurnal variation But this is a question which can ided by more prolonged investigations

To conclude, there can be no doubt that at times of great ab disturbance we have currents in the upper atmosphere and in the crust of the earth which, so far as we can see, her be due to atmospherical electricity or to induction, or tance of both The proportion of the mixture can only be by further inquiry and by the multiplication of stations mospherical electricity and earth currents may be observed t to be mentioned that the experience of the Kew observers thus extends, is unfavourable to the hypothesis of a on between aurora and atmospheric electricity.

Lunar Solar and Lunar-Solar From the fact observed by 8 that the moon's magnetic influence varies nearly as inversely proportional to the cube of the moon's distance earth it is impossible to refrain from associating it either ectly or indirectly with something having the type of tidal action, what way this influence operates we cannot tell. Is it that the earth current observed by Adams (§ 101) are n current generated in the conducting crust of the earth magnetic change caused by the moon, inasmuch as these were found by him to be strongest in one direction about t hours 3 and 15 when the lunar diurnal magnetic effect me most rapidly in one direction (§ 95), while they were be strongest in an opposite direction about the 9 hours , when the lunar-diurnal magnetic effect is changing most in an opposite direction?

We might perhaps expect from the analogy of the tides that should possess a semidiurnal magnetic effect similar in type of the moon Now Sir George Airy in his analysis of the ments observed at Greenwich (*Phil Trans*, 1870) during Hampton magnetograph has detected in such currents a semi- inequality having maximum in one direction at solar hours , while it has maxima in the opposite direction at solar hours The reference to solar hours in this inequality is thus similar to that which the inequality observed by Adams lunar hour

If there be induced currents of this nature in the crust of h we might reasonably suppose that there will be correspond- ents in the upper regions of the earth's atmosphere, and in ce with the suggestion made by Professor Stokes (§ 132) t perhaps suppose that these currents will be strongest when r atmospheric regions are heated by the sun and thereby l better conductors It is not possible to suppose that the of daylight upon the lunar magnetic effect discovered by § 97 may be due to this cause, and may it not also induce cognize the possibility of a maximum lunar influence (§ 99) of maximum sun-spots when there is reason to believe that diation is most powerful?

Secular Variation —Sabine and Walker are agreed in g this variation as cosmical in its origin and they are ly of opinion that it is caused by some change in the con- f the sun. It seems difficult if not impossible to attribute ything else, since the terella of Halley cannot be now as having a physical existence. Again it is more than it is probable—that there are solar variations of much longer period than eleven years On the other hand the given in § 81, tending to show that an access of sun-spots pr change in the magnetic state of the earth consistent with t thesis that the magnetizing power of the sun has th augmented, requires to be confirmed by more observatio even then it is certain that this magnetic change produc considerable change in spotted area is extremely small. W therefore regard the very large secular magnetic change as non-cumulative magnetic influence of some long continu variation, nor does it seem possible to attribute the cl solar influence at all unless we regard this influence as pr results of a cumulative nature

It is possible however, to regard solar influence as prod cumulative effect in one of two ways, or by a combination For Time is necessarily an element in any influence acti the hard iron system of the earth -presuming the earth to such a system. There are in fact indications in the result that a system of this kind is perhaps connected with the A pole yet, even allowing the influence of time, it seems dif account for the peculiarities of the secular variation by a thesis of this nature But (2) any long continued variation power would no doubt act cumulatively in producing an in diminution of the large pear-fields round the poles of the ea the course of time this cumulative change in the extent position of these might perceptibly alter the distribution convection currents of the earth—and these, according to th herein indicated, might in their turn perceptibly alter the magnetic system

113. *Concluding Remarks.* If we agree to look for an exp of terrestrial magnetism and its change to strictly terrest causes, we may derive some assistance in our search from s siderations connected with symmetry as enable us, for exa once to perceive that when two perfectly similar things are together we cannot have electrical separation, because the reason why the one should be positively and the other ne electrified Suppose then that an observer stands at the and looks towards the north, and then turns his back t north and looks towards the south. In the first position regard the northern system of meteorological processes and in and in the second the southern. Now if symmetry obtain lutely in these systems that is to say, if the observer, wh regarded the northern or the southern system of things, either case precisely similar phenomena at his right hand his left then we should see no reason why the earth shou magnet, or why one hemisphere should be the seat of magn the one kind rather than of the other If then we regard m logical processes and motions as being in some way the terrestrial magnetism, we must direct our attention to that element which causes a want of perfect symmetry such as described in meteorological phenomena. This element ca be anything else than the rotation of the earth, which is f to right to an observer facing the north, but from right to l observer facing the south.

114. Now if we look upon the terrestrial meteorologica modified by the earth's rotation as having produced some cho past the magnetic state of the earth, it seems most na regard the system which formerly produced this magnetic being likewise that which at present maintains it in its ef and which also accounts for the various magnetic change take place It would seem therefore that terrestrial met and terrestrial magnetism are probably cognate subjects, a they ought to be studied together in the well-founded hope phenomena of the one will help us to explain those of the

Furthermore, if these meteorological processes derivi one sided character from the earth's rotation—are to be as accounting not only for the origin but for the mainte the earth's magnetic system, we can hardly fail to imag these processes must derive part of the energy which they from that of the earth's rotation. Tidal energy we know is from this source; but we must likewise regard part of th displayed in convection currents whether in the air or in t as derived no doubt from the same source. And we may allow that in the phenomena of tidal action, as well as in convection currents of the air and ocean, there may be, no a transmutation of actual energy directly through friction n but likewise a transmutation of it, ultimately perhaps in but first through the intermediate agency of electrical which serve to maintain the magnetic state of the earth produce magnetic changes.

Now if this be the case, if there be a large and complicated of tidal and convection currents all tending to change the energy of the earth ultimately into heat, whether directly friction or indirectly through the medium of electricity, it impossible with the present state of our knowledge to calcul the smallest pretensions to accuracy at what rate this transm is taking place, and hence at what rate the velocity of th rotation is being slowly diminished.

METHODISM

I Wesleyan Methodism

history of Wesleyan Methodism embrace (1) the Methodism of Oxford, which was strictly An lic dly rubrical, though it was also more than rubrical evangelical Methodism of the Wesleys after th ion (in 1738), of which the Wesleyan doctrin ion and sanctification were the minute to and ion, while preaching and the class meeting were th motive and organizing forces a movement wh Wesley's death had developed into a form contain least in embryo all the elements of a distinct organization although in it neral d ctrin iberate claims it purported to be only an unattach l l society and (3) Wesleyan Methodism in th of Wesley, which, by steps at first rapid and aft r though leisurely, distinct and consistently unfold dependent position and his own ultimate attainment as a church

Oxford Methodism The beginning in November 1729 John Wesley, returning to Oxford from Lincolnshire, where he had been serving his father a curate, found that his brother Charles, then at Christ Church, had gathered a number students to join him in observing weekly communion. John Wesley's reconsecration to God, his infant association. Then first dated the custom of the weekly communion was the immediate fruit of the Greek Testament with which they paired rubrical observance of fated hours for private devotion visitation of the sick, of the poor and of prisoners, instruction of neglected children. They never themselves adopted any common denomination but of the list of derisive names they received from without that "Methodists" prevailed, sobriquet the fitness of which, indeed, as descriptive of one mechanical and unspiritual feature of Wesley's character (which he impressed also on his followers), was undeniable.

The first Oxford Methodism was very churchly. Between 1733 and 1735, however, a new phase was developed. Its adherents became increasingly patristic in their theories and tendencies, and Wesley came much under the influence of William Law. In regard to this period of his history, Wesley himself says that he

> "set the bow too far by making antiquity the ultimate rule, as subordinate, rule with Scripture by clinging to the writings, by extending antiquity so far by which in practices to have been universal in the Church, but by so, by not considering that the [illegible] provincial could bind only that province and the [illegible] general only those provinces which represented them. But of those decrees were adapted to particular times and, consequently when the circumstances ceased, must bind even those provinces."

It was in 1736, during his residence in Georgia whither he had gone as a missionary of the Propagation Society, that he learnt those lessons. Notwithstanding his asceticism and his rubrical punctilios the foundations of his High Churchmanship were gradually giving way. When returned to England he had already accepted the doctrine of "salvation by faith," although he had not yet learned that view of the nature of faith which he was for years to teach for half a century. He had, however, written in the journal of his homeward voyage he tells us that, "in the ends of the earth,' that he "who went to America to convert others was never himself converted to God." In this result his Oxford Methodism came to an end.

The original Methodism of Oxford never at any one time seems to have numbered as many as thirty adherents. There was a set called "Methodists," but there was no organization, no common bond of special doctrine or discipline; there were habits and usages mutually expected upon, but there was no official authority, only personal influence. The general features of the fraternity, if such a unity it may be called, seem to suggest closer affinities with the "Tractarian" school in its earlier stages than with anything else in modern history, and the personal ascendency of John Wesley may remind us in some measure of the influence exercised a century later by Dr Newman. There was no more any germ of permanent organization in the Oxford Methodism of 1735 than in the patristic and "Tractarian" school of Oxford of 1833.

Methodism after Wesley's Conversion. John Wesley landed at Deal, on his return from Georgia, on February 1, 1738. His journals on the homeward voyage, says Miss Wedgewood,[1] "chronicle for us that deep dissatisfaction which is felt whenever an earnest nature wakes to the incompleteness of a traditional religion; and his whole life, compared with his two years in Georgia, makes it evident that he passed at this time into a new spiritual region." . . . . . "By Peter Bohler," in the hand of God," he writes in his journal, "I was, on March 4, fully convinced of the want of that faith whereby alone we are saved." This "conviction" was followed on March 24 in the same year (1738) by his "conversion."

Like most good men of that age in England, Wesley before he came under the influence of his Moravian friends had regarded faith as a union of intellectual belief and voluntary self-submission the belief of the creeds, submission to the laws of Christ and to the rules and services of the church, acted out day by day and hour by hour, in all the prescribed means and services of the church and in the general duties of life. From this conception of faith the element of the supernatural was wanting, but equally that of personal trust for salvation on the merits of Christ. The work of Bohler was to convince Wesley that such faith as this, even though there might be more or less of divine influence unconsciously mingled with its attainment and exercise, was essentially nothing else than an intellectual and moral act or habit, a human operation and result altogether different from the supernatural spiritual faith of a Christian. This conviction led him a few days afterwards to stand up at the house of the Rev. Mr Hutton, College Street, Westminster, and declare that five days before he had not been a Christian. When Bohler warned not thus to despise the benefits of sacraments and grace, he rejoined, "When we renounce everything and fly to faith and get into Christ, then and not till then, have reason to believe that we are Christians." It is true that for several years after this he remained High-Church

[1] One evidence of this is to be found in the early and wide influence of the various members of the Oxford Methodist company after their brief association at the university came to an end, in which way the Wesleys went: we know also the separate path which their friend Whitefield made for himself. John Clayton, the High Churchman, settled at Manchester, renounced the Wesleys and began their evangelical movement, and remained an unbending Churchman to the end. Benjamin Ingham became a great evangelist in Yorkshire, founded societies, and, with his societies or churches, took the decisive step of leaving the Church of England and entering the position of avowed Dissent. The saintly Gambold, a poet as well as a theologian and preacher, became a Moravian bishop. James Hervey was in after life a famous evangelical clergyman, but of "Low" and Calvinistic views. These were the chief of the Methodists of Oxford.

[2] *John Wesley and the Evangelical Reaction of the 18th C*

[3] A disciple of Zinzendorf, then in England on his way to A

his principles and opinions, but nevertheless his was dead at its roots.

xperience also made Wesley an evangelist. He rgotten gospel to preach, the gospel by which e to be converted, as he had been, and to be made reatures." And this result, this new birth, was ndent on any churchly form or ordinance, on any prerogative or service, or on any sacramental grace ence. To raise up, accordingly, by his preaching sonal influence, a body of converted men, who themselves become witnesses of the same truth by had been saved, was henceforth to be Wesley's . This was the explanation under which he great preacher, this also made him an organizer ving with success into classes and societies. In the the preaching power; in the class-room was the and personal influence. The vital link between ist and the class-meeting was the doctrine and e of "conversion." Thus Wesleyan Methodism d, not from Wesley the ritualist, but from Wesley ecluse.

y's doctrine offended the clergy. His popularity eacher alarmed them. The churches were soon inst him. He attended the religious meeting hurch of England basis which had existed in and elsewhere for fifty years, so far as there were to him, the Moravian meetings, and meetings in s of private friends, but these were quite nt for the zeal and energy of himself and his who had been "converted" a few days before. Accordingly in 1739, he followed the example Whitefield, and preached in the open air to immense. In the same year also he yielded to the urgency followers and to the pressure of circumstances, coming possessed of an old building called "the y," in Moorfields, transformed it into a meeting. Here large congregations came together to hear hers. About the same time, in Bristol and the ning colliery district of Kingswood, he found himged, not a little against his will, to become the premises for the purpose of public preaching and meetings. Here was the beginning of that vast of preaching houses and meeting rooms, all of them ly fifty years settled on Wesley himself, which, aving in any way belonged to the Church of , became, through Wesley, the possession of the st Connexion.

eligious societies through which the Wesleys, after nversion, exercised at first their spiritual influence part, as has been intimated, Moravian, that in ame of which the rules were drawn up by Wesley in 1738 (May 1), being the chief of these, and societies in connexion with the Church of England, e out of those which sprang up in the last years Stuarts, as if to compensate for the decay of sm within the church. In 1739, however, a strong of antinomian quietism gained entrance among the ns of England (Bohler himself having left for in the place of 1738), and Wesley, after vainly ing for a time against this corruption, found it ry formally to separate from them, and to establish y of his own, for which a place of meeting was provided at the Foundery. This was the first nder the direct control of Wesley, and herein was al and vital beginning of the Wesleyan Methodist , that is, of Wesleyan Methodism. Hence the ns celebrated their centenary in 1839. It was not, r, till 1743 that Wesley published the Rules of his

By that time not a few other local societies had ded to that at the Foundry, the three chief centres being London, Bristol, and Newcastle. Hence Wesley called his Society, when he published the "Rules" in 1743, the "United Societies." His brother's name was joined with his own at the foot of these Rules, in their second edition, dated May 1, 1743, and so remained in all later editions while Charles Wesley lived. Those Rules are still e rules of Wesleyan Methodism. Since Wesley's death they have not been altered. During his life only one change was made of any importance. In 1743 the offerings given weekly in the classes were for the poor, there being at that time no Conference and no itinerant preachers except the two brothers; after a few years the rules prescribed that the weekly contributions were to go "towards the support of the gospel." The Society is described as "a company of men having the form, and seeking the power, of godliness, united in order to pray together, to receive the word of exhortation, and to watch over one another in love, that they may help each other to work out their salvation." "The only condition previously required of those who desire admission into these societies" is "a desire to flee from the wrath to come, and to be saved from their sins." The customary contribution was a minimum of a penny a week or a shilling a quarter.

In 1739 these societies were not divided into "classes." But in 1742 this further step in organization was taken, and the change is recognized in the rules of 1743. Leaders were appointed to these classes, and became an order of spiritual helpers and subpastors, not ordained like lay elders in the Presbyterian churches, but, like them, filling up the interval between the pastors that "labour in the word and doctrine" and the members generally, and furnishing the main elements of a council which, in after years, grew up to be the disciplinary authority in every "society." In every society there was from the beginning a "steward" to take and give account of moneys received and expended. After a few years there were two distinct stewards, one being specially appointed to take care of the poor and the "poor's money," the other being, in general, the "society steward." And, finally,—though hardly, perhaps, during Wesley's lifetime,—in the larger societies there came to be two stewards of each description. The leaders and stewards together constituted "the leaders' meeting," of which, however the complete circle of functions grew into use and into recognition only by degrees. The Rules of the Society, which are strict and searching, relate to worship, to conduct, and to the religious life, but do not once mention or refer to the Church of England, the parish church, or the parish clergy. The only authority at first was the personal authority of the two brothers, exercised either directly or by their official delegates. After years had passed away the leaders' meeting came to have an important jurisdiction and authority, but its rights and powers were neither defined nor recognized until after Wesley's death. From first to last there is no trace or colour of any Anglican character in the organization. Moravians or Dissenters might have entered the fellowship, and before long many did enter it who had either been Dissenters or, at any rate, had seldom or never entered a church. What would to-day be called the "unsectarian" character of his society was, indeed, in Wesley's view, one of its chief glories. All the time, however, this "unsectarian" society was only another "sect" in process of formation. Wesley for many years before his death had seen that, unless the rulers of the church should come to adopt in regard to his society a policy of liberal recognition, this might be the outcome of his life work. And it would seem as if in his private confidences with himself he had come in the end at times to acquiesce in this result.

Still more decisive, however, was the third step in the

pment of Wesley's "Society." The clergy not only ed the Wesleys from their pulpits, but often repelled and their converts from the Lord's Supper. This rst done on a large scale, and with a systematic ess and persistency, at Bristol in 1740. Under circumstances the brothers took the decisive step of istering the sacrament to their societies themselves, r own meeting rooms, both at Bristol and at Kings. This practice having thus been established at Bristol, not likely that the original society at the Foundery rest content without the like privilege, especially as f the clergy in London acted in the same manner e at Bristol. There were therefore at the Foundery eparate administrations. Here then, in 1740, were f we include Kingswood, three—separate local es, formed, it is true, and both served and governed ained clergymen of the Church of England, but not ing to that church or in any respect within its ment. As thereafter during Wesley's life one of others, or some cooperative or friendly clergyman, most always present in London and in Bristol for ministration of the sacraments, these communions, once begun, were afterwards steadily maintained, the Supper being, as a rule, administered weekly. on Sundays and on week days full provision was for all the spiritual wants of these "societies," apart her from the services of the Church of England. ly link by which the societies were connected with hurch—and this was a link of sentiment, not an one was that the ministers who served them umbered among its "priests."

741 Wesley entered upon his course of calling out achers, who itinerated under his directions. To the es founded and sustained with the aid of these ers, who were entirely and absolutely under Wesley's al control, the two brothers, in their extensive ys, administered the sacraments as they were able. lpers only ranked as laymen, many of them, indeed, men of humble attainments and of unpolished ways. e ordinary reception of the sacraments the societies oral were dependent on the parish clergy, who, how ot seldom repelled them from the Lord's table. So r the ordinary opportunities of public worship they had no resource but the parish church. The simple in their preaching-room was, as Wesley himself l, defective, as a service of public worship, in some unt particulars; besides which, the visits of the nts were usually, at least at first, few and far n. Wesley accordingly was urgent in his advices junctions that his societies generally should keep to arish churches; but long before his death, especially tinerant preachers improved in quality and increased ber, there was a growing desire among the societies their own full Sunday services, and to have the ents administered by their own preachers. The oment of these preachers into ministers, and of the es into fully organized churches, was, if not the ble, at any rate the natural, result of the steps Wesley took in order to carry on the work that was nally opening up before him.

44 Wesley held his first Conference. The early Conferences iefly useful for the settlement of points of doctrine and e and for the examination and accrediting of fellow- rs. They met yearly. Conferences were a necessity for and became increasingly so as his work continued to grow m. It was inevitable also that the powers of the Conference, h for many years the Conference itself only existed as it sufferance, and only exercised any authority by the per- of its creator and head, should continually increase. The as that in 1784 Wesley could no longer delay the legal tion of the Conference, and that he was compelled, if he rovide for the perpetuation of his work, to take measures for vesting in trustees, for the use of "the people called ists," under the jurisdiction of the Conference as to the ment of ministers and preachers, all the preaching places property of the Connexion. The legal Conference was d consisting of one hundred itinerant preachers named by and power was given to the "legal hundred" continually first to fill up the vacancies in their own number, to a expel preachers, and to station them from year to year, no being allowed to remain more than three years in one stati

By this measure Wesley's work was consolidated into a religious organization, having a legally corporate chara large property rights. And yet Wesley would not allow t organization to be styled a "church." It was only a "— the "United Society"—the Society of "the people called [illegible] the "Methodist Society." And of its members were not probated Dissenters were by him reckoned as b to the Church of England, although a large and increa portion of them seldom or never attended the services church. The explanation of this apparent inconsistency Wesley admitted none to be Dissenters except such as w the eye of the law those who, "for conscience sake, re join in the service of the church or partake of the sa administered therein" and that he interpreted "the Ch England" to mean, as he wrote to his brother Charles, believers in England, except Papists and Dissenters, who b word of God and the sacraments administered among them

But Wesley was to carry his Society to a yet higher development and one which made it still more difficult to [illegible] its character from that of a distinct and separate In 1738 Wesley had been three times a High Churchman some time even after he had entered upon his course of t and independent evangelism he continued to hold, in the High Church view. But in 1746 he abandoned once his ecclesiastical High Churchmanship, although he never either a political or a Jurisdictarian Low Churchman, standard and manner of the 18th century. He relate journal under date January 29, 1746 how his views were tioned by reading Lord Chancellor King's account primitive church. From that time forward he consistently tained that the "uninterrupted succession was a fable w man ever did or could prove." One of the things taught Lord King's book was that the office of bishop was origin and the same with that of presbyter, and the practical which Wesley drew was that he himself was a "Scriptural pos," and that he had as much right as any primitive or mo bishop to ordain ministers, as his representatives and help should administer the sacraments, invested of himself, societies which had placed themselves under his spiritual The right, as he conceived it to be, he held in abeyance fo forty years, but at length he was constrained to exercise by so doing, in effect led the way toward making his S distinct and independent church.

In 1784 the American colonies having won their indepe it became necessary to organize a separate Methodism for where Methodist societies had existed for many years gave formal ordination and letters of ordination to Dr Coke, a presbyter of the Church of England, a superintende bishop for America, where Coke ordained Francis As presbyter and superintendent (or bishop) and Coke and together ordained the American preachers as presbyters. that ordination date the ecclesiastical commencement of A Episcopal Methodism, in which the bishops are only chie the presbyters whom they superintend, superior in [illegible] bu same order. The Episcopal Methodism of America repres day the largest aggregate of Protestant communicants and pers of the same ecclesiastical name to be found in any on in the world.

The following year (1785) Wesley ordained ministers f land. These ministers were quite outside of the est Presbyterianism of the day, with its lukewarm "moder while the Scotch sect which had seceded from the state would hold no terms with Arminians like Wesley and he fo Hence Wesley was compelled to make special provision administration of the sacraments in Scotland. He t ordained some of his ablest and most dignified preach created them formally in his correspondence the s title of "Reverend," and appointed them to administer th ments north of the Tweed.

At length, in 1788, Wesley obtained a number of preach Tyerman says seventy, to assist him in administering the sa to the societies in England; and of these he ordained one der Mather) to be superintendent or bishop, his brother being now dead, and Dr Coke sometimes absent for long pe America. The number of societies which demanded to h sacraments administered to them in their own places of continually increased, and their claims were often too st be resisted, especially when the parish priest was either

…t of the Methodists or a man of disreputable conduct. …Wesley's death (in 1791) it would seem that there were more …dozen of his preachers who had at different times, in Scot… …n England, been ordained to administer the sacraments. …foregoing view of the development of Methodism as an …ation, during the lifetime of its founder, will have conveyed …al idea of its structure and polity. There is one cardinal, …variable, element in the organization, however, of which …n a word has been no occasion to speak. The societies of …ham each of the connexion of one or more "classes," …emselves grouped into circuits, each of which was placed …he care of one or more of Wesley's Conference preachers, …e called in a variety of phrases, the "assistant being …et preacher of a circuit and the helper being a colleague …hereunder. The societies were directly responsible to …, who had absolute power over them, and exercised it …the Conference. The same power be equally possessed in …ference, at the annual meetings, but he made it a rule …his life to act in accordance with the Conference as to all …s of importance affecting the permanent trust of the …n property, or appeals to the courts, and their govern… …He thus preserved the connexion both practically and …to a great extent constitutional the legislative control of …ference after his death.

…time of Wesley's death there were in Great Britain the …[illegible] …were 313 preachers, 22 preachers' and …members. In Ireland there were 29 circuits, 58 preachers, …06 members. There were also 11 missionaries employed in the …dies and North America, 19 preachers, and 5,000 members; …ole of members in the United States were returned as …

…already been explained, the connexion of the early society …a leaders' meeting, of which society-stewards and poor-…as well as leaders were members. It must here be added …he circuit had its quarterly meeting, of which at first only …s-stewards and the circuit-stewards or treasurer for the …n connexion with the itinerant preachers were members. …Leaders' however in one circuit were sometimes …the first, associated with the stewards in the quarterly …at least had their place to attend. The quarterly meeting …dained in Wesley's Methodism until the year 1797. The …meeting had no defined authority until one year after …death. Its regular business and expenditure …lay absolutely with the "assistant," subject only to …Mr Wesley. Many years, however, before Wesley's death …come the usage for the "assistant," or, in his absence, the …his colleague, to consult the leaders' meeting as to …at questions, whether of appointment to offices or of discipline …ere called "society" approached in character to …n, the leaders' meeting began to acquire the character …tion of a church court, and private members to be treated, …ny matter of discipline, as having a status and rights …ht be pleaded before such a court. The rents, indeed, …ven after Wesley's death were guaranteed to leaders' …and members of societies had, there can be no doubt, so …ng as he lived, been generally recognized as …

…were entitled to vote in early Methodism, but in later …e allowed at least in their original form to fall out of …ere no reference to them in the "Minutes of Conference" …s about half a century after Wesley's death they held a place in the …ed by a society. Originally there were usually in each …the society-rooms bands, the members of which were collected …various, usually classes, one band composed of married …ber of unmarried men, one of married and another of un… …women. All the members of society however, were not …ly members of band. Some maturity of experience was …ired, and it was the responsibility of the "assistant" to admit …ber to a band or to expel. After Mr Wesley's death, where …so-called were kept up, they lost their private character, …ame weekly fellowship meetings for the society.

"love-feast" was a meeting the idea of which was borrowed …e Moravians, and which was also recorded as reviving the …institute of the early …In the love-feast the members of …societies came together for a collective fellowship meeting. …ure of the meeting, a memory of the primitive *agape*, was …presence at a certain portion of bread or cake and drink of …common.

…y be supposed that in such a system as Methodism a large …of preachers and exhorters from all the social grades …within the societies, could not but be continually raised …ese during Wesley's life, acted entirely under the directions …sistant, and were by him admitted or excluded, subject to …l to Wesley. Once a quarter often in connexion with …rt quarterly meeting a meeting of these local lay helpers, …local preachers," was held for mutual consultation and …ment, and to examine and accredit candidates for the office.

3. *Wesleyan Methodism after Wesley's Death.* — When Wesley died the Conference remained as th… of union and fountain of authority for the Con… But between the meetings of Conference Wesley ha… as patriarch and visitor with summary and s… jurisdiction. The first need to be supplied after hi… was an authority for the discharge of this particula… tion. In America Wesley had organized a sys… bishops (presbyter-bishops), presbyters or elder… deacons or ministers on probation. Among some … preachers who had been most intimate with Wesle… was a conviction that his own judgment woul… approved such a plan for England. No documen… ever, remains to show that such was his desire. T… request he left behind him for the Conference to … was one which rather looked in another directio… well-known letter produced before the Conference … first meeting after his death by his friend and … attendant, Mr Bradford, in which he begged the m… of the legal hundred to assume no advantage o… other preachers many respect. The preachers, accor… in their first Conference after Wesley's death, ins… appointing bishops, each with his diocese or pr… divided the country into districts, and appointed … committees to have all power of discipline and di… within the district, subject only to an appeal … Conference, all the preachers exercising equal righ… in the Conference, the "legal hundred" merely con… and validating *pro forma* the resolutions and decis… the whole assembly.

At first the preachers stationed in the district… instructed to elect their own chairmen, one for each … But the plan was speedily changed, and the chairme… elected each year by the whole Conference; an… method has been maintained ever since. The "… meetings" as they are generally called—are still … mittees" of the Conference, and have *ad interim* its… and responsibilities as to discipline and adminis… Originally they were composed exclusively of pre… but before many years had passed circuit stewar… district lay officers came to be associated with the pr… during the transaction of all the business except … was regarded as properly pastoral.

The relation of the Conference to the government … Connexion having thus been determined, the q… which next arose, and which occupied and indeed co… the Connexion for several years (1792–95), was that … administration of the sacraments, especially of the … Supper, to the societies. The societies generally … on their right to have the sacraments from the … preachers. Many of the wealthier members, howev… in particular a large number of the trustees of … opposed these demands. At length, between 17… 1795, after more than one attempt at compromi… been made by the Conference, the feeling of the s… as against the trustees became too strong to be … resisted, and accordingly at the Conference of 17… "plan of pacification" was adopted, the leading pr… being that, wherever the majority of the trustees … chapel, on the one hand, and the majority of the s… and leaders, on the other, consented to the adminis… of the sacraments, they should be administered, but … opposition to either the one or the other of these auth… In England the Lord's Supper was always to be a… tered after the Episcopal form; in Scotland it mig… if necessary, be administered, as it had common… before, after the Presbyterian form. In any case, he… "full liberty was to be left to give out hymns and … exhortation and extemporary prayer." The result w… within a generation the administration of the sacr…

societies came to be the universal rule. By this ion the preachers assumed the powers of pastors, rdance, however, only and always with the desire oice of their flocks. No formal service or act of ion was brought into use till forty years after- All preachers on probation for the ministry, he completion of their probation, were "received l connexion" with the Conference, this reception im investment with all pastoral prerogative. Modern lism has developed more fully and conspicuously toral idea.

ooner was the sacramental controversy settled than ther question as to the position and rights of th me to the front in great force. A comparatively arty, led by Alexander Kilham, imported into the ion ideas of a republican complexion, and demanded e members in their individual capacity should be zed as the direct basis of all power, that they should lect the leaders and stewards, that all distinction ference between minister and laymen should be way (elected laymen being sent as delegates from nits in equal number with the ministers), that they y should possess no official authority or pastoral ative, but should merely carry into effect the ns of majorities in the different meetings. In the of a very violent controversy which created pamphlets oadsheets, chiefly anonymous, from Kilham's pen, ting his views and containing gross imputations on nisters generally, and in particular on some not but distinctly indicated, were disseminated through ieties. The writer was tried at the Conference of condemned for the publication of injurious and fiable charges against his brethren, and by a majority vote expelled from the Conference. In the following a he founded the "New Connexion," the earliest of ganized secessions from Wesleyan Methodism.

s much more moderate than Kilham prevailed in nnexion at large. At the Leeds Conference of 1797 is was laid of that system of balance between the atives of the ministers and the rights of the laity has been maintained in it principles ever since, hich, in reality, has governed the recent provisions 78) for the admission of lay representatives into the ence not less than the former development of an Methodism. The admission of members into iety had, up to 1797, been entirely in the hands of nerant preachers, that is, the "assistant," hence o be styled the "superintendent," and his "helper." w regulations, without interfering with the power inisters to admit members on trial, declared that eaders' meeting shall have a right to declare any on trial improper to be received into society, and uch declaration the superintendent shall not admit erson into society"; also that "no person shall be d from the society for immorality till such immorality ved at a leaders' meeting."[1] For the appointment urch officers (leaders and stewards) the following ions were made, the second based on recognized the first on general but not invariable practice:

"1. No person shall be appointed a leader or steward removed from his office, but in conjunction with the leader ng, the nomination to be in the superintendent, and the tion or disapprobation in the leaders' meeting.

"2. The former rule concerning local preachers is confi viz., that no man shall receive a plan as a local preacher, the approbation of a local preachers' meeting."

The Conference at the same time made several pro for carrying out the process, which had been going some years, of denuding itself of direct responsibi regard to the disbursement of the Connexional The principle was established that such matters wer administered by the district committees acting in -pondence with the quarterly meetings of the circui was also provided that circuits were not to be without the consent of the respective quarterly me and, finally, it was resolved that, in the case of a rule made by the Conference for the Connexion, it within a circuit might be suspended for a year quarterly meeting, if it disapproved of the rule. ever, the Conference, after twelve months' interv adhered to the new rule, it was to be binding on the Connexion.

The powers of district committees, as defined by Conference, were confirmed and enhanced, power being given to call special meetings of the committee convened when necessary to settle the affairs of a di circuit. In the same Conference all the principa of Methodism, in regard both to the ministry and laity, were collected and (in a sense) codified, ma The new regulations adopted that same year, a whole, under the title "Large Minutes," was accep binding by the Conference, each minister being re to sign his acceptance individually. This compos itself based on one which had been prepared by W is still accepted by every Wesleyan minister on his tion as containing the rule and principles to wh subscribe. During the sitting of the critical Con at Leeds an assembly of delegates from bodies of t throughout the kingdom was simultaneously held form of the regulations enacted by the Conference a considerable extent, determined by the nature an of the representations made by this body of trustees was one request, however, which the Conference di declined to grant, namely, that lay delegates Conference. The Conference replied that they co admit any but regular travelling preachers into the and preserve the system of Methodism entire, partic the "itinerant plan." It was not many years wards that anything was heard again as to this ma

By the settlement now declared the outli Methodism as an organized church were fairly com Many details have since been filled in, and many c have been made in secondary arrangements, b principle of development have remained unchanged Connexion after 1797 had a long unbroken pe peaceful progress. The effect of the "Kilhamite tion," indeed, was after 1797 not greatly felt by the body. The number of Methodists in the United Ki in 1796, the year of Kilham's expulsion, was 95,3 1797 it was 99,519; in 1798 the New Connexion first Conference, and reported 5037 members, the of the parent body being 101,682. Nor was it t that the New Connexion reached 6000.

During the period of quiet growth and development followed 1797 the influence of one superior mind (J Bunting, 1779-1858) was to prevail with increasing swa was to be the period of the gradual development of lay co-o in the administration of the various departments of Con extension and enterprise, a development which prepared for the important legislation of 1852 and following years, the ultimate settlement of the respective provinces and

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[1] this regulation it was assumed that the old rule of society by a member disqualifies and virtually expels himself by con- absence from class, without reason for such absence, until ed. The case provides only for expulsions for "immorality." ent legislation has introduced a provision which ensures to mber before he ceases to be recognized on account of non- ce the right of having his case brought before a leaders' if he desires it. This rule of 1797 has always been under y the Conference as constituting the leaders' meeting in effect leaving the superintendent with his colleague or colleagues ers to act as judge. Appeal has always lain from the leaders' to the district meeting, and, finally, to the Conference.

inisters and laity which was made in 1877 78. It was
e the period of the gradual completion of the pastoral
its practical application to the ministe of the body.
iod may be deemed as extending from the revolutionary
1791 97 to the epoch of political and municipal reform
, 1828 35, which coincides with a second period of politico-
tical agitation in Wesleyan Methodism
97 the Conference, as already mentioned, had refused to
ected laymen or lay delegates any place either in the
ce or in district committees. Within a few years after
owever, the practice grew up for the circuit stewards to
ne district committee ring the transaction of financial
, and in 1815 this was recognized in the Minutes of
ce as an established rule, and it was enacted that no
increase of the income of the minister should be sanctioned
Conference until approved by a majority of the district
ee during the attendance of the circuit stewards. Since
ption of this rule the lay element in the district committees
ably increased and developed. Another characteristic and
nt feature in the organization of Wesleyan Methodism,
rew into distinct form and prominence during the period
er review, was that of the administration of all the Con-
l departments (except such as were regarded as properly
, by means of mixed departmental committees, appointed at
ecessive Conference. These committees made recommenda
the Conference in regard to such new legislation as they
d, if desirable and to the appointment of the members of com-
and, for each department, a large committee of review, of
he members of the ordinary committee of management
he nucleus, came to be held each year immediately before
ference. In the committees the number of ministers and
en were equal. On the principle, between 1811 and 1835,
n had been made for the management of all the funds of
nexion and their corresponding departments of administra
The first mixed committee appointed by the Conference was
mittee of privileges in 1806.
evelopment of the pastoral position and charac of the
of the body after 1797 could not but advance a line
to the development of the position and claims of the
In 1818 the usage of the Conference was conformed to what
g been the ordinary unofficial custom and the preachers
be styled in the *Wesleyan Methodist Magazine* and in
ficial publications "Reverend," a fact which may
but which in reality was of important significance.
34, after the idea had been long entertained and the project
n repeatedly discussed, it was determined to establish a
al institution for the training of ministerial candidates.
e now four colleges, with two hundred and fifty students
the practice of ordination by imposition of hands was

ual ince, however, as these in the general organization
elopment of the Connexion, and especially in the status
ofessional training of the ministers, could not be made in
body without offence being given to some, whose tendencies
disallow any official distinction between the ministry and
y, and who also objected to the use of the organ. This
g element was strong in the West Riding of Yorkshire, and
on the placing of an organ in Brunswick Chapel, Leeds,
trustees with the consent of the Conference, a violent
n broke out. The consequence was a disruption, the first
of, under the title "Protestant Methodists." But this
ended, some years later, in a more considerable
t, the Connexion was in 1828 entering on a period of agita
the current of political affairs was approaching the rapids of
he Reform Act marked the centre and the point of maximum
ent. A body like Wesleyan Methodism could not but feel
ence the excitement of this movement. It is true that Wesleyan
never been political, that few of its members
ed electors, and that the ministers and the better
of the "Societies" were strongly Conservative in their general
Nevertheless the democratic element of the community shared in the
movement of the time, and the Conservative tone of the
ts and of the mass of the society to do duty was not in full har-
with the popular spirit of the people generally. Accordingly
ments of disturbance, which only partially exploded in the
stant Methodist secessions, continued to make themselves
different parts of the Connexion, during the following years
ical controversy. The decision of the Conference in 1834 to
a college for the training of ministerial candidates gave
offence to the malcontents. Such an occasion was all that
ting for the various discontents of the Connexion to gather
d. The demands made by these agitators proceeded on a basis
ratic ecclesiasticism such as it is very difficult to apply suc-
to a system of associated churches. The result was a third
n, based on the same general ground of ecclesiastical prin-
s the two preceding, which was organized in 1836, and with
new secession was known first as the "Wesleyan Methodist A
tion"; but for a number of years past it has been merged i
larger body of seceders designated "The Methodist Free Chu
Its leader at the first was the Rev. Dr Warren, who left it, h
not many months after it was formed, and took orders in the
of England.[1]

The controversies of 1835–36 left their mark on the leg
and official documents of the Connexion. The principles
remained intact, some further guards only being added to
any danger of hasty or irresponsible action on the part o
intendents, and at the same time "minor district meetings
organized in order to facilitate appeals. One error was, h
committed by the Conference. In 1797 no provision had be
for bringing the circuit, through its quarterly meeting, int
relations with the Conference. In 1836 a right of direct m
to the Conference was given to the circuit quarterly meeting
was so fenced round with conditions and limitations as to
practically inoperative, and at the same time provocative
picion and irritation.

The effect of the secession of 1836 on the general progres
Connexion was not great. The number of members repo
1835 in Great Britain and Ireland was 371,251 (there
decrease in England of 951), in 1836 381,369, in 1837 384,7
the next ten years the advance of the Connexion in number
general prosperity was apparently unprecedented. The Ce
Fund of 1839 40 amounted to £221,000. In the midst, h
of all the outward prosperity of Methodism partly perhaps
sequence of it very perilous elements were at work. The
tionary ideas of the Chartist period (1840-48) and of Con
politics (1848 49) reacted on Wesleyan Methodism as the
ideas of 1791 and of 1851 had done at those epochs. The
of old controversies- ecclesiastical, quasi political, and pe
still smouldered, and at length burst into fresh flame. Fr
a strong spirit of opposition to the leaders of the Connexi
especially to Dr Bunting, was fanned by the circulation of
mous "fly leaves" of a very scurrilous character. At th
time the policy of the Conference and of the ministers in t
cuits had proceeded more than was wise on the old line
general administration relied too much on the footing of
confidence on the part of the people and on the power o
prerogative in the hands of the minister. The memorial
1836 was indicative of the too exclusive spirit of pastoral
ment which had prevailed. The wisdom of Dr Bunting
five and twenty years led the way in gradually liberalizing
polity and the policy of Methodism, and adapting them
changing conditions of the times. But this wisdom seems
found its limits before 1849, when the internal dissensions
their climax. In that year James Everett, the chief autho
fly sheets, and two other ministers, Samuel Dunn and
Griffith, who had identified themselves with him, were e

till after the Conference of 1850. The union of the "M
Free Churches," in which was incorporated the "W
Association" (of 1836), was formed by the seceders. The
Connexion" also received some thousands of the seceders
ranks. But by far the greatest part of those who left wo
neither of these bodies.

Between 1850 and 1855 the Connexion in Great Brit
Ireland lost 100,000 members, and not till 1856 did it
recover. In that year the numbers were returned as
showing a small increase over the preceding year. Since th
and unity have prevailed unbroken.

The convulsion of 1849 52 taught the Connexion, and
under the Conference, lessons of the highest importance.
the quarterly meeting was so defined as to make it the gre
sentative meeting of the circuit, including stewards, leade
preachers, and trustees. The right of memorial to the Co
was given to it in the widest and freest sense. These
bodies invite ministers to the circuits, or decline so to d
mine and pay their "allowances," as salaries to ministers
called in the Connexion, and review all the interests of the
spiritual or financial. They had also conferred upon them
the right to appoint a circuit jury of appeal from the ver
findings of a leaders' meeting in certain cases of discipline
1852 Conference legislation has still proceeded in the dir
recognizing and enlarging the functions and rights of t
The committee of review system, already spoken of, had b
siderably developed between 1835 and 1849, and include
department of ordinary administration. In 1861, howeve
a representation of the departmental executive committee
still the leading element in each committee of review, a p
provement was made in their constitution by giving to ea
districts of British Methodism the right to send a lay repres

[1] This "Warrenite" secession, as at first it was commonly called, gav
lawsuit which led to the judicial recognition by the Court of Chanc
Conference Deed Poll of 1784, and the "Large Minutes" of 1797, as

l these preparatory Conference committees. In 1877 and s final and natural consummation of the whole course of since 1791 was effected in the constitution of the united ce of ministers and lay representatives. The ministers met selves to discharge the functions which belong to them ommon pastorate of the Connexion. As to all the points in their specific character and common responsibility, as ually exchanging and itinerating pastors in common of a mon flock, they take mutual counsel in a separate assembly ference, in its ministerial and lay or representative session, ter the pastoral business is completed, and occupies a full tween Sundays in discussing and settling the business of funds and the general administrative departments of the The Conference in its pastoral session assembles on the last in July, that session closing on the Friday or Saturday lowing; the representative session occupies the following It is legally necessary that the decisions of the Conference its sessions should be confirmed and validated by the vote legal hundred." This confirmation is, however, given as a f course.

Conference in its pastoral session is not formally representa- each district is assigned by the preceding Conference a mount of representation, there being at present thirty five. The numbers allocated to the districts vary according to

nces. The total number of ministers and laymen com- he Conference in its representative session was 480, or 240 s and 240 laymen. The basis of the lay representation in ference is the constituency of lay electors in the district es. The Connexion at large is represented by the lay of the general Connexional departments. The business ed in the Conference during its representative session re- all the Connexional departments of general administration, committee of privileges, foreign mission, the maintenance cation fund (and the schools) for ministers' children, chapel general, metropolitan, and provincial), the home mission tingent fund, district sustentation funds, army and navy zation, lay mission work, the worn out ministers' and s' widows' fund, the theological institution with its four Sunday and day schools and the children's home and ge, higher education, the extension fund of Methodism, ns and divisions of circuits and districts, and the Lord's rvance and temperance questions.

President of the Conference is chosen by the ministers by the opening of the pastoral session. After the election dent follows that of secretary. These elections, however, ake place until the vacancies in the hundred have been. Such vacancies are caused by death by absence for two gether without a dispensation, by expulsion, or by super- n, which takes place ordinarily after two years' retirement full work of the ministry.

rincipal statistics of the denomination at the last Conference ere as follows:—

	Member		On Trial	Retired or Supernumerary Ministers.	Sunday Schola
itain.....	393,754	40,6	1,549	81	279
.. ..	24,475		200		11
missions.[1]	89,369	12	545		16

e Sunday scholars in Great Britain, 177,965 were over years of age, and 93,127 were members of society or on members.

gan Methodism in Ireland has always been part and parcel h Methodism, but since 1872 it has had a branch Confer- its own. The acts of this Conference are, in accordance provision in the Conference Deed Poll, made valid by the nce with them of a delegate from the British Conference, o the Irish Conference what the legal Conference is to the Conference. Ten ministers of the Irish Conference are s of the "legal hundred" of the British Conference. The f pacification" of 1795 was not carried out at the time by the nference. In the year 1816, however, it was adopted a The result was a secession which assumed the designation ive Wesleyans," a very different body from the Primitive ists of England. In 1878 the Primitive Wesleyans were to the parent Connexion. The number of members in has, owing to emigration, not increased of late years. The rn showed 21,475 members.

ated Conferences.—For more than twenty years there were "affiliated Conferences" of British Methodism. But there only two the *French Methodist* Conference, and that of *frica*,—the latter constituted quite recently (1882). Since nch Methodism has been under an affiliated Conference. ensions of the French Connexion, however, are very small, s dependent to a considerable extent on pecuniary aid fur-

[1] Chiefly in the West Indies, Africa, India and China.

nished by the Wesleyan Missionary Society. The last st return showed 1769 members, 126 members on trial, 27 m 1 minister on trial, and 3 supernumerary or retired ministe British Conference has a right of veto as to certain points lation in the case of affiliated Conferences.

Australasian Methodism was for more than twenty yea an affiliated Conference, dating from 1851. Since 1876, t the Australasian Conference has been independent. The Conference meets once in three years, having under it our Conferences—one for New South Wales and Queensland, and Victoria and Tasmania, a third for South Australia, and a for New Zealand. These Conferences—the general and the a are all mixed and representative after the same general pa the British Conference. They have also under their charge part of their Connexion, the Wesleyan missions in Tonga which were begun by the parent body before the original a yearly Conference for Australasia was organized. The nu 1881 were for the Methodism of Australia 28,310 membe 363 ministers, and for the South Sea missions 35,111 memb 16 missionaries of Europe in blood and a very large nu native ministers and assistant ministers.

Canadian Methodism was also affiliated till 1873, when it an independent Connexion. It includes six provincial ann ferences and one General Conference which meets every thr The General Conference is mixed and representative, the Conferences are purely ministerial. Canadian Methodism a powerful position in the Dominion. It numbers as nearly be ascertained about 110,000 members and is strongest in Canada. It possesses a university—the Victoria Unive Upper Canada.

The Doctrines of Methodism.—In doctrine all br of Methodism are substantially identical. W doctrines are contained in fifty three sermons kn the "four volumes" and in his *Notes on the New Tes* The Conference has, however, published two cate one for younger the other for older children, of w new and carefully revised edition has lately been comp In general, Wesleyan theology is to be described a system of evangelical Arminianism. In par Wesleyan divines insist on the doctrines of origi general redemption, repentance, justification by fa witness of the Spirit, and Christian perfection,—t has been customary for Methodists to say, the doctr a "present, free, and full salvation." By the wit the Spirit is meant a consciousness of the Divine through the atonement of Jesus Christ. Wesleyan often been represented as holding the Calvinistic d of "assurance." The word, however, is not a W phrase, and assurance, so far as it may be said to be by Methodists, signifies, not any certainty of final sa but merely a "sense of sin forgiven."[2]

II. American Episcopal Methodism.

The beginnings of American Methodism are trace the year 1766, when a few pious emigrants from introduced Methodism into New York. On recei appeal in 1768 from the New York Methodists, wh engaged in building a preaching house, Wesley laid t of America before the Conference at Leeds; in 17 two preachers, Boardman and Pilmoor, volunteered to the colonies. Boardman went to New York, P to Philadelphia. In 1771 two other Methodist itin Francis Asbury—the most famous name in Am Methodism—and Richard Wright, went out to A In 1773 Thomas Rankin, a preacher of experience

[2] Besides Wesley's *Sermons* and *A Sin* in reply to Dr Taylor of Norwi theological views. Most of these m *Commentary*, Watson's *Institutes* (4 vols.), the series of *Lectures to th* "The Holy Catholic Church," and Dr Rigg's *Essays*.

[3] For the history and constitution of Wesleyan Methodism the follo may be consulted:—Wesley Works, especially his *Journal*; Southey Tyerman's *Wesley*; Rigg's *Living Wesley*, and *Character and Life of Jo* Jackson's *Life of Charles Wesley*; *Minutes of Conference*, Vol. I., 17 George Smith, *History of Wesleyan Methodism*, 3 vols.; Dr Abel Steven *of Methodism*, 4 vols.; Pierce *Polity of Methodism*, Dr Williams' *Ch and Polity of Wesleyan Methodism*, Rigg, *Connexional Economy*; *Minutes*, 1877 to 1881.

ley, held the first Conference in Philadelphia, when were 10 itinerant preachers and 1160 members. he breaking out of the War of Independence the Methodist preachers were unpopular, and all but Asbury went back to England. At the end of the owever, in 1784, Wesley sent out Dr Coke, and an Methodism was organized as an independent with Dr Coke and Francis Asbury as its presbyters. The history of American Methodism since that is too vast and complicated for any attempt to be o summarize it here. Methodism is more properly l in its character a n American church than any in the States. In Massachusetts and some other New England States it is less powerful than Con ough in, which fell from there much of its ancient supremacy, in the city of New York it is less powerful re by reason, and indeed, occupies a position less ly influential than might have been expected. But adelphia it is very powerful; so also in Baltimore Cincinnati. If not "home" in New York city it is here in the States, and generally throughout the and mid western States it is the prevalent form d than any other church.

The Methodist Episcopal Church Episcopacy is other Episcopal churches. The bishops are superintendents, presidents over the whole territory of Methodism in rotation, holding over the annual Conferences. These Conferences are ministerial. But the General Conference, which meets once years, and which is the Conference of legislation is lical, mixed and representative. The first General Conference in 1792 the initial delegated or representative Conference the first mixed or ministerial and lay General Conference. There were still but few districts assembling in the al Methodism of America, and now there are but few. The maintain the unity of the Connexion in the interval between al Conferences by their visitation and by their co-partnership with the Episcopal clergy. ministers also called presbyters supplement the action and superintendency of the bishops. e the over districts, holding all the circuit quarterly meetings, holding the district meetings at which such meetings have arged.

The Episcopal Methodism is distributed into five distinct churches, which, however differ from each other in no ry important particulars of discipline, government. The American Methodist Episcopal Church South separate organization in 1845 by reason of the slavery ry. The coloured churches, of which there are three, pendently from local causes. The following are the latest

	Ministers	Members
The Episcopal Methodist Church	1,112	1,091
The Episcopal Zion Church		
Methodist Episcopal Church		

Methodist Episcopal Church alone there are one hundred Conferences presided by twelve bishops. The church has ions, the heads of which some of distinguished ability. Its foreign missionary scene of the most recent and excited. The missionaries are in India, China, an. The Methodist Church South also has some influential ties, particularly that at Nashville, and has missions, in Japan and Mexico.

es these Methodist Episcopal churches, with their total of 00 church members, there are two other churches which do me the name at all, but are yet essentially Methodist in and discipline, not varying in any important particulars Episcopal Methodism of America. Of these one is called ed Brethren, with 15,000 members, the other the Evan- Association, with 113,000 members.[1]

Episcopal Americo-Methodism. The bodies included under l are chiefly secessions from the original stock of American sm, founded on principles of democratic church government, s to those of the English Methodist secessions. The only considerable body, however, is the Methodist Protestant with 125,000 members. The minor bodies, four in number altogether less than 60,000 members, the principal be American Wesleyan Church, with 25,000 members.

III. Other Methodist Bodies in Britain.

The bodies still to be noticed, while differing points of church government, agree as to doctri in general as to the means of grace and as to inner s fellowship with the parent "Connexion." Th maintain class meetings and love feasts, have l meetings and quarterly meetings, and largely emplo preachers.

The Methodist New Connexion was founded in 1797 Alexander Kilham, who died in 1798. Its general princi indicated above. Its statistics for 1881 were as follow ministers and 27,770 members including the 6 on missions bers 3882 on trial, and 74,744 Sunday scholars."

United Methodist Free Churches. This organization in its form must be identified with the Wesleyan Methodist As of 1836. That body first absorbed into itself, in great "Protestant Methodists" of 1828. It was afterwards gr created, and its organization in some points modified, when number of the seceders from the parent Connexion in 1850 it rank. The main body of its Conference does not consist, of the New Connexion, of an equal number of circuit minis elected circuit lay delegates; but of circuit delegates, ministerial or lay elected without any respect to office, m or other. Its circuits are independent of the contro Conference. The Connexional bond, accordingly, in this de tion is weak, and the itinerancy is not universal or uniform rule or its operation. The amalgamation between the W Methodist Association and the "Wesleyan Methodist Ref of 1850 took place in 1857. At that time the combined numbered 11,000. At present (1881-82) they number 72, cluding 7772 members on the mission stations, besides 7824 The number of ministers is 392, with 10 retired or "supernu merary." The number of Sunday scholars is 190,957.[3]

Primitive Methodism. In this earnest and hard-working nation the ministers, of whom some are women, are very "the servants of all." The Conference is composed, in add twelve permanent members, of four members appointed by ceding Conference, and of delegates from district meeting principle of proportion is that there should be two laymen member of "travelling preacher," and the "travelling pr have no pastoral prerogative whatever. The Conference is s and the Connexional bond is strong. This body was fou Hugh Bourne and William Clowes, local preachers w separated from the Wesleyan Connexion, the former in 1 latter in 1810, because of their violation of Conference reg as to camp meetings and other questions of order. The Co had, in 1807, pronounced its judgment against camp m which had been introduced into the country from America, Bourne and Clowes were determined to hold such m founded thus by zealous and "irregular" lay preachers, tive "Methodism, as the resulting new body called itself, h in its organization, its spirit, and its customs strong trac ancestry. It has been a very successful body, aiming simply evangelistic work, and is now numerous and powerful, nu among its ministers, not only many useful preachers, but marked originality and power and also of superior cul There has for many years past, if not from the beginning very friendly feeling between the old Wesleyan Connexion Primitive Methodists. Its latest statistics (1881-2) sho "travelling preachers" 185,312 members, and 388,350 scholars.[4]

Bible Christians. The Primitive Methodists sprang up midland counties, the Bible Christians in Cornwall. Thes resemble the "Primitives" in their character and spirit. founder was a Cornish local preacher called O'Bryan. He Connexion is often known as the Bryanites, and Cornish e have propagated this denomination widely in the colonie Conference is composed of ten superintendents of distr president and secretary of the preceding Conference, lay d one from each district meeting, and as many of the t preachers as are allowed by their respective district mee attend. In general it may be said that the ministerial members of the Conference are about equal in number. The for 1881-82 showed in England (chiefly the west and south

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[1] See *Jubilee Volume of the New Connexion*; also the *General Rule Minutes of Conference*, 1881, published at the New Connexion Book-Roo

[3] See *Foundation Deed of the United Methodist Free Churches*; als *of Conference*, 1881, 119 Salisbury Square.

[4] See John Petty, *History of the Primitive Methodist Connexion*; als *of Conference* 1881, 6 Sutton Street, London, E.

[1] best authority as to American Methodism is Dr Abel Stevens's *History*. The statistics are given in the *Methodist Year Book*, New York, 1882.

d in the Channel Islands 136 itinerant preachers, 21,209 s (besides 690 on trial), and 36,335 Sunday scholars. In the number of members was 6652, and in Australia and aland 3671.'

Wesleyan Reform Union is an aggregate of local Methodist churches, loosely held together by a Conference, and is he results of the great Methodist disruption of 1851-52. urns for 1881-82 showed 18 ministers and 7728 members.

enical Methodist Conference.—This Conference was held in ad Chapel, London, in September 1881. Representatives esent from all the Methodist bodies throughout the world, as estimated that these represented not less than 5,000,000 bers and 20,000,000 of population. Whilst in church tion these bodies differed, as has been shown above, in and in respect of their purely spiritual discipline and f grace, they were all agreed in principal matters. The ce was entirely practical in character. The object was to zeal and union among the constituent bodies as to all points of Christian sympathy and activity, at home and and especially as to home mission work, general philan Christian education, and a Christian use of the press. There representatives present from the Methodist bodies in all the world.[2]

Calvinistic Methodists.—Between the Methodism of Wales t of England there was never any other than incidental on. Indeed, although the name of the Welsh movement rowed from the English, not only was Welsh Methodism dependent in its origin, but in reality it s beginning, as an eal movement, was earlier than that of English Methodism. Vesleyan Methodism, furthermore, Welsh Methodism was out distinguished by the fact that it was Calvinistic in its . For some years Whitefield's name was placed by the of Welsh Methodism at the head of their movement, but nexion was not at any time much more than nominal, eld being, indeed, too often and too long together in to exercise any real presidency over the Methodism of the ality.

uction, however, must be made between Welsh Methodism rangelistic movement and as an organization. In its later tinctly organized form, its main elements date from 1811, he actual unity and the final consolidation of the organization om so recent a period as 1864. At that date we find the tic Methodism of North and of South Wales for the first ited in a common organization and government, and brought he supreme control of one "General Assembly."

spiritual awakening from which Welsh Calvinistic Methodived its earliest inspiration and impulse began in 1735 and most contemporaneously and quite independently, in three t counties of South Wales. Howell Harris, a gentleman of sition, born and bred at Trevecca in the parish of Talgarth, of Brecon, is the most prominent name connected with early Methodism. His first strong religious convictions and im ate from 1735. He was sent to Oxford in the autumn of that "cure him of his fanaticism," but remained only one term. return to Wales he began to exhort and preach in private and in such buildings as he could obtain the use of, being then oughout his life a simple layman. Of learning or theology but little; but he was an extemporary preacher of prodigious nce, and often of overwhelming power and pathos. While was thus preaching in the county of Brecon, Daniel Rowad been spiritually awakened at Llangeitho in Cardiganshire, men knowing nothing whatever of each other. Rowlands ordained clergyman, of some arning and of great ce. He was a pulpit orator, and refully prepared his l discourses. In Pembrokeshire, in, in that same year 3, Howell Davies began to preach the same doctrine in the pirit as the other two preachers, and ith effects scarcely, if less remarkable. The work thus gun in three distinct within the space of one year was strict connexion with tablished Church, and so continued to be throughout the tury. These single-minded preachers pursued their work es knowing nothing of the parallel work which Whitefield st begun in England. In 1738, however, Whitefield, in st of England, heard of Howell Harris, and in that year revivalists met in Cardiff. In 1739 Howell Harris had to extend his preaching tours far and wide, visiting not outh but North Wales, and, wherever he went, founding s societies in connexion with the Church of England, of a er resembling those called De Woodward's societies, which g been in existence throughout England, the chief difference hat the Welsh societies were "evangelical," Calvinistic, vivalist. It was in the same year that Wesley founded iety in England. In 1742 the clergymen connected with the Welsh movement were ten in number, and there were ing in concert with these forty lay "exhorters," as the called. In that year the first "association" of Welsh Calv Methodists was held at Waterford or Watford, in Glamorga Whitefield consented to preside, and joined his preach that of the Welsh evangelists. The first Calvinistic Me Conference was held at Waterford, under Whitefield's pres on January 5, 1743, eighteen months earlier than Wesley Conference. For a short time the Calvinistic Methodism of was linked to that of England. After 1748, however, Wh ceased to act as in any sense the official head of the Calv Methodists of England, and their organization, always loos gradually dissolved.

There was no Wesley in Welsh Methodism, and accordingly was no organic unity among the societies. Her Welsh M ism. Each local society was under the care of an "exhorte named layman. A number of these local societies were c together into a district, over which an "overseer" had chi also was usually an unpaid layman, though exercising n the function of a pastoral pastor. Sometimes, however, as case of Rowlands, he was a paid clergyman. The s attended their parish churches and there received the sacra The meetings or preachings held in the societies were called "house-to-house purposes."

In 1751 Howell Harris ceased to itinerate and retired to Tr From this time his leadership in the Methodist movement se have come to an end, and the movement languished for many after. Not till 1762 is any "revival" chronicled. In 1763 lands was obliged to quit his curacy at Llangeitho and bec Established Church. His people built him a chapel. He thu 1763, became a Dissenting minister, and, retaining his fa much of his power to the end of his course, he died in 1790.

Fifty years had now passed since the first victories of Methodism had been established by Howell Harris, and the ment, instead of having grown to strength and maturity, ap to have spent its force, almost in all directions, at least as any outward signs. But the Rev. Thomas of Bala was to be one of the chief means of reviving it. H the earlier Methodists, was a churchman, he had taken his at Oxford and served a curacy in Somersetshire. The door Established Church having been closed against him becaus style of preaching, he joined the Welsh Methodists in 17 his first sphere of marked influence was in North Wa he took a leading part in a great revival of which Bala From this pe may be dated the spring of Calvinistic Methodism, from which its later rise Charles zealously and successfully promoted the establishm "circulating schools" and of Sabbath schools. He was, the soul of the great Christian educating movement in Wale began in the last decade of the 18th century; and it was t his earnest zeal in seeking to provide Bibles for his Welsh especially the Sunday schools, that the British and Foreig Society was established. Though Methodism came the effectually rooted in the soil of Principality, was 1811 that the Welsh Calvinists took that step in the direc ecclesiastical independence which English Wesleyans ha sixteen years before by calling their preachers to the official of pastors and ordaining them to administer the sacraments.

From 1790 till almost the present time the work of g moulding the constitution of Welsh Calvinistic Methodi proceeded. The 'rules regarding the proper mode of con the quarterly association' were drawn up by Charles and upon in 1790. In 1801 the *Order and Form of Church Gov and Rules of Discipline* were published. In 1811, as h shown, ministerial ordination was initiated. In 1823 t *fession of Faith* was promulgated. And in 1864, as h already mentioned, the first "General Assembly" was h the two associations of North and South Wales respectiv united into one body. The constitution is now a modifie byterianism, each church managing its own affairs su successive appeal to the monthly meeting of the county quarterly association of the province, while the latter be refer the decision to the annual General Assembly.

The Welsh Methodists (or Welsh Presbyterians, as t now often called) have two theological colleges, one at B the other at Trevecca. They have also a foreign missionary with missions in Brittany, among their congeners of th race, and in Bengal.

In recent years this church has made great progress. In number of members was 58,678, in 1870 it was 92,735, and the returns showed 1171 churches, 118,979 communicants, Sunday scholars. The number of ministers is not officiall but is estimated at 600. The North and South Wales ass are now also known as synods.[3]

(J. H

Bible Christian Memorial Volume, 1866; *Minutes of Conference*, 1881, om, 26 Paternoster Row.

Proceedings of First Methodist Ecumenical Conference, Wesleyan Book-ity Road.

[3] See W. Williams, *Welsh Calvinistic Methodism, a Historical Sketch and Times of Howell Harris*; Tyerman, *Life of the Rev. George Whit Diary of the Calvinistic Methodists* 1882.

HODIUS, the apostle of the Slavs, was a native
salonica, and was born about the year 825. His
lity is unknown, but most probably he was a
ed Slav; the family of which he was a member
to have been one of considerable social distinction,
himself had already attained high official rank in
vernment of Macedonia before he determined to
n his secular career and embrace the monastic life.
unger brother Constantine (better known as Cyril,
ne he adopted at Rome shortly before his death)
o distinguished himself as a secular "philosopher"
stantinople before he withdrew to the cloister and
nde. Constantine about 860 had been sent by the
r Michael III. to the Khazars, in response to their
for a Christian teacher, but had not remained long
them; after his return to within the limits of the
, his brother and he laboured for the instruction of
avonic or Slavonicized population, especially by
of translations of the Scripture lessons and the
al book used in Christian worship. About the
3, at the invitation of Rastislav, king of "Great
a," who desired the Christianization of his subjects,
the same time that they should be independent of
mans, the two brothers went to his capital (its site
own), and, besides establishing a seminary for the
on of priests, successfully occupied themselves in
ng in the vernacular and in diffusing their religious
ne. After four years they seem to have received
epted an invitation to Rome from Pope Nicholas
had just been engaged in his still extant corre-
nce with the newly converted Bulgarian king, his
ecurred before their arrival, but they were kindly
l by his successor Hadrian II. Constantine died
e, but Methodius, after satisfying the pope of his
oxy and obedience, went back to his labours in
via" as archbishop of Pannonia. His province
s to have been, roughly speaking, co-extensive with
ins of the Raab, Drave, and Save, and thus to have
d parts of what had previously belonged to the pro
of Salzburg and Passau. In 871 complaints on this
were made at Rome, nominally on behalf of the
hop of Salzburg, but really in the interests of
rman king and his Germanizing ally Swatopluk,
av's successor; they were not, however, immediately
ful. In 879, however, Methodius was again sum-
to Rome by Pope John VIII., after having declined
up the practice of celebrating mass in the Slavonic
; but, owing to the peculiar delicacy of the relations
e with Constantinople, and with the young church
lgaria, the pope, contrary to all expectation, ulti-
decided in favour of a Slavonic liturgy, and sent
hius (880) back to his diocese with a suffragan
, and with a letter of recommendation to Swatopluk.
uffragan, a German named Wiching, unfortunately
quite the reverse of helpful to his metropolitan,
rough his agency, especially after the death of John
in 882, the closing years of the life of Methodius
mbittered by continual ecclesiastical disputes, in the
of which he is said to have laid Swatopluk and his
rters under the ban, and the realm under interdict.
ate of the death of Methodius is variously given;
ost trustworthy tradition says that it took place on
6, 885. He was buried at Welehrad (probably
eissenberg). The Greek Church commemorates St
on February 14 and St. Methodius on May 11; in
oman Church both are commemorated on March 9.

Schafarik's *Slawische Alterthümer*, where the original
ties are fully referred to. The subject of the present notice
probably not to be identified with the Methodius, a painter
nk, who, according to a well-known legend, converted Boris
aria by means of a picture of Christ's second coming.

METHYL, a chemical term which until lately wa
in two radically different senses, namely, as desig
either the atom-group CH_3, which in numberless ch
formula figures as a "radical" (compare CHEMISTR
v. p. 552), or a gaseous substance of the same compo
which, however, nowadays is generally called "dim
to distinguish it from the radical. A gas of the co
tion and the specific gravity ($C_2H_6 \div H_2 = 15$) corresp
to C_nH_n can be produced in two principal ways,-
by the decomposition of zinc-ethyl by water (Frankl

$$Zn(C_2H_5)_2 + 2OH \,.\, H = Zn(OH)_2 + C_2H_5H\ ;$$

and, secondly, by the electrolysis of acetate of
solution (Kolbe), we have virtually

$$2CH_3 \,.\, COOH = (CH_3)_2 + 2CO_2 \;\Big|\; {}^{+H_2\,.}_{-}$$
$$\qquad\qquad\qquad\qquad\quad {}^{+\text{pole.}}\qquad\quad {}^{-\text{pole.}}$$

These two gases used to be distinguished as two di
substances, Frankland's being looked upon as hyd
ethyl, $C_2H_5 \,.\, H$, Kolbe's as "real methyl" (CH_3)
until Schorlemmer proved their identity by showin
both, when treated with chlorine, yield the same id
chloride of ethyl, $C_2H_5 \,.\, Cl$. This confirmed th
generally adopted notion that the radical ethyl i
nothing but methylo-methyl, $H_3C - CH_2$*, so th
filling up of the gap* by an H must necessarily p
"hydride of ethyl" and "dimethyl" in one. The
methyl" which chemists used to dream of, and which
treated with chlorine, would yield two CH_3Cl's an
to $HH + ClCl = HCl + HCl$, does not, and according
present knowledge cannot, exist. A quasi apology f
"marsh gas," CH_4, the principal component of t
mixture which bubbles up from any marshy pond w
mud is stirred up with a stick. It is always pr
when vegetable matter decays in the presence of
and in the relative or absolute absence of air.
everybody knows as "fire damp" is nothing but a
sarily explosive) mixture of air with impure mar
produced in the constantly progressing metamorpl
the coal deposits; in certain districts streams of ma
are issuing forth from cracks in the earth; the "hol
of Baku is such a marsh-gas spring, which, havin
caught fire by accident, continues burning to th
Perfectly pure marsh gas can only be obtained fro
methyl, $Zn(CH_3)_2$, by its decomposition with wate
supra); a nearly pure preparation is procurable by
a mixture of acetate of potash or soda and caustic a
dull redness:-

$$\underset{\text{Acetate.}}{CH_3 \,.\, COONa} + NaOH = \underset{\text{Carbonate.}}{Na_2CO_3} + CH_3H\,.$$

Marsh gas can be prepared synthetically by the
of bisulphide of carbon vapour and sulphuretted hy
(both producible from their elements) on red-hot
$CS_2 + 2H_2S + 8Cu = 4Cu_2S + CH_4$ (Berthelot). A r
of marsh gas and chlorine, when exposed to direct su
explodes with formation of hydrochloric acid an
coal. In diffuse daylight only part of the hydr
eliminated and "replaced" by its equivalent in cl
which in general leads to the formation of four
$CH_3Cl = CH_4 + Cl_2 = HCl$, chloride of methyl; C
chloride of methylene; $CHCl_3$, chloroform; CCl_4
chloride of carbon. Of these several chlorometha
they are called, the first here interests us more th
of the rest, because from it any other methyl co
can be produced by the substitution of the proper
radical for the Cl of the CH_3Cl. Thus, for insta
can convert it into methyl-alcohol by treating the
with aqueous caustic potash at 100° C. (Berthelot)
is a most important synthesis, because it is this
alcohol that, in practice, always serves as the
point in the preparation of other methyl compound

Methyl-Alcohol.—This substance, in ordinary p

r made synthetically, but simply extracted from
pirit, a commercial substance which is produced
ially in the dry distillation of wood. The wood-
s contained in the aqueous portion of the tar pro
n this operation, along with acetic acid. To recover
he tar-water is neutralized with lime and distilled,
he acetate remains, while the spirit distils over,
with a deal of water, which, however, is easily
d, as far as necessary, by redistillation and rejection
less volatile parts. The "crude" wood-spirit, as
otained, is not unlike in its general properties to
y spirit of wine, from which, however, it is easily
uished by its abominable smell. The ordinary
cial article, besides a variable percentage of water,
s from 35 to 80 per cent. of methyl alcohol; the
nsists chiefly of acetone, but besides includes
yl-acetal, $C_3H_4(OCH_3)_2$, acetate of methyl, and
us other minor components. In Great Britain
uantities of wood spirit are used for the making
pylated spirit, a mixture of ordinary spirit of wine
ne-ninth of its volume of wood-spirit, which is
to be sold duty free for the preparation of
es, and for other industrial purposes. In former
here as elsewhere, wood spirit itself used to be
ed as a cheap substitute for spiritus vini; but this
nger so, since the aniline-colour industry has created
demand for pure methyl alcohol. Hence in some
ntal works the wood spirit, instead of being sent
such, is being worked up for its components, by the
ng sequence of operations:—(1) dehydration by
(2) heating, under an inverted condenser, with
soda, to convert the acetate into hydrate of methyl;
truction of the bad smells by mild oxidation; (4)
tion in a kind of Coffey's still, whereby it is split
approximately pure alcohol, acetone, and "tails."

ew industry led to the invention of the following technical
for the determination, in a given spirit, of the percentages
ethyl-alcohol and of acetone.

lcohol is determined by saturating 5 c.c. of the spirit with
e acid (volatilization of alcohol and iodide of methyl being
by means of a cold-water bath and an inverted condenser),
product poured into water. Iodide of methyl separates
heavy oil, which is measured as it is. According to direct
c.c. of pure methyl-alcohol yields 7·45 c.c. of crude iodide
Kramer and Grodzky).

e determination of the acetone the following reagents are
(Kramer):—(1) a solution of iodine, prepared by dissolv-
·254 grammes of iodine, by means of (say) 500 grammes
of potassium, in water, and diluting to 1 litre; (2) a
of caustic soda containing twice (NaOH) grammes per litre;
ol-free ether. Ten c.c. of the soda are placed in a gra-
ylinder and mixed intimately, first with 1 c.c. of the spirit,
h 5 c.c. of the iodine solution. Iodoform separates out (if
is present) in minute yellow crystal plates; this product is
out" by means of 10 c.c. of ether, and determined by
ing an aliquot part of the ethereal layer in a tared watch-
dryness and weighing the residue. C_3H_6O yields CHI_3;
part of iodoform indicates 0·28 parts of acetone.

formula of methyl-alcohol and its true chemical
er were correctly ascertained by Dumas and Péligot
y as 1834; yet pure methyl-alcohol may be said to
een an unknown substance until 1852, when Wöhler
us to prepare it, by first extracting the CH of the
H in the wood-spirit as oxalate of methyl, and then
posing the (purified) oxalate with water.

most convenient raw material to use nowadays is the
cial "pure" alcohol; if wood-spirit is employed it had
rst be purified by distillation over caustic soda (*vide supra*).
mation of the oxalate then is best effected (according to
er Watt) as follows:—500 grammes of oxalic acid crystals
ed with 200 c.c. of oil of vitriol; then 500 c.c. of the
e added, the whole kept for a time at 80° C., and then
to stand cold for twenty-four hours.
arge crop of oxalate crystals—partly $(CH_3)_2C_2O_4$, partly
C_2O_4—is separated from the liquor by pressure and subse-
quent drying over vitriol, and then decomposed by distillat
water.

The aqueous alcohol thus obtained is dehydrated by t
known methods used in the preparation of ordinary absolute

According to Kramer, a purer preparation than Wo
obtained by extracting the methyl as formiate instead of as
which is easily effected by digesting the wood-spirit with
acid of 1·22 specific gravity, and purifying the formic e
fractional distillation. This ether boils at 32°, the oxalate
C., hence a proper combination of the two methods sh
infinitely superior to either. What now follows must, in ge
understood to refer to Wohler's preparation.

Pure methyl-alcohol is a colourless liquid simila
general properties, in its behaviour to other che
inert liquids, and in its action as a solvent to o
absolute alcohol, from which, however, it differs
entire absence from it of all spirituous odour.
paration which smells of wood-spirit may be con
at once as impure. According to H. Kopp, its
gravity is 0·8142 at 0° C. and 0·7997 at 16·4.
volume at t° be V, then (from 0° to 61°)

$$V = 1 + 0{\cdot}001187\,t + 1{\cdot}361 \times 10^{-6}\,t^2 + 8{\cdot}711 \times 10^{-9}\,t^3$$

The boiling point is 64·6 to 65·2. The tension cur
determined by Regnault and by Landolt; but the
of the two observers do not agree except (approxi
at P = 760 mm. Methyl alcohol has quite a charac
tendency to "bump" badly on distillation, which, ho
can be prevented by addition of a small fragment
sodium, which produces a feeble but sufficient cu
hydrogen. Its specific heat is 0·713; latent heat of
264; combustion heat, 5307 per unit weight (Fav
Silbermann). The refractive index for the D (s
ray is 1·3379 + ·0013 for 10 + 5° C. (Dale and Gla

Methyl-alcohol mixes with water in all proportio
contraction.

Since Wohler's discovery a table for the specific gra
aqueous methyl alcohols has been constructed experimen
A. Dupré, but unfortunately his alcohol boiled at 58·7, a
sequently must have been something different from what g
goes by this name.

In its chemical reactions methyl alcohol, $CH_3.$
very similar to ordinary (ethyl) alcohol, $C_2H_5.O$
consequently, in the same sense as the latter, analo
water, H.OH. Thus, for instance, metallic sodi
potassium dissolve in ether alcohol with evolut
hydrogen and formation of ethylates or methylates
alkali metals. Example:

$$CH_3OH + Na = CH_3.ONa + H.$$

The two methylates crystallize from the solutio
crystal alcohol, which can be driven off in an atm
of hydrogen by heat, without decomposition of th
themselves. Water at once decomposes them into
alkali and alcohol, $CH_3.ONa + H.OH = NaOH + C$
Yet the reverse reaction takes place when the al
treated with a large excess of caustic soda.

The action of acids on methyl alcohol is in
quite analogous to that on, for instance, caustic sod
this important difference, however, that what in t
of NaHO goes on so readily in aqueous solution
$CH_3.OH$ succeeds only under circumstances pre
the accumulation of water. In these circumsta
have, for instance,

(1) $\overline{CH} + OH.CH_3 - H_2O = Cl.CH_3$;

(2) $(C_2H_3O_2)H + OH.CH_3 - H_2O = C_2H_3O_2.CH_3$;
Acetic acid. Acetic ether.

and so on with all monobasic acids. A dibasic acid
may act as $(X)H_2$ or as $(XH).H$; thus, for instanc

(3) $(C_2O_4H)H + OH.CH_3 - H_2O = C_2O_4.HCH_3$;
Oxalic acid. Methyl oxalic acid.

(4) $(C_2O_4)H_2 + 2OH.CH_3 = 2H_2O + C_2O_4.(CH_3)_2$
Methyl oxalate.

asic acid forms two methyl acids and one neutral
e have, for instance,

m PO_4H_3; $PO_4(CH_3)H_2$; $PO_4(CH_3)_2H$; $PO_4(CH_3)_3$.

ld, however, be a great mistake to suppose that
for instance (Ex. 3 and 4), the monomethyl or
thyl compound is formed depends on the quantity
l alcohol employed per unit of acid. This depends
largely on other conditions, as will be illustrated
paragraph. The methyl salts of oxygen acids are
ters, in opposition to the chloride, bromide, iodide,
and oxide, which are set apart as ethers. Broadly
, ethers are not, while esters are, readily decom-
y water into their components; but the nitrate
) behaves in this respect like an ether.

with Sulphuric Acid.—Methyl-alcohol mixes with
riol with considerable evolution of heat and (always
tial) conversion of the two ingredients into methyl
acid. Equal volumes of acid and alcohol give
eld. To prepare pure methyl sulphates, dilute
ture largely with water, avoiding elevation of
ure (which would regenerate the ingredients), and
with carbonate of baryta. Filter off the sulphate
to obtain a solution of the pure methyl sulphate
$_2$.Ba (where Ba = 137 eq.), from which this
sily obtained in crystals. From the baryta salt
r methyl sulphate is readily obtained by double
sition with a solution of the respective sulphate;
itself, for instance, by means of sulphuric acid.
r temperatures the reaction between vitriol and
lcohol results in the formation of methyl-ether,
, or of normal sulphate of methyl, $(CH_3)_2SO_4$.
r is a gas condensable into a liquid which, under
of one atmosphere, boils at −21° C.

dissolves in about one thirty-seventh of its volume of
more largely in alcohol and in ether; most abundantly
vitriol, which dissolves about six hundred times its
methyl-ether gas, thus affording a very handy means
g up the gas for use. The solution need only be diluted
n volume of water to be broken up into its components
ver).

ied oxide of methyl is now being produced on the
urious scale, and sold as a powerful refrigerating
One part of sulphuric acid is mixed with a little
part of dehydrated wood spirit, and the mixture
125° to 128° C. (130° being carefully avoided),
ethyl ether goes off. When the mixture is
d, more wood spirit is added to the residue so as
blish the original specific gravity (of 1·29), and
ing resumed, which again furnishes a supply of
and so on. This proves that the process is not, as
e supposed, one of mere dehydration, but a cycle
ns analogous to those in the ordinary process of
ation, as shown by the equation:—

$_4H_2 + CH_3OH = SO_4.HCH_3 + H_2O$.

$O_4 + H.CH_3 + H.O.CH_3 = SO_4(HH_2)(CH_3).O.CH_3$.

ter, $SO_4(CH_3)_2$, though obtainable by distillation of the
ith 10 parts of vitriol, is more conveniently prepared from
hyl sulphuric acid by distillation in vacuum at 130°–140°
$= 2SO_4CH_3.H + SO_4H_2 + SO_4(CH_3)_2$. It is a colourless
melling like peppermint, specific gravity 1·327 at 18°; it
87° to 188° C.

ide of methyl, CH_3Cl, readily produced by the action
chloric acid gas and hot methyl-alcohol (preferably
resence of chloride of zinc as an auxiliary dehy-
is a gas which, under ordinary pressure, condenses
uid at −23° C. The gas, at ordinary temperatures
very readily soluble in alcohol), is only sparingly
by water, which, however, at 6° unites with it
solid hydrate. Condensed methyl chloride has
an article of commerce, being largely produced
nethylamine (*vide infra*) and used as a powerful
frigorific agent, as well as for the extraction of perfumes from flowers. Regarding nitrite of methyl, NO—O—CH_3, its interesting isomeride nitromethane, O_2N-CH_3, and nitrate of methyl, NO_3CH_3 we must refer to the handbooks of organic chemistry.

Iodide of methyl, CH_3I, is obtained by distilling methyl-alcohol with hydriodic acid, which latter is best produced off-hand by addition to the alcohol of iodine and amorphous phosphorus. It is a colourless liquid of 2·269 specific gravity, boiling at 42·5° C., insoluble in water.

Organic Methyl Esters.—The more volatile ones are in general easily obtained by distillation of the respective acid with methyl-alcohol, or with methyl-alcohol and oil of vitriol (virtually $SO_4.H.CH_3$); the less volatile ones more conveniently by passing hydrochloric acid gas into a methyl-alcoholic solution of the acid. We have no space for the individual substances; but the salicylate $C_7H_5O_2.CH_3$ may just be named as being the principal component of the essential oil of *Gaultheria procumbens* (wintergreen oil).

Methylamines.—The general result of the action of ammonia on an ester is the formation of alcohol and acid amide. Example—

$$\underset{\text{Acetate of methyl}}{(C_2H_3O).O.CH_3} + HNH_2 = CH_3.OH + \underset{\text{Acetamide.}}{C_2H_3O.NH_2}.$$

With iodide of methyl this reaction is an obvious impossibility; what really takes place (as A. W. Hofmann has shown for this and all analogous cases) is that the iodide unites with the ammonia into the HI compound $HI.NH_2CH_3$ of a base NH_2CH_3, which can be separated from the acid by distillation with caustic potash, and when thus liberated presents itself as a gas surprisingly similar (almost to identity) to ammonia. The analogy extends to the action on iodide of methyl, which, in the case of methylamine, NH_2CH_3, leads to the formation of dimethylamine, $NH.(CH_3)_2$; and from the latter again trimethylamine, $N(CH_3)_3$, can be prepared by a simple repetition of the operation. These three amines are closely analogous in their chemical character to ammonia, the points of difference becoming the more marked the greater the number of (CH_3)'s in the molecule. Trimethylamine, having lost all its ammonia hydrogen, cannot possibly act upon iodide of methyl like its analogues. What it really does is to unite with the iodide into "iodide of tetramethyl-ammonium," $I.N(CH_3)_4$, analogous to iodide of ammonium, INH_4, we should say, if it were not the reverse, because the organic iodide (unlike its prototype, which is an ammonium compound only in theory), when treated with moist oxide of silver (virtually with AgOH), really does yield a solution of a true analogue of caustic potash in the shape of hydroxide of tetramethyl-ammonium, $N(CH_3)_4.OH$.

In regard to the actual preparation of these several bodies, which is not so simple as might appear from our exposition of their mutual relations, we must refer to the handbooks of organic chemistry. But we must not omit to state that trimethylamine, which only the other day was never seen outside a chemical museum, is now being manufactured on a large scale, and promises to play an important part in industrial chemistry. The waste liquors obtained in the distillation of alcohol from fermented beet-root molasses serve as a raw material for its preparation. These liquors, when evaporated to dryness and subjected to dry distillation, yield, besides tar and gases, an aqueous liquid containing large quantities of ammonia, acetonitrile, methyl alcohol, and trimethylamine. This liquor is neutralized with sulphuric acid, and distilled, when the nitrile and the methyl-alcohol distil over, to be recovered by proper methods. From the mixed solution of the sulphates of ammonia and trimethylamine the former is separated out as far as possible by crystallization; the mother-liquor

cilled with lime; the volatile bases are absorbed in chloric acid; the hydrochloric solution is evaporated; ne sal-ammoniac which comes out at first is, as far as le, fished out. The last mother-liquor is evaporated yness, and in this form represents commercial hylamine hydrochlorate. It is this product which for the preparation of methyl chloride (*vide supra*), ocess being founded upon the fact that a concentrated n of the salt, when heated, breaks up $3HCl \cdot N(CH_3)_3$ $N(CH_3)_3$ of free trimethylamine + $NH_4 \cdot CH_3HCl$ of chlorate of monomethylamine and $2CH_3Cl$ of methyl de.

se processes are being carried out industrially by nt in France. But this base trimethylamine seems ed to do more than provide us with a new refrigerat ent. The attempt has been made—it would appear, success—to utilize it for the preparation of pure ate of potash from native chloride of potassium, s ordinary ammonia, in the famous ammonia soda s, serves for the conversion of common salt into soda

yl Cyanides.—There are two distinct bodies which, by com- n and by synthesis, are both $CH_3 + NC$; they are named nitrile" (formerly called simply cyanide of methyl) and ide of methyl or methylcarbamine respectively.

onitrile was discovered by Dumas in 1847. It may be pre- by the distillation of a mixture of methylsulphate and of of potassium; but is obtained more easily and in a purer distilling acetamide with phosphoric anhydride. Acetate onia may be used instead of the amide, but it does not work

$CH_3 \cdot CO \cdot O(NH_4)$	$CH_3 \cdot CO \cdot (NH_2)$	$CH_3 \cdot CN$
Acetate of NH_3	Acetamide	Nitrile
$= A$ (say).	$= A - H_2O$.	$= A - 2H_2O$.

a colourless liquid of a pungent aromatic odour, with specific ·805 at 0°, and boils at 82° C. When heated with aqueous (at the wrong end of a condenser) it breaks up with for- of ammonia and acetate of potash. Whence we conclude e methyl is combined more directly with the carbon of the on, thus:

$$N\{C^{\prime\prime\prime}—CH_3\} + 2H_2O = NH_3 + CH_3 \cdot COOH.$$
Acetic acid.

conclusion is supported by the action on the nitrile of nascent en, which leads to the formation of ethylamine, thus (Men-

$$NC—CH_3 + 4H = H_2N \quad CH_2CH_3.$$
Ethylamine.

er case we pass from a monocarbon to a dicarbon body, y from methyl to ethyl alcohol.

isocyanide is prepared by heating iodide of methyl with e of silver (CH_3I; $2NCAg$) and ether in a sealed up tube to 140°, to produce the crystalline body $AgNC + NCCH_3$, and The double cyanide, when distilled with some water and e of potassium, breaks up into its components,—the $NCAg$ g $(NC)_2AgK$; and the cyanide of methyl distils over. It is a ss liquid, characterized by quite an unbearably irritating and ng smell. The specific gravity is ·756 at 14°, the boiling point It combines with hydrochloric acid into a crystalline salt s readily decomposed by water into methylamine and formic Whence we conclude that in this case the cyanogen is tied nethyl by its nitrogen; thus:—

$$C\{N—CH_3\} + 2H_2O = H \cdot COOH + NH_2 \cdot CH_3.$$
Formic acid. Methylamine.

thyl here remains methyl, being separated by an N from the on-carbon, which latter passes into formic acid.

must not close this section without at least referring to *ethylphosphines*, as being a set of bodies related to PH_3 hine) as the methylamines are to NH_3 (ammonia), and similar e in their chemical character, in so far as they are bases. ints of difference between the two series are of pretty much ne sense as those between the two prototypes. Thus, for e, while trimethylamine $N(CH_3)_3$ is a strong base, but inert gen gas, trimethylphosphine is a relatively feeble base, contact with air readily absorbs oxygen with formation of e $P(CH_3)_3O$, the like of which in the nitrogen series has no ce.

hur Compounds of Methyl.—Substances analogous to methyl- and methyl-ether respectively can be obtained by the dis- n of methyl sulphate of potassium with strong solutions of the potassium sulphides KHS and K_2S respectively. The $CH_3 \cdot SH$ is known as methyl-mercaptane, the other (CH sulphide of methyl. Both are very volatile stinking Sulphide of methyl claims a special interest as being the s point for the preparation of an important class of bodie trymethyl sulphine compounds. The sulphide $(CH_3)_2S$ unites with the iodide CH_3I into crystals of iodide of tri sulphine, $(CH_3)_3S \cdot I$, a substance which is closely analogou chemical character to the iodide of tetramethyl-ammonium. oxide of silver, for instance, converts it into a strongly basic h $S(CH_3)_3 \cdot OH$, which in its avidity for acids almost beats its a in the nitrogen family. An investigation of its salts was pu by Crum Brown and Blaikie.

Methyl Arsenides.—Arseniferous bases constituted like m di-methylamine (bodies such as AsH_2CH_3, analogous to NH do not seem to exist. What we do know of are—(1) a tri arsine and the iodide and the hydroxide of tetramethylars —$As(CH_3)_3$, $As(CH_3)_4I$, and $As(CH_3)_4OH$, bodies discove Cahours and Riche; (2) a whole series of monomethylic $As(CH_3)X_2$ (where X = Cl, Br, or X_2 = O,S), discovered by Ba 1857; (3) the kakodyle compounds, a series of bodies, $As(C$ or $As(CH \ldots X_2$, which were discovered and investigated by R. in 1842. The great investigation marks an epoch in the his organic chemistry, and our article would not be complete wit least a short summary of its result. Bunsen started in his inv tion with a liquid which had been obtained by Cadet as early a by the dry distillation of equal parts of white arsenic and ani acetate of potash, and which nobody cared to investigate fr it emits fumes which have an indescribably sickening smell intensity of poisonous action, compared with which that of arsenuretted hydrogen will appear insignificant. It was reserved for Bu attack this awful substance and force it to give an account o According to Bunsen, Cadet's liquid is substantially an $(AsC_2H_6)_2O$, which has strongly basic properties, readily ex its O for Cl_2, &c. To obtain the pure substance, the l distilled with corrosive sublimate and hydrochloric acid, w the first instance yields the pure muriate of the base $As(C$ in the form of a liquid volatile above 100° into vapours whi fire spontaneously in air. From this chloride of kakodyle t oxide is obtained by distillation with caustic potash. Th oxide emits no fumes, its specific gravity is 1·462; it boi 150°. A mixture of its vapour with air detonates at 50° C. the chloride again, Bunsen obtained the free radical *kak* $(AsC_2H_6)_2$ by treatment with metallic zinc in a special app so constructed that all the several operations involved co carried out without bringing the contents in contact with a necessary precaution, because kakodyle is a liquid which fire in air spontaneously even at ordinary temperatures. kakodyle is a heavy colourless liquid boiling at about 170° freezing at -6°. When exposed to oxygen or chlorine it destructive combustion; but on slow access of air it is oxidiz its oxide, $(AsC_2H_6)_2O$, and kakodylic acid; with chlorine it unites into the chloride which it came from; it also unites with sulphur and other elements, in short, it is exactly to dyle compounds what potassium is to potash and potash "a true organic element," as Bunsen himself put it. Th covery of Bunsen's was greeted with an enthusiasm whic difficult in these days to realize. With us now, a rad intrinsically as it was different in 1842. By the st of kakodyle the "radical" seemed suddenly rose from an un hypothesis to the rank of a theory based on experiment. however much our theoretical notions may shift, Bunsen's r will stand as a piece of monumental scientific work.

Kakodylic acid, $As_2O_3(CH_3)_2 \cdot OH$, is most conveniently pared from the oxide by addition of water and oxide of mer $H_2O + 2HgO$ supplying the $H_2 + O_3$ required for $1(AsC_2H_6)_2O$ is a crystalline monobasic acid, soluble in water. Unli kakodylides of the $As \ldots X_3$ type, it has no smell, and is violent poison. It takes six grains of it to kill a rabbit.

Metallic Methides.—Examples of these are—$Sb(CH_3)_3$; Sb $Mg(CH_3)_2$; $Zn(CH_3)_2$; $Pb(CH_3)_4$; $Al(CH_3)_3$; $Sn(CH_3)_4$. To idea of the chemical character of this interesting class of bo choose *zinc-methyl* as a representative example, and state the chief points of its chemical history. This body was discov Frankland in 1849. It is prepared by boiling iodide of meth granulated zinc in a flask connected with an inverted condens so contrived otherwise that the contents are protected agains of moisture and oxygen. Under these circumstances the i gredients gradually unite into a non-volatile and solid co $[Zn \cdot (CH_3)$. When this body is heated with more of io methyl, it undergoes decomposition, with formation of io zinc and of dimethyl gas, $I—Zn \quad CH_3 + CH_3I \quad ZnI_2 +$ which reaction to some extent takes place unavoidably in t paration of the zinc salt, however great an excess of metal taken. What survives needs only to be subjected to dry dist (in the absence of air) to yield a distillate of zinc-methyl:—

$$2I—Zn \cdot CH_3 = ZnI_2 + Zn(CH_3)_2.$$

methyl is a colourless liquid of 1·386 specific gravity at 10°·5, oils at 46° C ; in contact with air it takes fire. Water ses it at once into hydrate of oxide of zinc and marsh gas, $_2 + Zn(OH)_2 + 2CH_4H$. Of other reactions the following iamed. (1) When digested with sodium it yields a precipi- metallic zinc, and a double compound of itself and sodium- This latter unites readily with carbonic acid into acetate , $NaCH_3CO_2$ $CH_3 \cdot CO \cdot ONa$ (Wanklyn). (2) With of acetyl it forms acetone, $Zn(CH_3)_2 + 2CH_3 \cdot CO$, $Cl_2 = 2ZnCl_2(CH_3)_2$ (Frankland). (3) Under somewhat different condi- including the presence of an excess of $Zn(CH_3)_2$, a compound ed which with water, yields tertiary butyl-alcohol (Boutle-

$$2CO(CH_3)_2 + Zn(CH_3)_2 = (CH_3)_4 O \cdot Zn(CH_3)_2 = A ;$$
$$A + 2H_2O = ZnO_2H_2 + CH_4 + 2(CH_3)_3 \cdot OH.$$
tertiary alcohol.

(W. D.)

TRONOME, an instrument for denoting the speed h a musical composition is to be performed. Its on is generally, but falsely, ascribed to Johann uk Maelzel, a native of Ratisbon (1772–1838). It of a pendulum swung on a pivot, below the pivot ved weight, and above it a sliding weight that the velocity of the oscillations by the greater or less from the pivot to which it is adjusted. The silent ome is impelled by the touch, and ceases to beat the impulse dies; it has a scale of numbers marked pendulum, and the upper part of the sliding weight ed under that number which is to indicate the of a stated note, as M.M. (Maelzel's Metronome) or ♩ = 72, or ♩. = 108, or the like. The number 60

a second of time for each single oscillation of the m,—numbers lower than this denoting slower, and numbers quicker beats. The scale at first ex- from 50 to 160, but now ranges from 40 to 208. complicated metronome is impelled by clock-work, a ticking sound at each beat, and continues its action works run down; a still more intricate machine a bell which is struck at the first of any number ts willed by the person who regulates it, and so the accent as well as the time.

earliest instrument of the kind, a weighted pendulum able length, is described in a paper by Etienne Loulié 1696; Amsterdam, 1698). Attempts were also y Enbrayg (1732) and Gabory (1771). Harrison, ned the prize awarded by the English Government chronometer, published a description of an instru- or the purpose in 1775. Davaux (1781), Pelletier, Buga (1790), and Weiske (also 1790) described arious experiments for measuring musical time. In Gottfried Weber, the composer, theorist, and essayist, ed a weighted ribbon graduated by inches or smaller , which might be held or otherwise fixed at any length, and would infallibly oscillate at the same as long as the impulse lasted: this, the simplest, is correct, the most enduring, the most portable, and apt invention that has come before the world, e can but wonder that it has not been universally ed. Stockel and Znaeckall produced each an instru- and Maelzel made some slight modification of that former, about the end of 1812, which he announced w invention of his own and exhibited from city to city Continent. It was, as nearly as can be ascertained, 2 that Winkel, a mechanician of Amsterdam, devised for reducing the movement length of all existing ments, on the principle of the double pendulum, rock- both sides of a centre and balanced by a fixed and a e weight. He spent three years in completing it, is described and commended in the *Report of the Lands Academy of Sciences*, August 14, 1815. Maelzel oon went to Amsterdam, saw Winkel and inspected ention, and, recognizing its great superiority to what ed his own, offered to buy all right and title to it. Winkel refused, and so Maelzel constructed a copy instrument, to which he added nothing but the s numbers, took this copy to Paris, obtained a patent and in 1816 established there, in his own name, a factory for metronomes. When the impostor re Amsterdam, the inventor instituted proceedings him for his piracy, and the Academy of Sciences d in Winkel's favour, declaring that the graduated sca the only point in which the instrument of Maelzel d from his. Maelzel's scale was needlessly and arbi complicated, proceeding by twos from 40 to 60, by from 60 to 72, by fours from 72 to 120, by sixes fro to 144, and by eights from 144 to 208. Dr Crote structed a time measurer, and Henry Stuart (the vi and father of the composer of the same name) made a in 1821, both before that received as Maelzel's was in England. In 1882 James Mitchell, a Scotsman an ingenious amplification of the Maelzel clock reducing to mechanical demonstration what formerly wholly on the feeling of the performer. Al "Maelzel's metronome" has universal acceptance, th metronome and still more Weber's graduated ribb greatly to be preferred, for the clock-work of the liable to be out of order, and needs a nicety of reg which is almost impossible; for instance, when Sir Smart had to mark the traditional times of the pieces in the Dettingen Te Deum, he tested them by metronomes, no two of which beat together. The v the machine is exaggerated, for no living performe execute a piece in unvaried time throughout, student could practise under the tyranny of its bea conductors of music, nay, composers themselves, w the same piece slightly slower or quicker on d occasions, according to the circumstances of perform

METSU, GABRIEL, a Dutch painter of celebrity in 1630, died after 1667), is one of the few ar renown in Holland whose life has remained Houbraken, who eagerly collected anecdotes of in the 18th century, was unable to gather more fr gossip of his contemporaries than that, as early as Metsu, at the age of forty-three, submitted to a da surgical operation. The inference drawn by su readers from this statement has been that death imm ensued. A more careful perusal would have sho Houbraken knew that Metsu had given lessons Musscher in 1665. Local records now reveal that was the son of Jacques Metsu, who lived most of h at Leyden, where he was three times married. The these marriages was celebrated in 1625, and Ja Garnijers, herself the widow of a painter, gave Gabriel in 1630. Connected by both his parents w Metsu was probably taught first by his father and Gerard Dow. He probably finished his training Rembrandt. So far back as 1648, but a few days than Jan Steen, who is said to have painted his Metsu was registered in the painters' corporation at and the books of the guild also tell us that he rem member in 1649. In 1650 he ceased to subscribe, an bearing his name and the date of 1653 give counten the ef that he had then settled at Amsterdam, w continued his studies under Rembrandt. His com at the time would naturally be De Hooch and Meer, whose example he soon followed when it cam turn to select the class of subjects for which his fitted him. Under the influence of Rembrandt duced the Woman Taken in Adultery, a large pictu the date of 1653, in the Louvre, in which no on suspect the painter of high life or taverns were it his name is written at full length on the canva artist who thus repeated the gospel subjects fam

and Eeckhout was also acquainted with the Oriental
be of Rembrandt, and ready to use it, like all his
poraries. But he probably observed that sacred
s ill suited to his temper, or he found the field
ongly occupied, and happily for himself, as well
his admirers, he turned to other subjects for
ne was better fitted. We may doubt whether he
he style of allegory as illustrated in a picture of
Protecting Virtue and Chastising Vice in the
of the Hague. There is every reason to think that
ugh and frosty composition was wrought by quite
master. What Metsu undertook and carried out
he first with surprising success was the low life of
rket and tavern, contrasted with wonderful versa
y incidents of high life and the drawing room.
of these spheres he combined humour with expres-
keen appreciation of nature with feeling, and breadth
elicacy of touch, unsurpassed by any of his contem-
s. In no single instance do the artistic lessons of
andt appear to have been lost upon him. The same
les of light and shade which had marked his school-
the Woman Taken in Adultery were applied to
s of quite a different kind. A group in a drawing-
series of groups in the market place, a single figure
gloom of a tavern or parlour, was treated with the
felicity by fit concentration and gradation of
a warm flush of tone pervaded every part, and, with
ne study of texture in stuffs was carried as far as it
en by Terburg or Dow, if not with the finish or
o of De Hooch. Metsu's pictures are all in such
ble keeping, and so warm and harmonious in his
or so cool and harmonious in his closing time,
ey always make a pleasing impression. They are
ubtle in modulation than Dow's, more spirited and
in touch than Terburg's; and, if Terburg may of
laim to have first painted the true satin robe, he
ainted it more softly or with more judgment as to
than Metsu.

Metsu married and became a citizen of Amsterdam
would only prove that his residence in the com-
capital of the Netherlands was later than historians
enerally assumed. But there is no reason to think
etsu claimed his citizenship at once. The privileges
rgess were given in exchange for a payment of dues,
ese painters had various ways of avoiding unless they
d. One of the best pictures of Metsu's manhood is
rket-place of Amsterdam, at the Louvre, respecting
it is difficult to distribute praise in fair proportions,
llent are the various parts, the characteristic move-
nd action of the *dramatis personæ*, the selection of
he expression and the gesture, and the texture of
ngs depicted. A tin can in the arm of a cook is a
of imitation, but the cook's face is also a marvel
ression. Equally fine, though earlier, are the
nan (dated 1661) and the Tavern (also 1661) at the
and Dresden Museums, and the Game-Dealer's Shop,
Dresden, with the painter's signature and 1662.

is one of the painters of whose skill Holland still pre-
xamples, yet whose best pictures are either in England or in
or in the galleries of Germany. The value of his works is
d at the Pommersfelden sale in 1867 the Jealous Husband
g his Wife's Letters, though but one of several replicas,
ght by Lord Hertford for little short of £2000, while for
e of the Prince of Orange, in the Gsell collection at Vienna,
was paid by Baron Rothschild in 1873. (J. A. C.)

TTERNICH, Clemens Wenzeslaus, Prince (1773–
first minister of Austria from 1809 to 1848, was
n of a Rhenish nobleman employed in high office by
ustrian court. He was born at Coblentz in 1773.
age of fifteen he entered the university of Strasburg.
rench Revolution was then beginning. Everywhere
the spirit of hope gave to men's language an exaltati
a confidence hardly known at any other epoch. B
darker reality soon came into view. Metternich
witness of the riot in which the town-hall of Strasbu
pillaged by a drunken mob; his tutor subsequently
a member of the revolutionary tribunal in Alsace.
are to trust to Metternich's own account of the for
of his opinions, the hatred of innovation, which
ruling principle of his later life, arose from his exp
of the terrible results which followed at this time fr
victory of so-called liberal ideas. But in reality Met
was an aristocrat and a conservative by birth and
His sentiment in things political was that of a men
a refined and exclusive society which trusts to no
gence but its own, and hardly sympathizes with
interests. The aggressions and violence of the Revo
from 1789 to 1799 gave Metternich an historical ba
his political theories, but the instinctive preferences
own mind were the same from first to last. He beg
as a young man of fashion and gallantry. His m
in 1795 with the Princess Kaunitz, a granddaughter
famous minister, fixed him in the highest circle of A
nobility. His first contact with the great political
was at the congress of Rastadt in 1798, where, und
auspices of the victorious French republic, arrange
were made for compensating the German princes and
whose possessions on the left bank of the Rhine had
ceded to France by the peace of Campo Formio. Met
was the accredited agent of a group of Westphalian
his private letters give a vivid picture of the roug
uncouth diplomatists who had succeeded to the p
servants of the old French monarchy. In 1801 Met
was appointed Austrian ambassador at Dresden,
1803 he was promoted to Berlin; but he had
become as yet a prominent man in Europe. His
Berlin was the turning point of his life. The war
third coalition was impending. Austria united with E
and Russia against Napoleon, and the task of the y
ambassador was to win over the court of Berlin
cause of the allies. Metternich seems to have d
that it was possible for him to do; but Prussia p
in its neutrality. The earnestness with which Met
had worked against France did not prevent him
remaining on the friendliest terms with M. Lafo
French ambassador at Berlin; and so agreeable an a
of him was transmitted to Paris by his rival that,
close of the conflict, Napoleon himself requeste
Metternich might henceforward represent Austria
Tuileries. Metternich was accordingly sent to P
1806. This was the beginning of the period when A
humbled but not exhausted by the blow of Austerl
by the losses accompanying the peace of Pressburg
mined, under the leadership of Count Stadion, to
for another war on a greater scale. But the sudde
throw of Prussia, and the alliance between Fran
Russia which was made at Tilsit in 1807, added imm
ably to the difficulties of the court of Vienna. It
clear that Napoleon was intending to dismember
and to gain for himself some part of the spoils of th
man empire. Metternich's advice was that Austria
endeavour to detach the czar from the French allian
by this means frustrate the plan of partition, but,
Russia held fast to Napoleon, that Austria itself shoul
with the two aggressors, and secure its share of
Oriental affairs, however, fell into the backgroun
in the summer of 1808 Metternich was convinc
Napoleon was intending to attack Austria, though
mediately. He warmly supported Count Stadion's
in raising the forces of Austria to the highest st
and, although he did not share the minister's hop

rising throughout Germany, he expressed in his
hes no distrust of the power of Austria to cope
Napoleon. This is the more singular because,
he disastrous issue of the campaign of 1809,
nich seems to have taken credit for having
l the policy of war. Napoleon again captured
; the battle of Wagram was lost; and after a long
tion Austria had to purcha e peace by the cession
of Austrian Poland and of its Illyrian provinces.
nich, who had virtually taken Count Stadion's place
ately after the battle of Wagram, was now installed
ter of foreign affair . The first striking event
ok place under hi administration wa the marriage
e Louise, daughter of the emperor Francis, to his
ror Napoleon. To do justice to Metternich's policy
be remembered that the alliance of Tilsit between
and Ru ia was still in existence, and that Austria
te as much threatened by the czar's designs upon
as by Napoleon's own aggressions. Metternich
seems, in spite of his denials, to have been the real
of the family union between the house of Hapsburg
onaparte, a most politic, if not a high-spirited
, which guaranteed Austria against danger from
t, at the same time that it gave it at least some
t of security from attack by Napoleon, and enabled
nich to mature his plan for the contingency of an
e breach between France and Russia. In 1812 this
occurred. Metternich, in nominal alliance with Napo-
nt a small army into southern Russia, allowing it to
erstood by the czar that the attack was not serious,
ollowed the annihilation of the French invaders.
Prussia, led by its patriots, declared war against
on, Metternich, with rare and provoking coolness,
s hand, merely stating that Austria would no longer
itself as a subordinate ally, but would act with all its
one side or the other. The result of this reserve
t Metternich could impose what terms he pleased on
and Prussia as the price of his support. The armies
se two powers, advancing into central Germany,
no match for the forces with which Napoleon took
l in the spring of 1813; and the hard fought battles
zen and Bautzen resulted in the retreat of the allies.
the combatants had made an armistice, Met-
tendered Austria's armed mediation, requiring
to content itself with the restoration of its territory
the Elbe, and leaving Napoleon a tendency in
y almost untouched. Napoleon, after a celebrated
w with Metternich, madly rejected terms
t every Prussian writer has denounced Metternich's
l of them as an act of bitter enmity to Prussia.
night of the 10th of August the congress of Prague, at
Austria, as armed mediator, laid down conditions of
was dissolved. Metternich himself gave order for
ghting of the watch fires which signalled to the
in Silesia that Austria had declared war against
on. The battle of Leipsic and the campaign of
n France followed, Metternich steadily pursuing the
of offering the most favourable terms possible to
on, and retarding the advance of the allied armies
he French capital. Metternich had nothing of that
l hatred towards the great conqueror which was
ant both in Prussia and in England; on the contrary,
he saw with perfect clearness that, until Napoleon's
es were much diminished, no one could be safe in
, he held it possible to keep him in check without
ing him, and looked for the security of Austria in
ablishment of a balance of power in which neither
nor France should preponderate, while Prussia
be strictly confined within its own limits in northern
ny. The assistance of the Austrian army, which
was no doubt necessary to the allies, had, so far as re
to Prussia, been dearly purchased. When, at the begin
of 1813, Prussia struck for the freedom of German
leading statesmen and patriots had hoped that the r
of the war of liberation would be the establishmen
German unity, and that the minor German princes,
had been Napoleon's vassals since 1806, would be force
surrender part of their rights as sovereigns, and subm
a central authority. This dream, however, vanishe

Austria entered the field as an ally. It wa
part of Metternich's policy to allow anything so re
tionary as German unity to be established, least o
under the influence of Prussian innovators. He
treaties with the king of Bavaria and Napoleon's
German vassals, guaranteeing them, in return for
support against France, separate independence and
reignty when Germany should be reconstructed. Ac
ingly, though the war resulted, through Napol
obstinate refusal of the terms successively offered to
in the limitation of France to its earlier boundaries and
large extension of Prussia's territory, the settlemen
Germany outside Prussia proceeded upon the lines
down by Metternich, and the hopes of unity raise
1813 were disappointed. A German confederation
formed, in which the minor sovereigns retained sup
power within their own states, while the central autho
the federal diet, represented, not the German nation
the host of governments under which the nation
divided. Metternich even advised the emperor Franc
Austria to decline the old title of German emperor
liking any open embodiment of the idea of German u
and preferring to maintain the ascendency of Austri
a gentle pressure at the minor courts rather than by
avowed exercise of imperial rights. In this unprogre
German policy Metternich was completely succes
His great opponent, Stein, the champion of German
and of constitutional systems, abandoned his wor
despair, and refused the useless post of president o
diet, which Metternich, with a kind of gentle irony, of
to him.

The second branch of Metternich's policy in 181
was that which related to Italy. Following the old ma
of Austrian statesmanship, Metternich aimed not on
securing a large territory beyond the Alps but at ma
the influence of Austria, predominant throughout the It
peninsula. The promises of national independence w
had been made to the Italians when they were called
to rise against Napoleon were disregarded. In the s
clauses of the first treaty of Paris the annexation of
Lombardy and Venetia was guaranteed to Austria, an
rest of Italy was divided into small states as of
Napoleon's return from Elba led to the downfall of M
who had been allowed to retain the kingdom of Naples
to the reunion of this country with Sicily, under the Bou
Ferdinand. After the second overthrow of Napo
Metternich endeavoured to make every Italian sove
enter into a league under Austria's presidency. Ferdi
of Naples accepted the position of vassal, but the pope
the king of Sardinia successfully maintained their
pendence. With the construction of the German federa
and the partial construction of an Italian federation,
under Austria's guidance, the first part of Metter
career closes. He had guarded Austria's interests
great skill during the crisis of 1813 and 1814. It wa
his own fault, but the fault of ages, that Austria's int
were in antagonism to those of German and of It
nationality. He thought as an Austrian, and as no
else; his task was to serve the house of Hapsburg, an
he did with signal ability and success. To denc
Metternich as a kind of criminal, according to the pr

sian writers, because he did not work for German
s to ignore the existence of such a thing as state
Judged by the ordinary standards of practical
and dips, not by the philosophy of history,
rich's action in 1813 and 1814 was that of a very
r man, and the qualities of calmness and dexterity
he displayed would have given an infinitely greater
ness to the life of his great rival Stein, who in
e and moral enthusiasm was so far above him.
second part of Metternich's career, which extends
15 to 1848, is that of a leader of European concert.
It is difficult to describe his attitude towards
all the great questions which were now arising
but one of absolute blindness and infatuation.
knowledged that exceptional circumstances in the
d made it possible for England to exist under a
tutions he knew that France would not surrender
ritto given to it by King Louis XVIII., but in all
rent state he maintained that there were no alter
but absolute monarchical government and moral
His denunciation of liberal and reformers
here and at all times are perfectly childish, and in
instances his hatred of change led him into errors
ment not surpassed in the annals of political
When Napoleon fell, there was a prospect of the
tion of constitutional government throughout a
art of Europe. King Frederick William, stimulat
effort of the Prussian people against France by the
of liberty, had definitely promised the establishment
al a general assembly. The czar had determined to
e parliamentary life into the kingdom of Poland,
n hoped to extend it, after some interval, to Russia.
deral Act drawn up for Germany at the congress of
declared that in every state within the German
a constitution should be established. Against this
movement of the age Metternich resolutely set his
Though wide general causes were at work, the
influence of the Austrian statesman had no small
in prolonging the existence of autocratic government,
developing that antagonism between the peoples
eir rulers which culminated in the revolutions of
The nature of the Austrian state, composed of so
heterogeneous provinces and nationalities, no doubt
natural for its representative to defend and exalt
ciple of personal sovereignty, on which alone the
f Austria was based; the relation of Austria to Italy
d the growth of the sentiment of nationality a real
of danger to the house of Hapsburg; but Metternich's
ence of constitutional and popular ideas was more
e outcome of a calculating policy. He was not a
much faith, but one belief he held with all the force
tious conviction,—namely, the belief that his own
d mission in the world was to uphold established
ty. All efforts to alter the form or to broaden the
f government he classed under the same head, as
of the spirit of revolution; and in one of his most
writings he places side by side, as instances of evil
for its own sake, the action of the secret societies
many, the Carbonaria of Italy, and the attempt of
glish to carry the Reform Bill. Working on prin
like these, and without the shadow of a doubt on
wisdom, Metternich naturally proved a great power
me when the sovereigns who had inclined to constitu
ideas began to feel the difficulties in the way of
them into practice. Metternich's advice, tendered
very grace of manner and with the most winning
suasive art, was indeed not hard for rulers to accept,
simply recommended them to give up nothing that
d got. It was at the congress of Aix-la-Chapelle
that the retrograde tendency, which was now suc-
ceeding to the hopes of 1815, first gained expression
agitation among the students at the German univer
caused some scandal in the previous year, and secret
had just been discovered in Russia. Metternich pl
king of Prussia with argument for withholding the
representation which he had promised to his peop
stimulated the misgivings which were arising in the
of the czar, hitherto the champion of European libe
A few months later the murder of Alexander
agent, Kotzebue, by a fanatical student gave Metter
excellent pretext for organizing a crusade against
liberty. A conference of ministers was held at Ca
The king of Prussia allowed his representative to
Metternich's lead. The resistance of the constit
minor states proved of no avail; and a series of reac
was passed which made an end of the freedom of th
throughout Germany, and subjected the teaching
discipline of the universities to officers of state. A c
tion was established at Mainz to investigate the consp
which Metternich alleged to have been formed for th
throw of all existing government, and for the creati
German republic, one and indivisible. To the followi
new articles were added by Metternich's direction
Federal Act, the most important being on
forbade the creation in any German state of an a
representative the community at large, and enjoi
system of representation by separate estates or order
possessed of certain limited definite rights, and al
subordinate to the supremacy of the crown. Met
would gladly have made an end of the parliamenta
stitution, which had already come into being in Bava
the southern states; but he was unable to attac
openly, and had to confine himself to the advo
strict monarchical principle through his representat
these courts. With regard to Prussia, however,
completely successful. The king of Prussia bro
promise of establishing a national representatio
satisfied his conscience by creating certain powerl
provincial diets, exactly as Metternich had recommende
Throughout Germany at large a system of repres
carried out against the advocates of constitutiona
The press was silenced; societies were dissolved
tions became more and more common. While Met
imagined himself to be stifling the spirit of dissent
was in fact driving it into more secret and more
courses, and convincing eager men that the regen
of Germany must be sought not in the reform but
overthrow of government.

Meanwhile revolution broke out in Spain and
Ferdinand of Spain, who had restored despotism, w
pelled, in March 1820, to accept the constitution
which he had subverted. The same constitutio
accepted a few months later by Ferdinand of
Spain was outside Metternich's range, but his ha
heavily upon Naples. A congress of the great pow
held at Troppau in October 1820. Metternich, w
president, as he had been at Vienna, and continued t
later congresses, completely won over the czar to h
views. Resolutions in favour of an intervention, i
case by force of arms, against the Neapolitan liberal
movement were adopted by Austria, Russia, and Prussia,
England and France held aloof. The congress w
adjourned to Laibach in Carniola, whither Ferdin
Naples was summoned, in order that he might
between the powers and his people, and induce th
to give up a constitution which offended the three m
courts. Ferdinand's journey and mediation were a
ture as regarded the Neapolitans, he pretended
went to negotiate on behalf of his people, when in
intention was exactly the same as Metternich's, nam

bsolute monarchy restored. The proceedings of
ngress at Laibach were a farce. A letter was
ed by Metternich for King Ferdinand to send to
jects, informing them that the powers would not
the constitution to exist, and that, in default of
ubmission the allied courts would employ force.
ish Government, while protesting against the joint
of the three powers as an assumption of international
entry, was perfectly willing that Austria, as a state
ened by the Neapolitan revolution, should act on
account. Metternich however, continued to treat
eapolitan question as the affair of Europe, and
ined his concert with Russia and Prussia. Early
l an Austrian force came in the name of the allies,
l central Italy. The armies opposed to it col
and the Austrians entered Naples on March 24.
the meantime a revolution broke out in Pied
which threatened to cut off the Austrians from
upport, and to raise all Italy against them. For a
t the bold action of Metternich seemed to have
l in immense danger both to his own conservative
and to the peace of Europe, for it was believed that
dmont's revolution would be answered, not only
eneral Italian movement, but by a rising against
rbons in France. The cloud, however, passed away.
was quickly restored in Piedmont; Lombardy was
eld by Austrian garrisons; and the conclusion of
lian difficulties in which Metternich had played a
fficult part with great resolution and dexterity, was
plete and brilliant personal triumph. No statesman
ope at this moment held a position that could com
th his own.

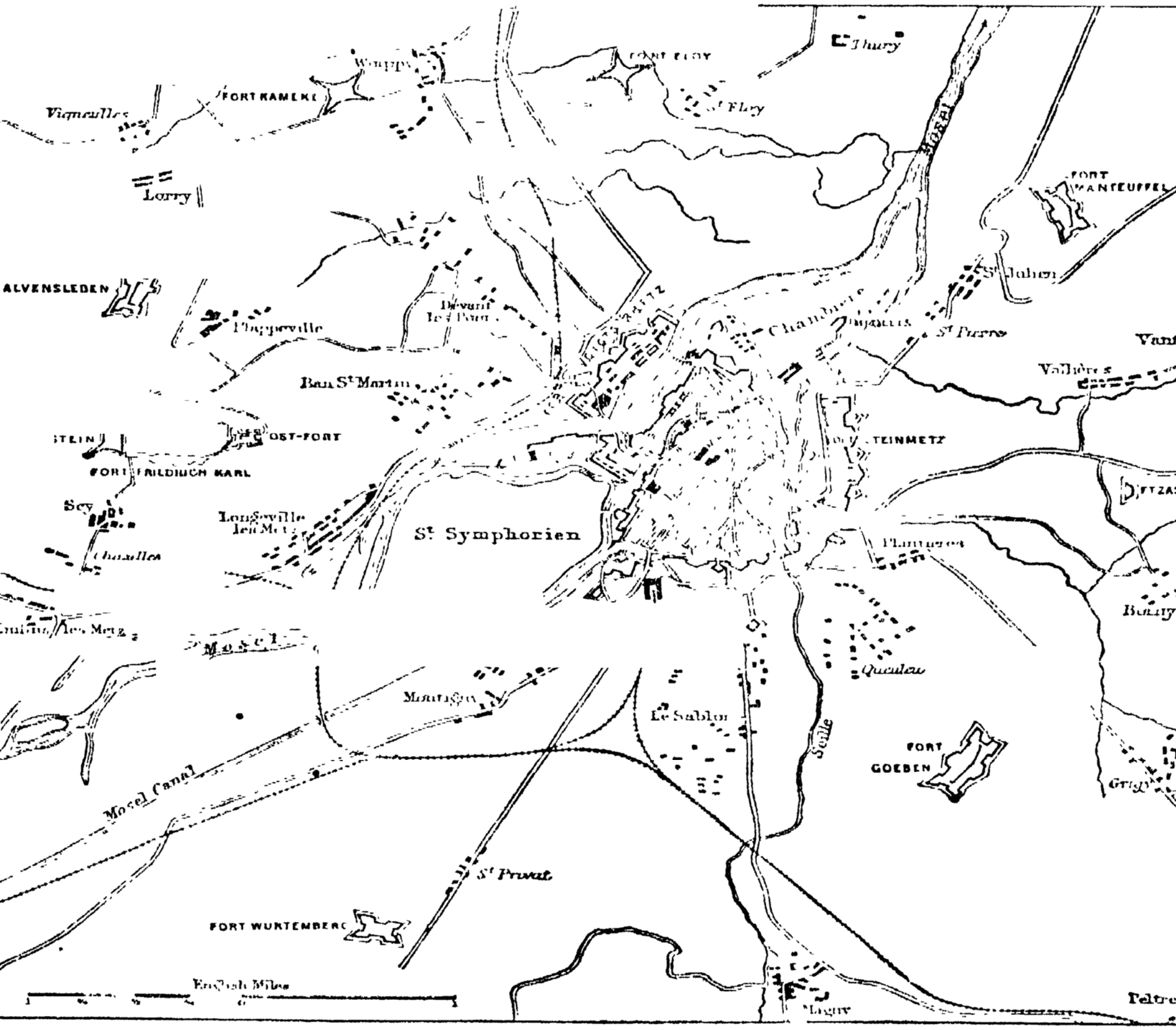
he congress of Verona, held in 1822, the affairs of
were considered by the powers. In the end, the
constitution was overthrown by a French invading
but, though the army employed was that of France
nciple of absolutism which animated the crusade
at which Metternich had made his own. A severe
however, now met him in another quarter. Greece
n against Turkish rule in 1821. The movement
entually a national and a religious one, but Metternich
it as a Jacobinical revolt against lawful authority,
ring, or affecting to confuse, the struggle for national
dence with the shallow and abortive efforts of politi-
alism in Italy and Spain. Metternich's attitude
the Greeks was for some time one of unqualified
y. If, under the pressure of the Tilsit alliance, he
been willing that Austria should join Russia in
ding Turkey, he had now reverted to the principle
intaining Turkey at all costs against a Russian
southward, and he attributed the Greek move-
to the efforts of Russian agitators unauthorized by
r. His desire was that the sultan should deprive
of all possible cause for complaint as regarded its
eparate interest, and so gain freedom to deal sum-
with the Greek. Metternich's hopes failed, partly
h the obstinacy of the Turks, partly through the
ng conduct of Alexander, and partly through the
of Castlereagh and the accession of Canning to
It was in great part owing to Canning's moral
t that Greece ultimately became an independent
and the extraordinary violence of Metternich's
ge whenever he mentions this English statesman
only too well the impotent character of his aims.
ulteran has left a more damning record against
f than Metternich in his bigoted abuse of Canning.
rock question, however, was only the first on which
dgment of events was now beginning to declare itself
Metternich and all his principles. The French
tion of 1830 shattered the moral fabric which he had so proudly inaugurated, and in great part
raised, in 1815. The accord that grew up be
England and France now made any revival
kind of presidency that he had once held in
impossible. He was indeed bold and rapid in
my troops into the papal territory when revolut
movements broke out there in 1831 and 1832, thoug
with France seemed likely to result from this step
was as unsparing as he had been in 1819 in suppress
agitation which after 1830 spread from France to Ger
and the union of the three eastern courts was one
exhibited in the meeting of the monarchs which took
at Munchengratz in 1833, and in a declaration delive
Paris, insisting on their right of intervention
revolution in other countries. It was, however, th
czar of Russia, Nicholas, who was now the real h
European conservatism; and the stubborn charact
narrow, unimaginative mind, of this prince m
impossible for Metternich to shape his purposes
delicate touch which had been so effective with h
decessor. But in Austria itself Metternich co
without a rival. In 1835 the emperor Francis
whom he had worked for nearly thirty years,
Metternich, himself falling into the mental habits
age, remained at the head of the state. 1848
revolution of that year ended his political caree
resigned office with the dignity of demeanour whi
never failed him; his life was scarcely safe in Vien
the old man came for a while to England, which
not visited since 1794. Living on till June 1859,
every great figure of his earlier life, and many that
peared on the horizon since his own prime, pass awa
a few more months of life would have enabled him
the end of that political order which it had been
work to uphold, for the army of Napoleon III. was c
the Sardinian frontier at the moment when he die
before a second summer had gone Victor Emmanu
been proclaimed king of Italy.

Metternich was a diplomatist rather than a stat
is influence was that of an expert manager of indiv
not of a man of great ideas. All his greatest wo
done before fifty; and at an age when most statesm
in the maturity of their powers he had become
and pedantic. His private character was very
He was an affectionate if not a faithful husb
delightful friend, and a most tender father. T
cessive egotism which runs through his writing
perhaps an impression of weakness which did not
belong to his nature. Drawn by a firmer pen, th
in which he describes himself labouring in the C
conferences of 1820, while his favourite daughter wa
in an adjoining room, would have been one of th
affecting things in political biography. The ma
could so have worked and felt together must have po
no ordinary strength of character, no common force
ntrol.

The collection of Metternich's writings published by hi
under the title of *Denkwurdigkeiten*, along with Fren
English editions, contains letters and despatches of grea
The autobiography is not always trustworthy, and must be r
caution. Gentz's correspondence is of first-rate importance
years 1813–30. Original papers are also contained in
German works upon particular events or movements,
Oncken for the negotiations of 1813; Welcker, Aegidi, N
for German affairs in 1819 and following years; Proke
Osten for Eastern affairs. (C.

METZ, the capital of German Lorraine, and one
strongest fortresses in Europe, is situated at the con
of the Moselle and the Seille, 80 miles to the nor
of Strasburg, and 190 miles to the east of Paris.
the seat of a military governor, the judicial and adm
tive authorities of Lorraine, a Roman Catholic

tant and Jewish consistories, and a chamber of com
The general appearance of the town is quaint and
lar, but there are also many handsome modern streets.
oselle flows through it in several arms, crossed by
n or fifteen bridges. In the south west corner of
wn is the esplanade, an extensive open space com
ng a fine view of the fertile "Pays Messin" around
The most interesting of the ten city gates is the
l'Allemagne or Deutsches Thor, a castellated structure
l in 1445, and still bearing traces of the siege of
s V. Metz contains seven Roman Catholic churches,
two Protestant churches, and a synagogue. The cat
with huge pointed windows, slender columns, and nu
flying buttresses, was begun in the 13th centu
finished in 1546, and belongs to the decadence
Gothic style. The Gothic churches of St Vincent
Eucharius, and the handsome garrison church, con
in 1881, also deserve mention. Among secular bu
the most important are the large covered mark
town-hall, the palace of justice, the theatre, the gov
house, and the various buildings for military pu
The public library contains 35,000 volumes, includ



Metz and Neighbourhood.

1 Palace of Justice. 4 Town Hall and Governor's House.

ve collection of works relating to the history of
e. In the same building is the museum, which
s a picture gallery, a numismatic cabinet, and a
on of specimens of natural history. Metz also
es several learned societies and charitable institu
a gymnasium, three seminaries, and a military
y. The cemetery of Chambiere contains the graves
0 French soldiers who died here in 1870.
commerce and industry of Metz have not yet
y recovered from the blow inflicted by the with
of French capital in 1871. The principal articles
nufacture are leather, coarse cloth and canvas, gun
powder, arms, needles, billiard tables, hats, and a
flowers. There are several large iron-works in the
bourhood. The trade of Metz is chiefly carried
leather, timber, wine, brandy, liqueurs, beer, pr
fruits, and hardwares. A large annual fair is held
The civil population of Metz, which in 1869 amo
to 48,066, sank in 1872 to 33,131. Since then
steadily increased, and in 1881 was 43,270, abou
of whom were Germans. The garrison of Metz c
of 10,000 men, or including the surrounding
nearly 16,000. The total of 58,813 includes 17,00
testants and 1600 Jews.

z —Metz, the Gallic Divodurum, was the chief town of the
ntiner, and was stormed by the Roman Mediomatrici, a
on which the present form has been derived by contraction
ecembers it one of the oldest and most important towns
The Romans recognized its great importance,
it and upheld it with water by an aqueduct,
ins of which, called "Les Arches," still exist. Under the Roman emperors Met
nected by military roads with Trier, Reims, Lyon, Strassburg, Besançon, and Trèves. Christianity was introduced
3d century, and in the course of the 4th century
n was planted by the Bishop Clemens, subsequently
ne the patron saint of the town. In 451 it was pillaged
ns of Attila. On the partition of the Carolingian
nt Metz fell to the share of Lothaire, and formed the
ince Lorraine. Its struggle for creation to be free
century have been crowned with success, powerful Metz acquired
ideur of a free imperial town in the 14th century and
great commercial prosperity. In 1552 it fell into the
of the French three years previously, and was heroically and
ally defended against Charles V by the young duke of
It was in vain that a French provincial town and
garrison of some 10,000 to 22,000 men. At the
e Westphalian Metz with Toul and Verdun, was formally
France by the peace, but it remained for upwards of
ntury. In Nov. 1870 the circle of the German troops
at Metz became and the French army of the Rhine
held the fortification of Metz, which were further
perfected by the Germans to a prodigious height. After
nt of ten weeks, during which not a single shot was fired at
s, Bazaine capitulated unconditionally to the victorious army
173,000 men, 6000 horses, 622 mounted cannon, and immense
of military stores of all kinds. By the peace of Frankfort
Metz was again united to the German empire. Marshal
ne, General Cambriels, and Kellermann were natives of Metz.
ttle Metz has always been of the highest importance
ve rank with Strassburg as one of the two great bulwarks
west frontier of Germany. The original town walls were
e in part in 1550, and the citadel was built in 1562. Its
works were reconstructed by the celebrated military
Vauban. Under Napoleon III the fortifications were three
meet the demands of modern warfare, and since 1871 the
have spared neither time nor money in completing and
ngthening its plan. The present fortifications of Metz
two lines, an inner circle of bastion and rampart crowned
rt cut and an outer circle of large detached forts on the
ing hills. The inner line is strengthened by two citadels
ne advanced à cheval de pont on the left bank of the
The outer circle consists of nine or ten large forts, con
ach to each other by smaller fortifications and commanding
pproaches to the city. They form a large fortified camp
circumference of 36 miles, within which are twelve villages
ir country houses and farms. The most distant of
ese forts is about 3½ miles from the cathedral. Their
ct position may be seen on the annexed plan. Previous
the name of Metz had never ascended to any pro-
ce of information. We refer to *die Kämpfe der Stadt Metz*, 1870–71, by Georg
ter von Langenau, 1886, and *Statistisch-topographische Beschreibung*
Metz. The official German account of the blockade of Metz in 1870
ers to the history of the Franco-German war issued by the General
Staff. An account according to Count Lang, *Die Kämpfe um Metz im Jahr* 1870, 2d ed., Metz 1870.

LEN ANTONY FRANCIS VAN DER (1631–1690),
ed to Paris about 1666 by Colbert, at the instance
Brun, to fill the post of battle painter to Louis XIV.
n 1631 at Brussels, he had at an early age eclipsed
ster Peter Snayers, and the works executed by him
Ian of France during the campaigns of Flanders
ded Louis, that from that date Van der
was ordered to accompany him in all his expedi
In 1673 he was received into the French Academy,
ained the grade of counsellor in 1681. Lodged in
ble hôtel richly pensioned and loaded with honours,
d at Paris in 1690. Detached works from his hand
be seen in various collections, but he is best repre
by the series of twenty-three paintings, mostly
ed for Louis XIV, now in the Louvre. They show
always retained his Flemish predilections in
ot colour, although in other respects his style was
ed by that of the French school.

Jean-André Rouquet, Les Artistes Anglois ou Peintres, 1755; Descamps, *Vies des Peintres Flamands*.

'URTHE ET MOSELLE, a department in the north-
France, formed in 1871 out of those parts of the old departments of Meurthe and Moselle which con
French, and deriving its name from the two principa
which water it. Prior to 1790 it belonged to
Lorraine, or to one or other of the bishoprics of Tou
and Verdun. It lies between 5° 25′ and 7° 5′ E
and 48° 25′ and 49° 5′ N. lat., and is bounded on
by Alsace-Lorraine, on the N. by Belgium and the
duchy of Luxemburg, on the W. by the departm
Meuse, and on the S. by that of Vosges. The sup
area is 2030 square miles. Geologically Meu
Moselle has five well-marked regions, following each o
regular succession from east to north-west. On the f
of Alsace are the Vosges mountains, of Trias an
(*grès Vosgien*), with a maximum elevation of 300
A narrow band of variegated sandstone divides the
from the second region, formed of shelly limestone,
extends as far as the Meurthe on the north and the
on the west. The third region is formed by the var
marls which cover the rich-saline strata of the neig
hood of Nancy. The Jura limestones of the L
Oolite, to the north-west and west of the departmen
the last two regions. Here there is a maximum el
of 1400 feet, and the plateau of Briey stretches out t
that of the Ardenne. Between the Vosges a
Ardenne the valley of the Moselle runs from so
north, forming the main artery of the departmen
lowest level (570 feet) occurs where the river lea
Only a small part of the drainage of Meurthe et
flows into the Meuse. The Moselle runs north-wes
at entrance into the department at Bras, a little
from Toul to Frouard, where it receives its pr
affluent, the Meurthe, and becomes navigable, nort
Frouard to Pagny sur Moselle, passing to Pont à M
The principal affluent of the Moselle are the Mad
the Orne on the left, and on the right, besides the M
the Seille, which in one part of its course for
boundary of Alsace-Lorraine. The Meurthe, whic
to the north-west from Raon l'Etape to Frouard, pa
to Baccarat, Lunéville, St Nicholas, and Nancy,
swelled on the right by the Vezouse and the Sane
on the left by the Mortagne. The principal tribu
the Meuse within the department is the Chiers, whic
its course by Longwy and Longuyon. Climatol
Meurthe et Moselle belongs to the Vosgian region
mean annual temperature is 52° Fahr., being 2°
lower than that of Paris (which has the same la
The thermometer in severe winters falls to 13°
while in summer it reaches 100° Fahr. This is
accounted for by the general elevation of the depa
the proximity of the mountains, the arrangement
valleys (which lie open towards the north), and t
tance from the sea.

More than half of the department consists of cultivable la
fourth of forests, and one tenth of meadow land. In 18
were 54,346 horses, more than 100,000 sheep, 85,000 pigs
cattle, 15,000 goats, 21,000 dogs, and 17,000 hives of bee
crops for the same year amounted to 454,192 quarters o
37,500 quarters of barley, 35,078 quarters of rye, 570,884
of oats, 9,079,125 bushels of potatoes, and 76,868 tons of h
Hops, tobacco, colza, hemp, and flax also occupy a cons
area. The annual yield of the vineyards (56 square miles in
exceeds 900,000, the wines of Toul are the best. T
common fruit trees are the pear, the apple, the walnut, the
and the plum. Of forest trees the oak and the wych-elm
frequent in the west of the department, the beech and t
the Vosges. The French school of forestry has its seat at
The metallurgic industry is highly developed, and has m
rapid progress within the last few years. Even in 187
was a consumption of 350,000 tons of coal, four fifths c
came from Saarbrück, and the remaining fifth from Belgi
1877 the iron ore obtained amounted to 1,000,000 tons, o
two-thirds came from the beds near Nancy, the remaine
the neighbourhood of Longwy. In 1880 the department p
a third of the pig-iron made in France (more than 500,0

the yield was 13 000 tons Beside- blast furnace , forge , ng-mills, there are manufactories of tiles and boring tool , ural implement , and furniture In the production of salt artment holds the fir t rank in France ; the salt-bearing ver more than 150 square mile , the beds having a mean s of 65 feet. The principal salt working centres (St Nicolas, ville, and Rosières aux Salines) lie between Nancy and e ; the annual value of rock salt and refined salt produced 4,500,000 , subsidiary to the production i an important ture of soda salts The other chemical product are of potash, bone black wax candles , soap and marble marrying and the manufacture of plaster and lime are also t branche of industry The flint glass manufactory at , which employs nearly 1500 workmen i well known, plate glass at Cirey with 1000 workmen produce plate sizes The faience manufactories of Lunéville, Toul, and are important Mention may also be made of the ture of window-glass, watch glasses, and drinking bo e acco manufacture at Nancy employ 1000 workmen tan ove making, hat making in felt and straw, wool printing, manufacture of army clothing are also carried on Nancy ined for it embroidery, which i however unimportance It also possesses factories for cotton printed on stuffs, but for hosiery The lace manufactories and ories , especially that of Tantonville, the largest in France, ploy protective Nancy also carries on distilleries, granulated sugar, manufacture of pasteboard objects and a large establishment The commerce of the department is facilitated by 700 miles of railway (the principal line being that from Strasbourg through Nancy , by a number of good roads, several navigable rivers and canals The most important waterway is that by the canal between the Marne and the Rhine, which Toul and Nancy, and traverses the department from west to The canal communicates with the Moselle, which enters the department from Frouard downwards, and with the new eastern canal, which unites the Moselle to Saint Epvre, and which is intended to connect the Marne and the Moselle with the Saône and the Rhone. The population of Meurthe et Moselle on 1st January 1891 was 419,674 souls It comprises the diocese of Nancy in the court of appeal of Nancy and forms a part of the district of the 6th army corps (Châlons sur Marne) There are 4 arrondissements (Nancy, Lunéville, and Toul , 29 cantons and 594 communes The chief towns are Nancy (the capital of the department, the seat of a university, of a prefect, and of a fortified place, population 68,130) and Pont à Mousson, celebrated for its glass wool

MEUSE, Maese, or Maas, a river of France, Belgium, Holland, discharging into the North Sea or German Ocean, has a course (variously measured) of some 500 or 600 miles, about 300 miles lying within France Rising in the department of Haute Marne (1345 feet), at a point on the plateau of Langres bordering on the Monts Faucilles, it follows a winding course, first from south to north, then north-west, and afterwards to north, across the department of Vosges, Meuse, and Ardennes, passing by Neufchâteau, Vaucouleurs, Commercy, St Mihiel, Verdun, Stenay, Mézières, and Givet Naturally navigable below Namur, it has been made so from Troussey, where it meets the canal which unites the Marne to the Rhine, and from Namur to Liege it admits vessels of from 6 to 7 feet draught. After traversing a wide valley covered by green meadows, the Meuse, below Mézières, flows through narrow gorges confined between rocky walls 200 or 300 feet high, bordered by the plateau of the Ardennes The hills of the Ardennes, by which it is hemmed in on its upper course, and its receiving any important affluent before the Sambre and the Semoy, which both fall into it on the right from the Ardennes. At the point where it leaves France its mean volume is about 1000 cubic feet. In this part of its course it flows picturesquely between the districts of Famenne and Condroz on the right, and those of Les Fagnes and Hesbaye on the left. Above Dinant it receives the Lesse, whose valley is celebrated for its wonderful grottoes, and at the foot of the citadel of Namur it is joined on the left by its principal affluent, the Sambre, whose north-easterly direction for 60 miles. It then takes its course through the hilly valley in which Huy, Seraing, and Liege are situated, receiving further on its right the Ourthe. Resuming a northerly direction, after making one to the north-west, and finally one to the west, the Meuse passes in front of the Dutch city of Maestricht to Roermonde, so called from it connection there with the Roer, and to Venlo, where the canal between the Meuse and the Scheldt begins Flowing thence through an absolutely unbroken plain, it finally joins the Rhine which it gives it own name, although the volume of water is twenty times less than that of the German It is at Gorcum that the Waal, the first separate branch of the Rhine, brings to the Meuse two-thirds of the volume of that river The Meuse soon after divides into two branches While the Merwede flows due west, the Old Meuse arm falls into the Biesbosch, an estuary of the sea, formed two hundred and fifty years ago by an irruption of the sea over a country then cultivated and thickly peopled, and now the object of attempts at reclamation. On reaching Dordrecht, where the river navigation and canal traffic meet, and where the raft which come down from the Black Forest are broken up, the Meuse again divides into two arms The Old Meuse flow due west while the northern arm joins the Lek, a second branch of the Rhine, and continues its course to Rotterdam. This is the important branch of the estuary of the Meuse and Rhine are being made to regulate and deepen it channel by constructing new canals in which the locks are so skilful Schiedam and Vlardingen, both on the right, are the first places of importance on the banks of the river.

MEUSE, a department in the north-east of France, formed out of a part of Lorraine and portions of the Three Bishoprics, the Clermontais, and Champagne, derives its name from the river by which it is traversed from south to north. It lies between 4° 56' and 5° 50' E long and between 48° 26' and 49° 38' N lat, and is bounded on the N by Belgium and the department of Ardennes, on the E by that of Meurthe et Moselle, on the S by those of Vosges and Haute Marne, and on the W by those of Marne and Ardennes. Of its superficial area, (1,247 square miles), about one half belongs to the basin of the Meuse, which is enclosed to the east and west by the eastern and western Argonnes. On the north-east it is watered by the Orne, a tributary of the Moselle, by the Chiers, which runs by Montmedy, and joins the Meuse a little beyond the northern limit of the department, and by other half and its waters to the Seine through the Aisne, a tributary of the Aisne, both of which take their rise in and by the Ornain, an affluent of the Saône, the latter being tributary to the Marne The Meuse, the most important river in its course through the department, has its highest elevation (1358 feet) to the south where the line of the ridge which separates the basin of the Meuse from that of the Seine The height gradually from south to north, but seldom falls below 1000 feet. The hill of the western Argonne similarly sink rapidly in the valley of the Aire, where the lowest level of the department (377 feet) is reached The climate of the is transitional between the region of the Seine and that of the Vosges, it winters are less severe than those of the latter but it is not so temperate as the former The mean annual temperature is 52° Fahr. As at Paris, the mean cold is 9° Fahr; the greatest heat rarely exceeds 90° Fahr.

More than half the surface of the department consists of arable lands, one fourth of forest, one tenth of meadow The proportion of horses is larger than in any other French department except La Manche There are 53 800 horses, 99,000 cattle, 115,000 sheep, 125,000 pigs, and nearly 30,000 bees The potatoes, and beet-root are the chief crops, and 1 77 to 966 of wheat, 101,660 quarters of barley, 58 650 quarters of 7 677,374 bushels of potatoes, beside peas, hemp, and flax vineyards produced more than 6,600,000 gallons of wine quality. The forests which are principally of oak, nourish game, as are the rivers in fish. The mineral wealth of the

ludes iron ore, good free stone, and fossil phosphates of lime. ; blast-furnaces, iron, copper, and bell foundries, wire- nd manufactories of tiles, hardware, and edge tools. The rming factories employ 15,000 spindles and 12,000 frames ben manufacture employs 5000 people and one hundreds re also employed in the spinning and weaving of hemp, flax, . The glass works, particularly the manufactory of painted ss, transferred after the war of 1870 from Metz to Bar- ; paper mills, saw-mills, and flour mills as well as the ture of straw, tiles, and woollen cloth are worthy of mention and embroidery is also carried on for a great number of ps. and the department has long been celebrated for its confectionery ontains more than 300 miles of railways, the principal lines at from Paris to Strasburg through Bar-le-Duc and Com- mercy, that from Paris to Metz through Verdun, and the line to the Meuse. The chief waterways are the canal com the Marne with the Rhine, and the canal of the Meuse; t together have a length of 146 miles. The population of the ment in 1881 was 289,861, a small number in proport its extent, and with a tendency to decrease. Ecclesiastic form the diocese of Verdun, it has its court of appeal at and constitute part of the district of the army corps of C sur-Marne. There are 4 arrondissements, Bar-le-Duc, Com Montmedy, and Verdun,—28 cantons, and 586 communes. le-Duc (population in 1881, 17,185) is the capital, Co has 5260 inhabitants and Montmedy 3000. St Mihiel (59 the Meuse, has good churches and some remarkable rocks, the seat of the departmental assize court.

MEXICO

I. ANCIENT MEXICO

The name Mexico is connected with the name of the people of Anahuac (q.v.) tribes calling themselves *Mexica* (*Mexi'ca*, or *Aztec*. The word is related to or to one the name of the Mexican national war god (better known as Huitzilopochtli). The Aztec from the 12th century appear to have migrated from place to ver the mountain-walled plateau of *Anahuac*, the ey, the water-encircled from its salt lagoons, and now known as the valley of Mexico. About 1325 anded on the lake of Texcoco the permanent settle- f Mexico Tenochtitlan, which is still represented by ital city Mexico. The name Mexico was given by panish conquerors to the group of countries over the Aztec power more or less prevailed at the time European invasion. Clavigero (*Storia Antica del* ., vol. i.) gives a map of the so-called "Mexican which may be roughly described as reaching from ent Zacatecas to beyond Guatemala. It is noted at both these names are of Mexican origin, derived ively from words for "straw" and "wood." Eventu- exico and New Mexico came to designate the still ions of Spanish North America, which (till cut by changes which have limited the modern republic ico) reached as far as the Isthmus of Panama on th and took in California and Texas on the north. in this wide sense it is of high interest to the ological, from the several native American civiliza- which appear within its limits, and which con- ly it loosely group themselves round two centres, xican proper and the Central American.

n early in the 16th century the Spaniards found ly from the West Indian Islands to this part of the nent of America, they came in view of nations cultured ove the level they had hitherto met with in the New Here were not rude and simple tribes like the s of the Antilles, but nations with organized armies, administrators, courts of justice, high agriculture chanical art; and, what struck the white men ally, temple-buildings whose architecture and sculpture ften of dimensions and elaborateness to astonish the rs and sculptors of Europe. How a population of s could inhabit a world whose very existence had ill then unknown to geographers and historians, and s nations could have reached so high a grade of ic industry and grandeur, was a problem which lly excited the liveliest curiosity of scholars, and gave a whole literature. Humboldt and Acosta shared inion of their time that the great fossil bones found xico were remains of giants, and it was argued that, re the deluge there were giants on the earth, there Mexico was peopled from the Old World in ante n times. On the other hand the multitude of American languages suggested that the migration rica took place after the building of the tower of Babel, and Sigüenza arrived at the curiously definite that the Mexicans were descended from Naphtuhim, Mizraim and grandson of Noah, who left Egypt for shortly after the confusion of tongues. Although speculations have fallen out of date, it is to be remem in their favour that they were stepping stones to mor argument; especially they induced the collection of traditions and invaluable records of races, language customs, which otherwise would have been lost for Even in the present century Lord Kingsborough w to spend a fortune in printing a magnificent compila Mexican picture writings and documents in his *Anti of Mexico* by his zeal to prove the theory advoca Garcia a century earlier, that the Mexicans were t tribes of Israel.

Real information as to the nations of Mexico Spanish times is very imperfect, but not altogether ing. It is derived partly from inspection of the themselves, their languages and customs, which n now briefly considered, before going on to the recoll handed down in the native picture-writings and ora tions. The remarks made by the accurate and expe observer Alexander von Humboldt, who had seen American tribes than almost any traveller, are still to the greatest weight. He considered the Americans of both continents to be substantially n race characters. Such a generalization will consider it, as is now generally done by anth gists, the Eskimo with their pyramidal skull complexion, and flat noses are removed into a by themselves. Apart from these polar nomad American indigenes group roughly into a sing or division of mankind, of course with local var If our attention is turned to the natives of Mexico ally, the unity of type will be found particularly The native population of the plateau of Mexico, Aztecs, may still be seen by thousands without any mixture of European blood, and the following desc may give a fair idea of them appearance.[1] Their st somewhat low, estimated about 5 feet 3 inches, bu are of muscular and sturdy build. Measurements skulls show them mesocephalic (index about 78), o mediate between the dolichocephalic and brachyc (narrow and wide skulled) types of mankind. The oval, with low forehead, high cheek bones, lon sloping outward towards the temples, fleshy lips, no and in some cases flattish but in others aquiline, moulded features, with a somewhat stolid and expression. Thickness of skin, masking the muse been thought the cause of a peculiar heaviness in t lines of body and face; the complexion varies from brown to chocolate (about 40 to 13 in the anthrop

[1] References may be found in Bancroft, *Native Races of th States*, vol. i. pp. 21, 573, 618, 646.

eyes black; straight coarse glossy black hair; and moustache scanty. Among variations from pe may be mentioned higher stature in some districts, ghter complexion in Tehuantepec and elsewhere. If e native Americans be compared with the races of gions across the oceans to their east and west, it will that their unlikeness is extreme to the races east f them, whether white Europeans or black African other hand they are considerably like the Mongoloid s of North and East Asia (less so to the Polynesians), the tendency among anthropologists is now generally nit a common origin, however remote, between the of Tartary and of America. This original connexion, ay be accepted, would seem to belong to a long past to judge from the failure of all attempts to discover nity between the languages of America and Asia. atever date the Americans began to people America, ust have had time to import or develop the numerous s of language actually found there, in none of which mmunity of origin been satisfactorily proved with er language group, at home or abroad. In Mexico he languages of the Nahua nations, of which the is the best known dialect, show no connexion of with the language of the Otomi tribes, nor either of ith the languages of the regions of the ruined cities tral America, the Quiche of Guatemala and the Maya atan. Indeed, within the Mexican limits, there are other language which, so far as philological h can at present decide, are independent of one . The remarkable phenomenon of nations so in bodily make but so distinct in language can be met except by supposing a long period to have since the country was first inhabited by the rs of peoples whose language has since passed into rent forms. The original peopling of America may te from the time when there was continuous land n it and Asia.

ould not follow, however, that between these remote d the time of the discovery of the New World by ns no fresh immigrants can have reached America. ay put out of the question the Scandinavian sea who sailed to Greenland about the 10th century, and afterwards to have coasted New England (see v, vol. i. p. 706), but do not seem to have found their enough southward for their visit to have any effect ico. But at all times communication has been open ast Asia and even the South Sea islands to the west f America. The importance of this is evident when sider that Japanese junks now drift over by the urrent to California at the rate of about one a year, ith some of the crew still alive (see C. W. Brooks in ft, vol. v. p. 51; *Overland Monthly*, San Francisco, p. 353). Further north, the Aleutian islands offer f easy sea passage, while in north-east Asia, near g's Strait, live Chukchi tribes who carry on inter- with the American side; the presence of Eskimo in rt of Asia (see Nordenskiold, *Voy. of Vega*, vol. ii. pp. 13, so plainly due to local migration that it is neglected paring the languages of the two continents. Asiatics s Japanese or Kurile Islanders, if they found their small numbers to America and merged into native might hardly leave descendants distinguishable he rest of the population even in the first genera or introduce their own language. Such assertions as e Guatusos of Costa Rica are a tribe with fair skin xen hair, and that Japanese words may be detected the Indians of British Columbia, are examples of ce which may be worth further sifting; but in an t like the present no proofs can be admitted unless far authenticated than these. What gives a more solid interest to the question of Asiatic influence in Ame that, though neither the evidence of features nor of la has substantiated it, there are details of Mexican civil which are most easily accounted for on the supposit they were borrowed from Asia. They do not seem enough to have to do with a remote Asiatic origin nations of America, but rather to be results of compar modern intercourse between Asia and America, pr since the Christian era. Humboldt (*Vues des Cor* pl. xxiii.) compared the Mexican calendar with that in eastern Asia. The Mongols, Tibetans, Chines other neighbouring nations have a cycle or series of animals, viz., rat, bull, tiger, hare, dragon, serpent, goat, ape, cock, dog, pig, which may possibly be an tion of the ordinary Babylonian-Greek zodiac fam ourselves. The Mongolian people not only count lunar months by these signs, but they reckon the suc days by them, rat-day, bull-day, tiger-day, &c., and by combining the twelve signs in rotation with th ments, they obtain a means of marking each year sixty-year cycle, as the wood-rat year, the fire-tiger ye This method is highly artificial, consisting, not in numbering, but in combining series of different te that the same combination does not recur till the the period. Thus the reappearance of its principle Mexican and Central American calendar (see p. 212) gestive of importation from Asia. Humboldt also di the Mexican doctrine, represented in the native pictu four ages of the world belonging to water, earth, a fire, and ending respectively by deluge, earthquake, te and conflagration. The resemblance of this to versions of the Hindu doctrine of the four ages or y of so remarkable a closeness as hardly to be accounti except on the hypothesis that the Mexican theolog tains ideas learnt from Asiatics. Among Asiatic pe resemblance to which attention has since been ca the Mexican belief in the nine stages of heaven an an idea which nothing in nature would suggest dire a barbaric people, but which corresponds to the of successive heavens and hells among Brahman Buddhists, who apparently learnt it (in common wi own ancestors) from the Babylonian Greek a trans theory of successive stages or concentric planetary s belonging to the planets, &c. The Spanish chr also give accounts of a Mexican game called *patolli* at the time of the conquest with coloured stones on the squares of a cross-shaped figure, according throws of beans marked on one side, the descripti this rather complicated game correspond closely wi Hindu backgammon called *pachisi* (see Tylor in *Anthrop. Inst.*, vol. viii. p. 116).[1]

The native history of Mexico and Central Ame entitled to more respect than the mere recollecti savage tribes, inasmuch as here memory was aid something like written record. The Mexican pictu far approached writing proper as to set down legi names of persons and places and the dates of events the rude drawings which accompanied these a helped the professional historians to remember the tions repeated orally from generation to generation. actual documents of native Aztec history, or co

[1] The appendix to Prescott's *Conquest of Mexi* con interesting summary of analogies between the civilization of and that of the Old World, but some of the arguments are ver elsewhere. One which has been often cited turns on the likene by Naxera between the Chinese language and that of the Otom of Mexico (whose name survives in that of their town Otompa Otumba). The examination of an Otomi grammar (such as *de la Grammaire Othomi*, Paris, 1863) will, however, conv philological reader that the resemblance is hardly of an an found a theory of a Chinese connexion upon

re still open to the study of scholar , while atter nquest interpretation of these were drawn up m by Spanish educated Mexicans , and hi tories l on them with the aid of traditional memory were by Ixtlilxochitl and Tezozomoc the mo t important picture writings , interpretation and hi tories may nd in Kingsborough's *Antiquities of Mexico* In Mexican the row of complex hieroglyphs to be ainted on the cotton cloth probably served n purpose up to the time of the Spanish invasion ument purporting to be hi tories , written down e in later time the more or le represent real of the pa t, but the task of separating the preponder thical part from what is real hi tory is of the utmost Among the most curious document of early the *Popol Vuh* or national book of the Quiche n of Guatemala, a compilation of tradition written y native sages found and translated by Father about 1700, not published by Scherzer (Vienna, and Brasseur de Bourbourg (Paris, 1861) The ompared to a picturesque barbaric style becomes time when there was only the heaven with its s toward the four wind but as yet there wa notion that clung to anything else nothing that lt elt or rubbed together or made a sound , there ght below but the calm sea alone in the ilent Alone were the Creator, the Former, the Feller, the Serpent, they who give being and whose name Then follow the creation when the creator with and the earth was formed like a cloud or a fog, mountain appeared like lobsters from the water, and pine covered the hill and valley , and then were peopled with beast and bird , but these could ik the name of their creators, but could only chatter d So man was made first of clay, but he was ile and crushed and melted in the water then ade a race of wooden mannikins , but these were creature without heart or mind, and they were d by a great flood, and pitch poured down on them aven those who were left of them being turned ape till to be seen in the wood After this he creation of the four men and their wives who ince for of the Quiche , and the tradition record nation of the nation to Tulan, otherwise called the Save and the race across the sea, whose waters were for they pre ent It is worth while to mention w early incident of the national legend of ada, because them Biblical incidents how how tradition incorporated matter learnt from the white Moreover, the Central American document, mythical hi an historical importance from its bringing in belonging also to the traditions of Mexico proper Quetzalcoatl, 'Feathered Serpent,' corresponds in name Mexican deity Quetzalcoatl , Tulan and the Seven are familiar word in the Aztec migration tradition, even mention of a chief of Toltecat, a name determinate to the famed Toltecs, of whom further t will be given to their place in Mexican history he legend of the *Popol Vuh* confirm what is learnt omparing the tradition of Central America and Mexico that, though the nation of these districts were not ted by language the intercourse and mixture n them had been sufficient to implant in them much n civilization, and to justify the anthropologist in ng both districts in one region Hi torical value of mary kind may be found in the latter part of the *Vuh*, which gives name of chief down to the time hey began to be n Spanish name , and the great city he became the deserted ruin of Santa Cruz. The district of Yucatan has also some vestiges of native traditions in the manuscript translated by D. Pio (in Stephens, *Incidents of Travel in Yucatan*) and remarkable 16th century *Relacion de las Cosas de Y* by Diego de Landa, published by Brasseur de Bou (Paris, 1864) As in the Guatemala traditions, w of ancient migration from the Mexican legendary of Tula , and here the leaders are four famous ch ancestors , who bear the Aztec name of the Tutul Xiu, interpreted means "Bird Tree Unfortunately f historical standing of these four ancestors , there are Aztec picture writings representation of four tre with a bird perched on it, and placed facing th quarters , which make it probable that the four Tutul tradition, in spite of the circumstantial detail of the and migration may be only mythic personifications four cardinal points (see Schultz Sellack in *Zeitsch. f.* 1879, p. 209) Nevertheless , part of the later Maya may be genuine for instance , when they relate th about three centuries before the Spanish conquest, wh king of Chichen Itza de troyed the great city of Ma Though the name and dates of Central American kings have too little interest to general reader for tra of them to be dwelt on here, they bring into view portant historical point, that the wondrous ruined this region are not to be thought monuments of a race in a forgotten past, but that at least some belong to history, having been inhabited up to the co apparently by the very nations who built them

Turning now to the native chronicles of the N nations, these are found to be quite central dated going back to the 12th or 13th century with some but not worthless recollections of national event from some centuries earlier These last mentioned trad in some measure borne out by linguistic evidence of of place , tribes , and persons, point to the immigra detachments or branches of a wide-spread race , spea common language, which is represented to us Aztec, still a spoken language in Mexico This la was called *nahuatl*, and one who spoke it a hi tongue was called *nahuatlecatl*, so that modern pologists are following native precedent when they term *Nahua* for the whole serie of people now consideration[1] Earliest of the Nahua nations, the are traditionally related to have left their norther of Huehuetlapallan in the 6th century and, thou remote date cannot be treated as belonging to hi tory, there is other evidence of the real existence nation Their name *Toltecatl* signifies an inhabi *Tollan*, "land of reeds," a place which, as has been pointed out, appears elsewhere in the national tradit this region, and has a definite geographical site present Tulan or Tula, north of the valley of A where a Toltec kingdom of some extent seems to ha its centre. To this nation is ascribed not only the but the highest culture of the Nahua nations , t was due the introduction of maize and cotton into the skilful workmanship in gold and silver, the art o ing on a scale of vastness still witnessed to by the m Cholula, and to be Toltec work , the Mexican hiero writing and calendar are also declared to have Toltec origin. With the Toltecs is associated the mys tradition of Quetzalcoatl, a name which presents i Mexican religion as that of a great deity, god of and in legend as that of a saintly ruler and civilize brown and beardless , worshippers describe him as of race, a white man with noble features, long black h full beard, dressed in flowing robes . He came from

[1] It should be noticed that this word is not etymologic nected with the somewhat similar word *Anahuac*, of which t ing is given at page 206

n Yucatan (for the stories differ widely), and dwelt
years among them, teaching men to follow h
and virtuous life, to hate all violence and war, to
e no men or beasts on the altars, but to give mild
gs of bread and flowers and perfumes, and to do
e by the votaries drawing blood with thorns from
wn bodies. Legend tells stories of his teaching men
writing and the calendar, and also the arts of work
silversmith, for which Cholula was long famed. Last
he departed, some say towards the unknown land of
an, but others to Coatzacoalco on the Atlantic coast
confines of Central America where native tradition
eps up the divine names of Cucumatz among the
s (see p. 208) and Cukulcan among the Mayas, these
having the same meaning as Quetzalcoatl in Aztec,
Feathered Serpent.' Native tradition held that
Quetzalcoatl reached the Atlantic he went back in
ion to tell he Cholulans that in a future year he
n, white men and bearded like himself, would land
rom the sea where the sun rises and come to rule
ntry. That there is a basis of reality in the Toltec

ons is shown by the word *toltecatl* having become
the later Aztecs a substantive meaning an artist
ed craftsman. It is further related by the Mexican
ns that the Toltec nation all but perished in the
entury by years of drought famine, and pestilence,
nly of the survivors remaining in the land, while the
grated into Yucatan and Guatemala, where, as has
eady pointed out, their name is commemorated in
ecords. After the Toltecs came the Chichimecs,
name, derived from *chichi*, "dog," is applied to
rude tribes, the Chichimecs here in question are
have come from Amaquemecan under a king named
names which hence Aztec imply that the nation
ahua; at any rate they appear afterwards as fusing
ore cultured Nahua nations in the neighbourhood
neco. Lastly is recorded the Mexican immigration
seven nations, Xochimilca, Chalca, Tepaneca,
a, Tlahuica, Tlascalteca, Aztaca. This classification
Nahuatlac tribes has a meaning and value. It is
at Aztlan, the land whence the Aztecs traced their
nd source, cannot be identified by geographers, while
ry of the separation of the seven nations at the place
Chicomoztoc or Seven Caves looks like national legend
than real history. But the later stages of the long
migration seem historical, and the map of Mexico
ows the names of several settlements recorded in the

migration map published by Gemelli Careri (*Giro*
ndo, Venice, 1728) and commented on by Humboldt;
these local names are Tzompan, "place of skulls,"
mpango in the north of the Mexican valley, and
tepec, "grasshopper hill," now a suburb of the city
ico itself, where the Aztecs are recorded to have
ted in 1195 the festival of tying up the "bundle of
and beginning a new cycle. The Aztecs moving
lace to place in Anahuac found little welcome from
hua peoples already settled there, whose own history
leed one of incessant jealousy and quarrel. One of
st clear events of the Aztec arrival is their being
tributary by the Tepanecs, in whose service
they began to manifest their warlike prowess
ht near Tepeyacac, where now stands the famous
of Our Lady of Guadalupe. Thus they overcame in
he Acolhuas, their superiors in civilization, who had
Tezcuco a centre of prosperity and improvement.
13th century the Aztecs by their ferocity had
their neighbours together against them; some
driven to take refuge on the reedy lake shore at
co, while others were taken as captives into
ican. The king of this district was Coxcoxtli,

whose name has gained an undeserved reputation
European as "Coxcox, the Mexican Noah, from a
the native picture writing where his name appears
with the figure of a man floating in a dug-out tree
has been mistaken even by Humboldt for a re
tation of the Mexican deluge myth. Coxcoxtli
the help of the Aztecs against the Xochimilcas
but his own nation, horrified at their bloodthir
ness of prisoners, drove them out to live for ye
want and misery on the island and swamps
great salt lagoon, where they are said to have ta
making their *chinampas* or floating gardens
heaped on rafts of reeds and brush, which in later
were so remarkable a feature of Mexico. A one
Aztec chiefs at the time of the founding of their
called Tenoch, *i.e.*, "Stone-cactus," it is likely tha
him was derived the name Tenochtitlan or "Stone
place." Written as this name is in pictures or re
probably suggested the invention of the well-known
of a prophecy that the war-god's temple should b
where a prickly pear was found growing on a roc
perched on it an eagle holding a serpent, this le
still commemorated on the coat of Mexico. A
Tenochtitlan, founded about 1325, for many years
ward probably remained a cluster of huts, and the
civilization of the country was still to be found am
other nations, especially among the Acolhua on T
The wars of this nation with the Tepanecs, which w
into the 15th century, were merely destructive, but
effects arose from the expedition under the Culhu
Acamapichtli, where the Aztec warriors were pro
and which extended far outside the valley of M
Especially a foray southward to Quauhnahuac, now
navacq, on the water-bed between the Atlantic and
caused the bringing of cold-mith and other craftsme
to Tenochtitlan, which now began to become great, the
laying aside their rude garments of aloe-fibre for
costly clothings, and coming out as traders for
merchandise. In the 15th century the last great
struggle took place. The Acolhua had at fi
advantages, but Ixtlilxochitl did not follow up th
Aztecs but allowed them to make peace whereupon
profession of subjection, they fell upon and sei
city of Tezcuco. The next king of Tezcuco, Nezahua
turned the course of war, when Azcapotzalco the T
stronghold, was taken and the inhabitants obliged
the conquering Acolhuas and Aztecs, the place th
graded became afterwards the great free market of
In this war we first meet with the Aztec name Moteu
afterwards so famous in its Spanish form Mont
About 1430 took place the triple alliance of the A
Aztec, and Tepanec kingdoms whose capitals were T
Mexico, and Tlacopan the latter standing much be
other two. In fact the Aztecs now became so power
that the rest of native history may be fairly cal
Aztec period, notwithstanding the picturesque mater
and intellectual culture which made Tezcuco ce
under Nezahualcoyotl and his son Nezahualpilli
the first Montezuma was crowned king of the Az
Mexican sway extended far beyond the valley pr
to Oaxaca, and the goal of conquered nations are
their shrines set up in Tenochtitlan in manifest ant
to the temple of Huitzilopochtli, the war-god of th
conquerors. The rich region of Quauhnahuac
tributary; the Miztec country was invaded, south
the Pacific, and the Xicalanco region to which re
Cruz. It was not merely for conquest and tribute t
fierce Mexicans ravaged the neighbouring lands, but th
a stronger motive than either in the desire to
multitudes of prisoners whose hearts were to be t

y the sacrificing priests to propitiate a pantheon of gods ho well personified their bloodthirsty worshipper. The sire for war captives as acceptable victims is related to ave brought about an almost incredible agreement among ation of the Mexican alliance, that they should from me to time fight battles among themselves in order to rovide prisoners for the altars. Thus there was something the character of a religious war in the expedition made 1469 under Axayacatl as far down the isthmus as ehuantepec, whence the Mexican army came back with ad of rich plunder and thousands of captives, and the ter ravages of the Totonac recorded as far as the Atlantic, hen the inhabitants were taken for sacrifice and their nd recolonized by Aztec. Montezuma left the Aztec mpire (as it is often somewhat ambitiously called) at the eight of apparent power but the cruel oppression of the ubject regions had made their life almost unbearable, and he second Montezuma, coming to a rule already labile to reak up from within, weakened it still more by upholding he claims of chief or noble against the common people hose warrior and trader had in great measure made

he property of the allied nations. The Mexican had ng tried to subjugate the stubborn little nation of Tlax llan (Tlaxcala) which had obstinately held out, though so ommanded in their very midst the people lived without salt, this ing no longer to be had from the sea coast. Montezuma ade a last effort to crush them, but in vain, and when he Spaniard came they were there as ready made allies anted on the high road to Mexico. From the date when he festival of the new cycle was first celebrated in hapultepec (a 52 year period) had passed when in 1507 he new fire, symbolizing the beginning of a new cycle as kindled for the last time on the breast of a human ictim. Rumours of the coming of the Europeans may ave before the date spread from Cuba, but in 1517 ordova touched in Yucatan, and in 1518 Grijalva was n the east coast of Mexico, and the Aztecs first met the hite men in whom they saw (partly with hope and partly ith fear) the fulfilment of the prophecy that Quetzalcoatl ould one day return. With the Spanish conquest under ernando Cortes (see Cortes) the native history of Mexico me to an end.

Civilization

While the purer tribes of America lived under the loose ay of chiefs and councils of old men, the settled nations of exico had grown to a somewhat highly organized government his may be seen by the elaborate balance of power maintained in he federation of Mexico, Tezcuco and Tlacopan, where each king

been more remarkable for number and extent than architectu grandeur, being but low one-storied buildings. The princip palace of Mexico consisted of hundreds of rooms and halls rang round three open squares, with women's apartments, granari storehouses, menagerie, aviaries, of such extent that one of t companions of Cortes records having four times wandered abo till he was tired, without seeing the whole. Not less rema able was the palace of Tezcuco, surrounded with its groves a pleasure gardens, and, though now hardly anything remains of t building above ground, the neighbouring hill of Tezcotzinco st has its stone steps and terraces, and the immense embankme carrying the aqueduct-channel of hewn stone which supplied wa to bear out in the solid rock still remains to prove that the chr nicles' descriptions, if highly-coloured, were at any rate genuine. T the 15th century the equestrian figures of Axayacatl and his son Mon zuma were to be seen carved in the porphyry hill of Chapultep but these as well as the hanging gardens have been destroyed, a only the groves of *ahuehuetl* (cypresses) remain of the ancient beaut of the place. That in the palace gardens flowers from the tie caliente were transplanted, and water-fowl bred near fresh and s pools fit for each kind, that all kinds of birds and beasts were k in well appointed zoological gardens where there were homes ev for alligators and snakes—all these testifies, not merely to barba ostentation, but to a cultivation of natural history which was re beyond the European level of the time. From the palaces and temples of thousands of servants attached to the royal service may

inherited at once the despotic power of the Mexican rulers and t heavy taxation of the people, in fact some of the most remarka of the picture writings are tribute rolls, enumerating by hundr and thousands the mantles, ocelot-skins, bags of gold dust, bro hatchets, loads of chocolate, &c., furnished periodically by the tow Below the king was a numerous and powerful class of nobles hitherto of whom (*tlatoani*) were great vassals owing little more th homage and tribute to their feudal lord, while the natural re of the multiplication of the noble class was that the king to keep th in check increased their numbers, brought them to the capital courtiers, and balanced their influence by military and household officers, and by a rich and powerful merchant class. The nob not only had privileges of rank and dignity, but substantial pow over the plebeian or peasant class (*macehualtin*), who submitted much the same oppression and extortion at their hands as w customary in the Old World. The tenures of land in Mexico w those generally appearing in barbaric countries where invasion a military despotism have encroached on but not totally supersed the earlier tribal laws. The greatest estates belonged to the kin or had been granted to military chiefs whose sons succeeded the or were the endowments of temples, but the *calpulli* or villa community still survived, and each freeman of the tribe held a tilled his portion of the common lands. Below the freemen w the slaves, who were war-captives, persons enslaved for punishme or children sold by their parents. Prisoners of war were mos doomed to sacrifice, but other classes of slaves were mildly treate retaining civil rights, and their children were born free.

The superior courts of law formed part of the palace, and th were tribunals in the principal cities, over each of which presided supreme judge or *cihuacoatl*, who was irremovable, and wh criminal decisions not even the king might reverse; he appoint the lower judges and heard appeals from them; it is doubt whether he judged in civil cases, but both kinds of suits were he in the court below, by the *tlacatecatl* and his two associates, bel whom were the ward-magistrates. Lands were set apart for t maintenance of the judges, and indeed nothing gives a higher i of the elaborate civilization of Mexico than this judicial syste which culminated in a general court and council of state presi over by the king. The laws and records of suits were set down picture writings, of which some are still to be seen, sentence death was recorded by drawing a line with an arrow across portrait of the condemned, and the chroniclers describe the barba solemnity with which the king passed sentence sitting on a gold and jewelled throne in the divine tribunal, with one hand on ornamented skull and the golden arrow in the other. Among t resemblances to Old World law was the use of a judicial oath, t witness touching the ground with his finger and putting it to lips thus swearing by Mother Earth. The criminal laws were extreme severity, even petty theft being punished by the thief bei stoned to the person he had robbed, while to steal a tobac pouch or twenty ears of corn was death; he who pilfered in t market was then and there beaten to death, and he who insulted Xi the god of the gold and silver smiths, by stealing his precious met was skinned alive and sacrificed to the offended deity. Thou also beer or "pulque" was allowed for feasts and to invalids moderation, and old people over seventy seem to be represent in one of the picture-writings as having liberty of drunkenne young men found drunk were clubbed to death and young wom stoned. Such a Draconian standard prevailing, it is hardly need to enumerate the special penalties of such offences as witchera fraud, removing landmarks, adultery, &c., which differed as

whether the criminal had his heart cut out on the altar, his head crushed between two stones, &c.; while even lesser punishments were harsh, such as that of slanderers, whose hair was singed with a pine torch to the scalp.

Based on conquest as the Aztec kingdom was, and with the craving for warlike glory fostered by the most bloodthirsty religion the world ever saw, it follows that the nation was above all other pursuits organized as a fighting community. To be a great soldier was the road to honour and office, and the king could not be enthroned till he had with his own hand taken captives to be butchered on the war-god's altar at his coronation. The common soldiers were promoted for acts of daring, and the children of chiefs were regularly trained to war, and initiated by being sent into battle with veterans, with whose aid the youth took his first prisoner, but his future rise depended on how many captives he took unaided in fight with warlike enemies; by such feats he gained the dignity of wearing coloured blankets, tassels, and lip-pewter, and reached such military titles as that of "guiding eagle." The Mexican military costumes are to be seen in the pictured writings, where the military orders of princes, eagles, and tigers are known by their braided hair, eagles' beaks, and spotted armour. The common soldier went into battle brilliant in savage war-paint, but those of higher rank had helmet-like head and beaks of prey, armour of gold and silver, wooden greaves, and especially the *ichcahuipilli*, the quilted cotton tunic two fingers thick, so serviceable as a protection from arrows that the Spanish invaders were glad to adopt it. The archers shot well and with strong bows, though their arrows were generally tipped only with stone or bone, their shields or targets, mostly round, were of ordinary barbaric forms, the spears or javelins had head of obsidian or bronze, and were sometimes hurled with a spear-thrower or *atlatl*, of which pictures and specimens still exist, showing it to be similar in principle to those used by the Australian and Eskimo. The most characteristic weapon of the Mexicans was the *macquauitl* or "sword wood," a club set with two rows of large sharp obsidian flakes, a well directed blow with which would cut down man or horse. These two last-mentioned weapons have the look of highly developed savage forms, while on the other hand the military organization was in some respects equal to that of an Asiatic nation, with its regular companies commanded each by its captain and provided with its standard. The armies were very large, an expedition often consisting of several divisions each numbering eight thousand men, but the tactics of the commanders were quite rudimentary, consisting merely of attack by arrows and javelins at a distance gradually closing into a hand to hand fight with clubs and spears with an occasional feigned retreat to draw the enemy into an ambuscade. Fortification was well understood, as may still be seen in the remains of walled and escarped strongholds on hills and steep ravines, while lagoon cities like Mexico had the water approaches defended by fleets of boats, and the causeways protected by towers and ditches. Even after the town was entered, the pyramid-temples with their surrounding walls were fortresses capable of stubborn resistance. It was held unrighteous to invade another nation without a solemn embassy to warn them of the miseries to which they exposed themselves by refusing the submission demanded, and this again was followed by a declaration of war, but in Mexico as in other more cultured countries this act of national morality degenerated into a ceremonial farce, where tribute was claimed from some neighbouring nation, or an Aztec god was offered to be worshipped in their temples, in order to pick a quarrel as a pretext for an invasion already planned to satisfy the soldiers with lands and plunder, and to meet the priests' incessant demands for more human sacrifices.

Among the accounts of the Mexican religion are some passages referring to the belief in a supreme deity. The word *teotl* god, has been thought in some cases to bear this signification, but its meaning is that of deity in general, and it is applied not only to the sun-god but to very inferior gods. It is related that Nezahualcoyotl, the poet king of Tezcuco, built a nine-storied temple with a starry roof above, in honour of the invisible deity called Tloquenahuaque, "he who is all in himself," or Ipalnemoan, "he by whom we live," who had no image, and was propitiated, not by bloody sacrifices, but by incense and flowers. Those who adopt the opinion of Asiatic admixture in Mexican culture will use it to account for this remarkable religious phenomenon, less easily accounted for by native development, while also the appearance of a rival deity of evil, bearing the name of Tlacatecolotl, or "man-owl," is mysterious. These divinities, however, seem to have had little or no place in the popular faith, which was occupied by polytheistic gods of more ordinary barbaric type. Tezcatlipoca was held to be the highest of these, and at the festival of all the gods his footsteps were expected to appear in the flour strewn to receive this sign of their coming. He was plainly an ancient deity of the race, for attributes of many kinds are crowded together in him, and he was prayed to in interminable formulas for help in war and for health and fortune, to deliver the nation from a wicked king, or to give pardon and strength to the penitent who had confessed his sins and been purified by washing. Between him and Quetzalcoatl, the ancient deity of [illegible] there had been old rivalry, as is related in legends of Quetzalcoatl coming into the land to teach men to till the soil, to work metals, to rule a well-ordered state; the two gods played their game at the ball game, and Tezcatlipoca, in the guise of a hoary sorcerer, persuaded the sick and weary Quetzalcoatl to drink the magic pulque that sent him roaming to the distant ocean, where he embarked in his boat and disappeared from among men. The deities are not easily analysed, but on the other hand Tonatiuh, Metztli the sun and moon, stand out in the distinctest personality as nature gods, and the traveller still sees in the huge adobe pyramids of Teotihuacan, with their sides oriented to the four quarters, evidence of the importance of their worship. The war god Huitzilopochtli, of whom one legend relates a supernatural conception in the ancient Tulian, while another story declares him to have been (like the Chinese war-god) a deified warrior chief, was the great god of the Aztec pantheon, his idol remains in Mexico, a huge monolith on which is sculptured on the one side his hideous portrait adorned with the humming bird feathers on the left half, the serpent his name, while the not less frightful war goddess Coatlicue, or "divine war death," occupies the other side. Tlazolteotl the goddess of the all nourishing maize was patroness of childbirth and mother of the gods, while Mictlantecuhtli, lord of darkness, ruled over the departed in the dim under-world. Numerous lesser deities presided over classes of society, events, and every act of life such as Tlaelcuani goddess of pleasure, wife of the amorous Tezcatzoncatl, god of strong drink, whose garments in irony clothed the drunkard's corpse, and Xipe, patron of the goldsmiths. Below these were the numerous crowd of nature spirits of mountain and grove, whose shrines were built by the road side to receive offerings from passers by. The temples were called *teocalli* or 'god's house,' and the teocallis of the greater deities rivalled, as they resembled in form the temple of ancient Babylon, were pyramids on a square or oblong base, rising in successive terraces to a small summit-platform. The great temple of Huitzilopochtli in the city of Mexico stood in an enclosed square, whence radiated the four principal thoroughfares of the city, and being enclosed by a square, or rather oblong wall, called the *coatepantli* or serpent wall from its sculptured serpents, measured nearly a quarter of a mile on each side. In the centre, the oblong pyramid of rubble cased with hewn stone and cemented, 375 × 300 feet at the base, and rising steeply in six terraces to the height of 86 feet, showed conspicuously to the people the long pacing figures of priests and victims winding round the terraces and up the corner flights of steps. On the paved platform were three-story tower temples in whose ground floor stood the sacred images and altars, and before that of the war-god the great sacrificial stone, humped so as to bend upward the body of the victim that the priest might more easily slash open the breast with his flint knife tear out the heart and hold it up before the god, while the captor and his friends were waiting below for the carcass to be tumbled down the steps for them to carry home to be cooked for the feast of victory. Before the shrines rocking with the din of the slaughter, the eternal fires were kept burning, and on the platform stood the huge drum covered with snakes' skin whose hollow boom was heard for miles. From the terrace could be seen some fifty more other temples within the enclosure, with their numerous blazing fires, and the *tzompantli* or 'skull-place,' where the skulls of victims by tens of thousands were skewered on cross-beams built into towers. There also might be seen the flat sacrificial stone *temalacatl* or "spindle stone," where captives armed with feathered weapons were allowed the mockery of a gladiatorial fight with well-armed champions. The great pyramid of Cholula, with its hemispherical temple of Quetzalcoatl at the top, a huge almost shapeless hill surmounted by a church, was also as long and twice as high as the teocalli of Mexico. A large fraction of the Mexican population were set apart as priests and attendants to the services of the gods. The rites performed such as are found elsewhere, prayer, penitence, processions, dances, chants, fasting and other austerities, but there are some curious touches of detail. Prayer and other formulas have been copied by Sahagun and other chroniclers, of endless prolixity, but without occasional touches of pathos. The following sentences from a prayer to Tezcatlipoca, intercessor for the people, are characteristic: "O our lord, protector most strong and compassionate, invisible and impalpable, thou art the giver of life; lord of the day, lord of battles, I present myself here before thee to say [illegible] concerning the need of the poor people, the people of no understanding [illegible] Know, O Lord, that thy subjects and vassals suffer a sore poverty, that cannot be told of nor described, for it is a sore poverty and desolateness. The men have no mantles, nor the women to cover themselves with, but only rags to cover every part that let the wind and cold in. [illegible] If they cry their chants, they now sell only cakes of salt and broken pepper, for the people that have something despise their wares, so that they go and sell from door to door and from house to house; and when they get nothing they sit down sadly by some fence or wall, or [illegible] some

icking their lips and gnawing their nails for the hunger that is in hem, they look on one side and the other at the mouths of those who pass by, hoping peradventure that one may speak one word to them. O compassionate God, the bed on which they lie is not a thing to rest upon, but to endure torment in; they draw a rag over them at night and so sleep. . . . O our Lord, in whose power it is to give all content, consolation, sweetness, ottine, prosperity, and riches, for thou alone art lord of all good, have mercy upon them, for they are thy servants. . . . I supplicate thee that thou wilt lift up their head with thy favour and aid, that thou wilt see good that they enjoy some day of prosperity and tranquillity, so that they may sleep and know repose, having prosperous and peaceable days of rule. . . . Should the nation for whom I pray and entreat thee to do them good not render good what thou hast given, thou canst take away the good and pour out cursing, so that all evil may come upon them, and they become poor in need, maimed, lame, blind, and deaf, then indeed they shall waken and know the good that they had and have not; and they shall call upon thee and lean toward thee, but thou wilt not listen, for in the day of abundance they would not acknowledge thy goodness towards them." These prayers seem entirely genuine, indeed there was no European model from which they could have been imitated, but at the same time it must be remembered that they come down in Spanish writing, and not untouched by Spanish influence, as in one passage where there is a mention of sheep, an animal of course unknown to the native Mexican. As to sacrifices, maize and other vegetables were as well offered and occasionally rabbits, quails, &c., but, in the absence of cattle, human sacrifice was the chief rite, and cannibalism prevailed at the feasts. Incense was constantly used, especially the *copalli* or copal well known to us for varnish, little terra cotta censers are among the commonest of Mexican antiquities. Long and severe penitential fasts were customary at special seasons, and drawing blood from the arms, legs, and body, by thrusting in aloe thorns and passing sharp sticks through the tongue, was an habitual act of devotion recalling the similar practices of devotees in India. The calendar of religious festival for the whole course of the Mexican year has been preserved. Each 20-day period had one or more such celebration. In the month of the "diminishing of waters," the rain gods or Tlaloc were propitiated by a procession of priests with music of flutes and trumpets carrying on plumed litters infants with painted faces, in gay clothing with coloured paper wings, to be carried on the mountains or in a whirlpool in the lake. It is said that the people wept as they passed by, but it so that must have been a customary formality, for the religion of the nation must have quenched all human sympathy. In the next month the god Xipe totec, already mentioned, had his festival called the "flaying of men" from the human victims being flayed, after their hearts were torn out, for young men to dress in their skins and perform dances and sham fights. The preceding festival of Camaxtli was marked by a severe fast of the priests, after which stone knives were prepared with which a hole was cut through the tongue of each, and numbers of sticks passed through. For the great festival of Tezcatlipoca, the handsomest and noblest of the captives of the year had been chosen as the incarnate representative of the god, and paraded the streets for public adoration dressed in a rich costume with feathers and garlands on his head and a retinue like a king, for the last month they married him to four girls representing the goddesses; on the last day wives and priests escorted him to the little temple of Tlacochcalco, where he mounted the stairs, breaking his earthenware flute against each step, this was a symbolic farewell to the joys of the world, for as he reached the top he was thrown by the priests, his heart torn out and held up to the sun, his head impaled on the tzompantli, and his body eaten as sacred food by the people drawing from his fate the moral lesson that riches and pleasure may turn into poverty and sorrow. The manner of the victim's death in these festivals afforded scope for variety, they dressed them and made them dance in character, threw them into the fire for the fire-god, or crushed them between two balanced stones at the harvest festival. The ordinary pleasures of festivals were mingled with all this, such as dances in beast-masks, chivalry fights, and children's games, but the type of a religious function was a sickening butchery followed by a cannibal feast.

The Mexican priesthood, being the educated class, were much concerned with the art of picture writing which they had developed to a stage quite above the rude figures of the American hunting-tribes, and used systematically as a means of recording religious festivals and legends as well as keeping calendars of years and recording the history of events which occurred in them. Facsimiles of several of these interesting documents, with their translations, may be seen in Kingsborough. On inspecting these it will be seen that their main principle is pictorial. Gods are represented with their appropriate attributes, the fire-god hurling his spear, the moon-goddess with a shell, &c. The scenes of human life are pictures of warriors fighting with club and shield, men paddling in canoes, women spinning and weaving, &c. An important step towards phonetic writing appears, however, in the picture names of places and persons. The simplest forms of these depict the objects signified by the name, as where *Chapultepec* or "grasshopper hill" is represented by a grasshopper on a hill, or a stone with a cactus on it stands for *Tetzcoco* or "stone cactus," the founder of *Tenochtitlan*. The system has, however, risen a stage beyond this when objects were drawn to represent, not themselves, but the syllables forming their names, as where a trap an eagle, a pricker, and a hand are put together not to represent these objects, but in order that the syllables of their names *mo quauh-tzo ma* should spell the word Moquauhzoma (see Aubin's introduction to Brasseur, *Hist du Mexique*, vol. i. p. lviii.). The analogy of this to the manner in which Egyptian hieroglyphs passed into phonetic signs is remarkable, and writing might have been invented anew in Mexico had it not been for the Spanish conquest. The Aztec numerals, which were expressed or reckoned by scores, were depicted by dots or circles up to 20, which was represented by a flag, 400 a score of scores by a feather, and 8000 a score of scores of scores by a purse; for convenience these symbols might be halved and quartered, so that 531 might be shown by one feather, one quarter of a feather, one flag, one half of a flag, and four dots. The Mexican calendar depended on the combination of numbers with picture signs, of which the four principal were the rabbit, reed, flint, house, *tochtli, acatl, tecpatl, calli*. The cycle of 52 years was reckoned by combining these signs in rotation with numbers up to 13, thus 1 rabbit, 2 reed, 3 flint, 4 house, 5 rabbit, 6 reed, &c. By according this calendar may be exactly illustrated with a modern pack of cards laid out in rotation of the four suits, ace of hearts, 2 of spades, 3 of diamonds, 4 of clubs, 5 of hearts, 6 of spades, &c. The Mexican ritual calendar of the days of the year, the same method carried further, the series of twenty day signs being combined in rotation with numbers up to 13; as this cycle of days only reaches 260, a series of nine other signs are affixed in addition to make up the 365 day year. It is plain that this rotation of signs served no useful purpose whatever, being less convenient than the ordinary counting such as the Mexicans employed in their other calendar already mentioned, where the 20 day periods had each a name like our months, and their days had signs in regular order. The historical interest depends on its resemblance to the calendar systems of central and eastern Asia, where among Mongols, Tibetans, Chinese, &c., series of signs are thus combined to reckon years, months, and days, for instance, the Mongol cycle of 60 years is recorded by the zodiacal series of 12 signs—mouse, bull, tiger, &c.—combined in rotation with the five male and female elements—wood, earth, iron, water, wood; as "male-fire bull" year, &c. The comparison is worked out in Humboldt's *Vues des Cordillères*, as evidence of Mexican civilization being borrowed from Asia. Naturally the Mexican calendar system lent itself to magic in the same way as the similar zodiacal signs of the Old World, each person's fate being affected by the qualities of the signs he was born under, and the astrologer priests being called in to advise on every event of life. Of all Mexican festivals the most solemn was that of the *xiuhmolpilli*, or "year binding," when the current cycle or bundle of years came to an end. It was believed that the destruction of the world, which after the Hindu manner the Mexicans held to have already taken place three or four times, would happen again at the end of a cycle. As the time drew near, the anxious population cleansed their houses and put out all fire, and on the last day after sunset the priests, dressed in the garb of gods, set out in procession for the hill of Huixachtla, there to watch for the approach of the Pleiades to the zenith, which was the auspicious signal for the lighting of the new fire. The breast of the captives was thrown down and fire kindled on his breast in the wooden drill of the priest; then the victim's heart was torn out and his body flung on the pile kindled with the new flame. The people watching from their flat housetops all the country round saw with joy the flame on the sacred hill, and hailed it with the thank offering of drops of blood drawn from their ears with sharp stone flakes. Swift runners carried burning brands to rekindle the fires of the land, the sacred fire on the teocalli of the war god blazed up again, and the people began with feasting and rejoicing the new cycle.

Mexican education, at any rate that of the upper class, was a systematic discipline much under the control of religion, which here presents itself under a more favourable light. After the birth of a child, the *tonalpouhqui* or "sun-calculator" drew the horoscope from the signs it was born under, and fixed the time for its solemn lustration or baptism, performed by the nurse with appropriate prayers to the gods, when a toy shield and bow were provided if it was a boy, or a toy spindle and distaff if it was a girl, and the child received its name. An interesting picture writing may be seen in Kingsborough, shows the details of the boy's and girl's education, from the early time when three small circles over the child show it to be three years old, and a drawing of half a tortilla or corn cake shows its allowance for each meal: as they grow older the lads are seen beginning to carry burdens, paddle the canoe and fish, while the girls learn to spin and weave, grind maize, and cook,—good conduct being enforced by punishments of increasing severity, up to pricking their bodies with aloe-thorns and hold

heir faces over burning chillis. The schools were extensive buildngs attached to the temples, where from an early age boys and irls were taught by the priests to sweep the sanctuaries and keep up he sacred fires, to fast at proper seasons and draw blood for penance, nd where they received moral teaching in long and verbose formulas hose fit for a soldier's life were trained to the use of weapons nd sent early to learn the hardships of war, children of craftsmen vere usually taught by their fathers to follow their trade; and for he children of nobles there was elaborate instruction in history, icture writing, astrology, religious doctrines, and laws. Marriage epended much, as they do still in the East, on comparison of the oroscopes of the pair to ascertain if their birth-signs were comatible. Old women were employed as go-betweens, and the arriage ceremony was conducted by a priest who after moral xhortations united the young couple by tying their garments ogether in a knot, after which they walked seven times round the re, casting incense into it, after the performance of the marriage eremony the pair entered together on a four days' fast and enance before the marriage was completed. The funeral rites f the Mexicans are best seen in the ceremonies at the death of a ing. The corpse laid out in state was provided by the priest with jug of water for his journey, and with bunches of cut papers to ass him safely through each danger of the road: the place where he two mountains strike together, the road guarded by the great nake and the great alligator, the eight deserts and the eight alls; they gave him garments to protect him from the cutting vind, and buried a little dog by his side to carry him over the ine waters. Then the royal body was invested in the mantle of is patron-gods, especially that of the war-god, for Mexican kings vere warriors: on his face was placed a mask of turquoise mosaic, nd a green chalchihuite stone as a heart between his lips. In older imes the dead king was burned on a throne with his property and lead attendants round him. But after cremation came in a nourning procession of servants and chiefs carried the body to the uneral pyre to be burnt by the demon-dressed priests, after which he crowd of wives and slaves were exhorted to serve their lord aithfully in the next world, were strangled and their bodies burnt. Common people would not thus be provided with a ghostly retinue, ut their simpler funeral ceremonies were as far as they went similar o those of their monarch.

The staple food of the Mexicans before the conquest has continued ith comparatively little change among [illegible] and has ven been adopted by those of European blood. Maize or Indian orn was cultivated on patches of ground where, as in the Hindu *dm*, the trees and bushes were burnt and the seed planted in the oil manured by the ashes. A sharp-pointed planting stick, a ooden shovel, and a bronze-bladed hoe called a *coatl* were the mple implements. The Mexicans understood digging channels o irrigation, especially for the cultivation of the *cacahuatl*, from hich they taught the Europeans to prepare the beverage *chocollatl*; hese native names passed into English as the words cacao, or cocoa, nd chocolate. Other vegetables adopted from Mexico are the tomata *omatl*) and the *chilli*, used as flavouring to native dishes. The aize was ground with a stone roller on the grinding stone or *metlatl*, till known over Spanish America as the *metate*, and the meal baked nto thin oval cakes called by Aztecs *thaoalli*, and by Spaniards *ortilla*, which resemble the *chapati* of India and the oat-cake of Scotland. The Mexicans were also skilful makers of earthen pots, n which were cooked the native beans called by the Spanish *frijoles*, nd the various savoury stews still in vogue. The juice extracted by tapping the great aloe before flowering was fermented into an intoxicating drink about the strength of beer, *octli*, by the Spaniards called *pulque*. Tobacco, smoked in leaves or cane pipes or taken as snuff, was in use, especially at feasts. It is related that n old times Mexican clothing was of skins or woven aloe and palm ibre, but at the time of the conquest cotton was largely cultivated n the hot lands, spun with a spindle, and woven in a rudimentary oom without a shuttle into the mantles and breech cloths of the nen and the chemises and skirts of the women, garments often of ine texture and embroidered in colours. Ornaments of gold and ilver, and jewels of polished quartz and green chalchihuite were vorn,—not only the ears and nose but the lips being pierced for ornaments. The artificers in gold and silver melted the metals by neans of a reed blowpipe and cast them solid or hollow, and were also skilled in hammered work and chasing, as some fine specimens remain to show, though the famous animals modelled with gold and ilver fur, feathers, and scales have disappeared. Iron was not known, but copper and tin ores were mined, and the metals combined into bronze of much the same alloy as in the Old World, of which hatchet blades and other instruments were made, though their use had not superseded that of obsidian and other sharp stone lakes for cutting, shaving, &c. Metals had passed into a currency for trading purposes, especially quills of gold dust and T-shaped pieces of copper, while cocoa beans furnished small change. The vast size of the market-squares with their surrounding porticos, and the importance of the caravans of merchants who traded with other nations, show that mercantile had risen into some proportion to military interests. Nor was the wealth and luxury of Mexico an surrounding regions without a corresponding development of ar The stone sculptures such as that remaining at Xochicalco which figured by Humboldt, as well as the ornamented woodwork, feathe mats, and vases, are not without artistic merit. The often cite poems attributed to Nezahualcoyotl may not be quite genuine, bu at any rate poetry had risen above the barbaric level, while th mention of ballads among the people, court odes, and the chants temple choirs would indicate a vocal cultivation above that of t instrumental music of drums and horns, pipes and whistles, t latter often of pottery. Solemn and gay dances were frequent, an a sport called the bird dance excited the admiration of foreigne for the skill and daring with which groups of performers dressed bird-like themselves down by ropes wound round the top of a hig mast, so as to fly whirled in circles far above the ground. Th ball-game of the Mexicans called *tlachtli*, was, like tennis, the pa time of princes and nobles, special courts were built for it, and th ball of india-rubber (perhaps the first object in which Europea became acquainted with this valuable material might not be touche by the hands, but was driven against the walls by blows of the kn or elbow, shoulder or buttock. The favourite game of *patolli* has bee already mentioned for its similarity to the *pachisi* of modern Indi

The accounts given by Spanish writers of the Central Americ in their state after the Spanish conquest are very scanty in com parison with the voluminous descriptions of Aztec life. They bra out perfectly, however, the fact of close connexion between the tw civilizations. Some Central-American peoples were actually Mexic in their language and culture, especially the Pipils of Guatemala an a large part of the population of Nicaragua, but there were descen ants of Aztecs or allied peoples who in the comparatively moder times of Aztec power invaded and colonized these distant countri (see Buschmann, *Aztek. Ortsnamen*, xviii., xx.). With regard to th Central American nations proper, especially the Mayas of Yucat and the Quiches of Guatemala, who dwelt in the cities and wo shipped in the temples of Chichen Itza and Uxmal, Palenque an Copan, the problem of Aztec connexion is deeper and obscure How closely related these nations were in institutions to t Mexicans appears, not only in their using the same peculiar weapon such as the spear-thrower and the toothed club or maquahuitl, b in the similarity of their religious rites such as drawing blood fr their bodies as an act of penance and sacrificing human victims cutting open the breast and to[illegible] heart, the connexion evident in such special points as the ceremony of marriage by tyi together the garments of the couple, or in holding an offender's ha over burning chillis as a punishment, the native legends of Centr America make mention of the royal ball-play, which was the sam as the Mexican game of tlachtli already mentioned. At the sam time many of the Central-American customs differed from t Mexican; thus in Yucatan we find the custom of the youths sleepi in a great bachelor's house, an arrangement common in variou parts of the world, but not in Mexico, the same remark applies the Maya exogamous law of a man not taking a wife of his ow family name (see Diego de Landa, *Relacion de Yucatan*, Brasseur de Bourbourg, p. 140), which does not correspond wi Mexican custom. We have the means of comparing the person appearance of the Mexicans and Central Americans by their po traits on early sculptures, vases, &c.; and, though there does n appear any clear distinction of race type, the extraordinary bac sloping foreheads of such figures as those of the Las Ichet of Palenq prove that the custom of flattening the skull in infancy prevail in Central America to an extent quite beyond any such habit Mexico. It is from the ruined cities now buried in the Centra American forests that we gain the best information as to the natio who built them. The notion sometimes propounded that the famous cities were of great antiquity and the work of extinct natio has no solid evidence, some of them may have been already aba doned before the conquest, but others were inhabited, and by t ancestors of the Indians who now build their mean huts and t their patches of maize round the ruins of the grander life of th ancestors. In comparing these ruins through the districts Yucatan, Chiapa, Guatemala, and Honduras, it is evident tha though they are not the work of a single nation, but of two or mo highly distinct in language, yet these nations had the great bo of a common system of pictorial or written characters. One spe men of a Central American inscription may give a general idea them all, whether it be from the sculptured façade of a temp sketched by Catherwood, or from the painted deer-skin called t Dresden Codex reproduced in Kingsborough, or from the chapt of Diego de Landa where he professes to explain and translate t characters themselves. These consist of combinations of faces, circl lines, &c., arranged in compartments in so complex a manner th hardly two are found alike. How they conveyed their meanin how far they pictorially represented ideas or spelt words in t different languages of the country, is a question not yet answer in a complete way; Landa's description (p. 320) gives a table of number of their elements as phonetically representing letters syllables, but, though there may be a partial truth in his rules, th

e too insufficient or too erroneous to serve for any general decipher ent Most of what has been written on this enticing subject is orthless, but a promising attempt has been made by E. S. Holden, ho has analysed the combined figures into their elementary lines *First Annual Report of Bureau of Ethnology*, Smithsonian Insti- ution, Washington, 1881; Cecil de Charency, *Melanges de Philologie de Paléographie Américaines*, Paris, 1883. One point as to the entral-American characters is clear, that part of them are calendar gns recording dates From the accounts given by Landa and other riters it is plain that the Central American calendar, reckoning he year in twenty-eight periods of thirteen days, was the same in s principle of combining signs as that of Mexico here mentioned t page 212 The four leading Maya signs called *kan*, *muluc*, *ix*, *cauac* orresponded in their position to the four Aztec signs rabbit, reed, int, house, but the meanings of the Maya signs are, unlike the ztec, very obscure A remarkable feature of the Central-American ins is the frequency of truncated pyramids built of hewn stone, ith flights of steps up to the temple built on the platform at top. he resemblance of these structures to the old descriptions and pic habitu- lly given to them The teocallis built by the Nahua or Mexican ation have been mostly destroyed, but two remain at Huatusco nd Tuspan figured in " t, vol iv. pp. 113, 456), which bear strong resemblance to ose of Palenque On the whole it is not o much to say that, in spite of differences in style, the best means t judging what the temples and palaces of Mexico were like is to e gained from the actual ruins in Central America On the and, there are features in Central-American architecture which arcely appear in Mexican Thus at Uxmal there stands on a erraced mound the long narrow building known as the governor's ouse (Casa del Gobernador), 322 feet long, 39 feet wide, 26 feet gh, built of rubble stone and mortar faced with square blocks of one, the interior of the chambers rising into a sloping roof formed courses of stonework gradually overlapping in a "false arch" he same construction is seen in the buildings forming the sides of quadrangle and bearing the equally imaginary name of the nnery (Casa de Monjes), the resemblance of the interior of one its apartments to an Etruscan tomb has often been noticed (see rgusson, *History of Architecture*, vol ; Viollet-le-Duc, in ruary). Attempts to trace the architecture of Central America direct derivation from Old World types have not been successful, hile on the other hand its decoration shows proof of original inven on, especially in the imitations of woodwork which, as the above- entioned architects have pointed out, passed into sculptured rnament when the material of construction became stone instead wood Thus the architectural remains, though they fail actually solve the historical problem of the high culture of the nations und the Gulf of Mexico, throw much light on it when their idence is added to that of religion and customs Whether Mexican vilization was a barbaric copy of that which flourished in the now serted Central American cities, or whether the nations who built ese cities themselves raised to a higher level a civilization derived om Mexico, two things seem probable, first, that the civilizations Mexico and Central America were pervaded by a common influence religion, art, and custom, second, that this common element ows traces of the importation of Asiatic ideas into America.

Among works of reference on the ancient history and civilization of Mexico d Central America may be mentioned H H Bancroft, *The Native Races of the ific States of North America*, London 1875–6 (contains the most complete mmary, with references to original authorities); Brasseur de Bourbourg, *Histoire des Nations Civilisées du Mexique et de l'Amérique Centrale* Paris, 59–60), a valuable collection of materials, but the author's own views are mostly , *Historia de la Conquista de Mexico*, Clavigero *Storia Antica* a, 1780 forms the substance of earlier writers, such as Acosta, Botturini, &c.). For special topics Lord Kings- nough, *Antiquities of Mexico* London, 1831–48 (contains facsimiles and inter- tations of pictu- es, and prints the native chronicles of Ixtlilxochitl and Tezozo- oc, a priest of moc, &c.), A von Humboldt, *Vues des Cordillères, et Monumens de l'Amérique*, Paris, 1816 (Mexican civilization, ir writing, cal- ndar, &c.). Travels and descriptions of antiquities, &c. apers (Bra- ssbc C Nebel, *Viaje Pintoresco y Arqueologico sobre la epública de* ort 1839–4 de Waldeck, *Voyage Pittoresque et Archeo- logique dans la Province d'Yucatan*, Paris, 1838, and *Palenque et Autres Ruines*, aris, 1866, D Charnay *Cités et Ruines Américaines*, avec texte par Viollet le Duc, aris, 1863; J L ste, b ork, 1841; *Incidents of Yucatan*, New York, 1858, Brantz Mayer, *Mexico*, New York, 1-54 *Mexico, or Mexico and the Mexicans*, London, 861, &c (E B T)

II. THE REPUBLIC OF MEXICO.

Mexico, Aztec *Mexitli*[1] (Estados Unidos de Mexico), s a federal republic in North America, bounded N. by he United States (California, Arizona, and New Mexico), E. by Texas and the Gulf of Mexico, S. by Guatemala and British Honduras, where the boundary lines are still partly undetermined, W. by the Pacific Ocean. Lying between 33° and 15° N. lat. and 87° and 117° W. long., Mexico stretches about 1950 miles north-north-west and south south-east, with a mean breadth of 400 miles, varying from about 1000 in 26° N. to 130 at the narrowest part of the Tehuantepec isthmus. It has a coast-line of nearly 6000 miles, about 4200 on the Pacific and 1600 on the Atlantic. The seaboard is little varied either by deep inlets, bold headlands, broad estuaries, or large islands. On the west side are the vast Gulf of California in outline somewhat resembling the Red Sea, and so named by some of the early navigators, and the open Bay of Tehuantepec, besides the smaller inlets of Acapulco and San Blas, forming two of the finest harbours in the world and almost the only safe ones in the republic. On the east side the coast is mostly beset by lagoons and sand banks, with no good havens, Campêche, Vera Cruz, Tampico and Matamoras being all little better than open roadsteads exposed to the fierce "nortes," or north-easterly gales, that sweep the Gulf of Mexico for a great part of the year. Of headlands the most prominent are Capes S. Lucas and Palmas at the south extremity of Lower California, Corrientes south from San Blas, and Catoche in the north-east of Yucatan. Besides this peninsula, which projects north north east, the only other is that of Lower California which projects south-south-east parallel to the mainland. The islands are few in number, and all of insignificant size, the most noteworthy being Tiburon and Angel de la Guarda in the Gulf of California, the uninhabited Revillagigedo group in the Pacific, and Cozumel off the Yucatan coast. Mexico comprises altogether twenty-seven confederate states, one territory, and the Federal District, with areas, populations, and chief towns as under:[2]—

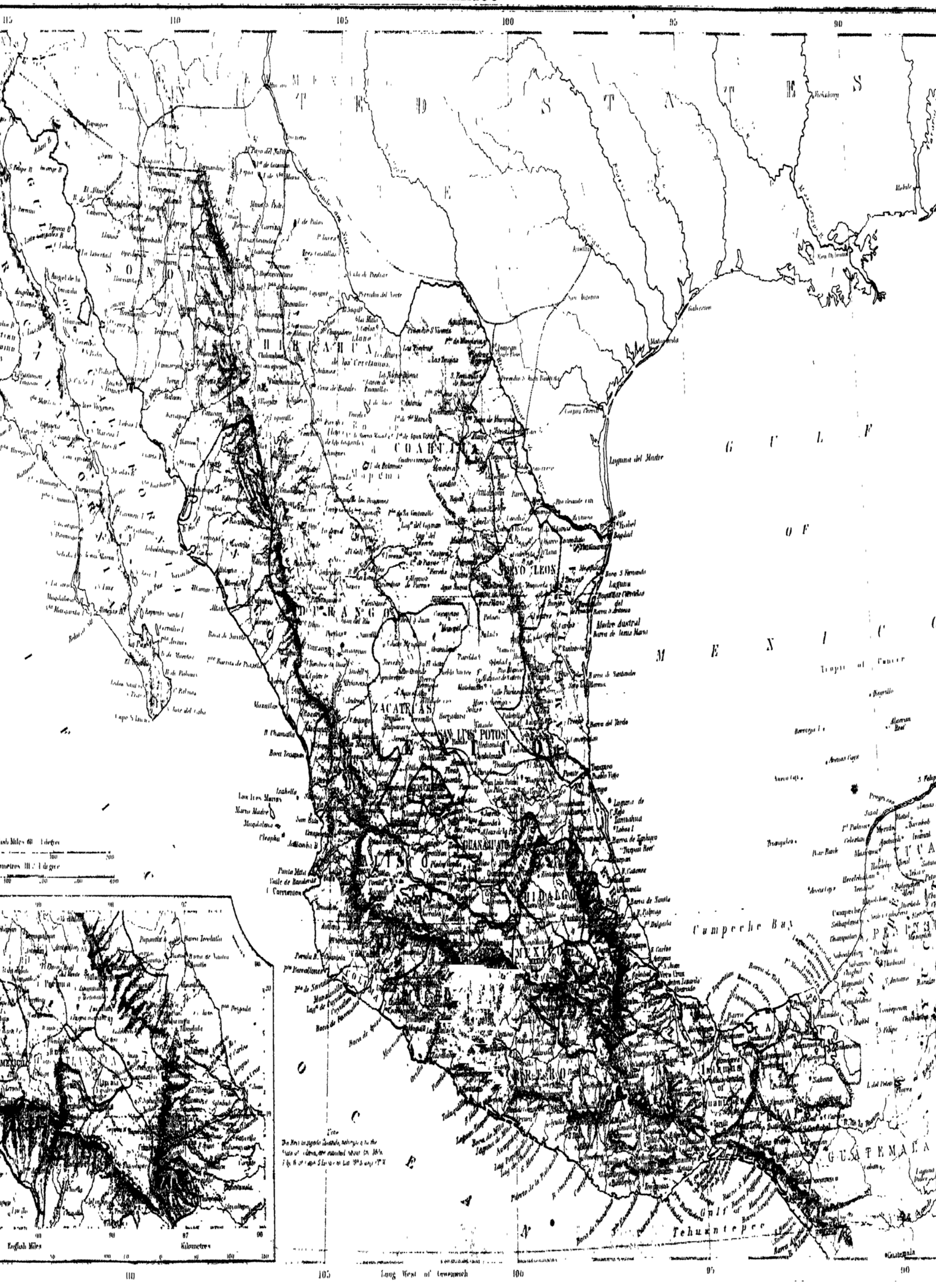
		Area in Square Miles	Population (1880)	Capital	Population (1877–80)
	Chihuahua	81,022	139,140		9,700
	Coahuila	165,295	180,758	Chihuahua	12,116
	Nuevo Leon	61,050	104,131	Saltillo	11,340
	Tamaulipas	11,363	194,861	Monterey	13,300
	Vera Cruz	28,659	144,747	Ciudad Victoria	7,800
	Tabasco	27,434	504,370	Jalapa	12,400
	Campeche	12,716	93,387	San Juan Bautista	6,800
	Yucatan	26,083	86,299	Campeche	15,190
	Sinaloa	32,658	285,384	Merida	32,000
	Jalisco			Culiacan	7,878
	Colima	18,967	994,900	Guadalajara	78,600
	Michoacan	2,393	65,827	Colima	24,572
	Guerrero	21,609	648,857	Morelia	20,400
	Oajaca	24,226	308,710	Bravos	5,800
	Chiapas	27,389	718,191	Oajaca	26,228
	Durango	16,769	219,735	San Cristobal	8,500
	Zacatecas	42,643	190,846	Durango	27,119
	Aguas Calientes	26,585	413,603	Zacatecas	32,000
	San Luis Potosi	2,216	140,130	Aguas Calientes	31,872
	Guanajuato	28,889	506,799	San Luis Potosi	34,300
	Queretaro	11,130	788,202	Guanajuat	56,112
	Hidalgo	3,429	179,915	Queretaro	27,560
	Mexico	4,480	434,090	Pachuca	12,500
	Morelos	9,598	696,058	Toluca	12,700
	Puebla	1,898	154,946	Cuernavaca	16,320
	Tlaxcala	11,761	704,372	Puebla	64,588
	Federal District	1,498	134,498	Tlaxcala	4,300
	Lower California (Territory)				241,110
			23,195	La Paz	2,396
		763,801	9,577,279		

Since the appearance of A. von Humboldt's classic work on *New Spain*, as Mexico was called in the colonial times, this region has continued to be regarded as forming a main link in the vast chain supposed to stretch across the entire length of the American continent from Cape

[1] In this, as in all other Aztec names, the *x* (or *j*) represents the English sound *sh*; hence *Mexitli* and *Mexico* should be properly pronounced *Meshitli*, *Meshico*. But they do not appear to have ever been so pronounced by the Spaniards, who naturally gave to the *x* its ordinary Spanish sound of the German *ch*.

[2] These figures, in the absence of scientific surveys and a trustworthy census, are necessarily more or less approximate The areas are those of Ripley and Dana, based on A. Garcia Cubas's *Carta geografica* (Mexico, 1874); the populations of the states and capitals are the estimates of Emiliano Busto in his *Estadistica de la Republica Mexicana* (Mexico, 1880). A writer in the *Times* of December 1882, estimates the whole population at 12,000,000, much too high a figure.

MEXICO



ENCYLLOPÆDIA BRITANNICA NINTH EDITION

Behring's Strait. But more recent research, and
y the surveys made by the French staff during the
operations between 1861 67,[1] have shown that
nd generalization must be abandoned. In remote
al epochs a marine channel seems to have flowed
the northern and southern sections of the New
at the isthmus of Panama, while Mexico itself
to be mainly a distinct geographical region
vely recent upheaval. Here there nowhere exists
nous mountain range, to which might properly be
the designation "Cordillera of the Andes," an
on which in any case is not current north of the
of Tehuantepec. Mexico forms, on the contrary,
able-land, somewhat in the shape of a cornucopia,
narrow end tapering to the south south-east, its
and concave sides facing the Pacific and Atlantic
vely, and with a general inclination northwards.
the so-called Cordilleras are merely the "cumbres"
pments of this plateau, which falls abruptly towards
ntic, and through a series of well-marked terraces
y lacustrine basins) towards the Pacific. Thus the
road from the capital runs in tolerably easy stages
vely through the Tetla (8000 feet), Mescala (5500),
lo (1800), and Peregrino (1600) valleys down to
ithin 10 miles of the seaport of San Blas. But
hern central plateau of Anahuac maintains its mean
n of 7000 to 8000 feet almost everywhere to within
0 miles of the Atlantic. Hence the railway opened
between Vera Cruz and the capital has had to be
by tremendously steep gradients to a height of
8000 feet within a total distance of 263 miles.[2]
neral but gradual northerly tilt of the table-land is
by the altitudes of the capital, Durango, Chihuahua,
o del Norte on the United States frontier, which
ectively 7600, 6630, 4600, and 3800 feet.
e same time the scarps rise in many places con-
y above the mean level of the plateau, which is
tersected and broken into a number of secondary
by several short cross ridges, generally following
nal direction from north north west to south south
The most continuous range is the Sierra Madre of
ific, which may be traced at a mean elevation of
,000 feet from Oajaca to Arizona, and which from
ajara to the northern frontier is crossed by no
route. Parallel to this is the Lower Californian
Sierra de la Giganta, 3000 feet), which, however,
ruptly eastwards, like the Atlantic escarpments.
alifornian peninsula seems to have been detached
e mainland when the general upheaval took place
roduced the vast chasm now flooded by the Gulf
fornia. Corresponding with the Sierra Madre of
ific on the west are the more interrupted eastern
f the central plateau, which sweep round the Gulf
ico as the Sierras Madres of Nuevo-Leon and
ipas at an elevation of about 6000 feet. These are
by the carriage routes from Tula to Tampico
pass 4820 feet), from Saltillo to Monterey (3400),
several other points.

ne central cross ridges the most important orogra
and historically is the Cordillera de Anahuac,[3] which surrounds the Mexican (Tenochtitlan) and Pueb
valleys, and which is supposed to culminate with Pop
catepetl (17,853 feet) and Ixtaccihuatl (15,705).[4] Bu
these giants belong to a different or rather a more recen
system of igneous upheaval, running from sea to se
between 18° 59′ and 19° 12′ N. in almost a straight li
east and west, consequently nearly at right angles to th
main axis of the central plateau. The line is clearl
marked by several extinct cones and by five active o
quiescent volcanoes, of which the highest is Popocatepet
lying south of the capital nearly midway between th
Pacific and Atlantic. East of this central point of th
system are Citlaltepetl, better known as the Peak of Orizab
(17,176 feet), 70 miles inland, and San Martin or Tuxt
(9708 feet) on the coast south of Vera Cruz, to whic
correspond on the west the recently upheaved Jorul
(4000 feet) in Michoacan, Colima (12,800) near the coa
in Jalisco, and the volcanic Revillagigedo group in th
Pacific. South of this line, and nearly parallel, are th
Sierras of Guerrero, and south of the Tehuantepec isthmu
those of Oajaca and Soconusco towards the Guatemal
frontier. In the same direction run the islands of Cub
and Hayti, which probably belong to the same Central
American system.

Mexico is thus physically connected through its olde
plateau formations with the North American table-land
and through its more recent volcanic upheavals with th
Central American igneous region. But as it advance
northwards this region loses in underground energy; hence
notwithstanding the remarkable upheaval of Jorullo i
1759, the Mexican cones show little signs of activity,[5] an
the land is now scarcely ever wasted by violent earth
quakes. Such phenomena are most frequent in the Pueb
valley; but, although often accompanied by the peculia
underground rumblings known as *bramidos*, they ar
seldom of a destructive character. The natives speak o
them rather as *temblores*, or "tremblings," than tru
terremotos.[6]

In a region where lofty ranges and plateau forma
tions with steep escarpments approach almost everywher
to within a few miles of the coast, little space is left fo
the development of large river basins. Most of th
streams are little more than mountain torrents rushin
impetuously from terrace to terrace seawards. Many als

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[1] The results of these surveys are embodied in the *Carte du Mexique*, 3,000,000, published at Paris in 1873

[2] In the steepest parts the mean is 2·51 in 100, or 133¼ feet to the The exact elevation of the capital above the sea at Vera Cruz to be 7550 feet, or 80 more than Humboldt's estimate.

[3] The term *Anahuac*, meaning in Aztec "near the water," seems to en originally restricted to the central lacustrine basin of tlan. But when the Aztecs reached both oceans they extended Pacific coast between Tututepec and Guatemala (Anahuac- , and to the Atlantic coast between the Alvarado and rivers (Anahuac-Xicalanco). The original use of the word is still current amongst the natives as practically synonymous wi Central Mexico. As a strictly geographical expression it is vague and often incorrectly used by modern writer

[4] This elevation is based on the calculations of Humboldt, Glenn and Gerolt; but in 1857 Senntag assigned an extreme height of ov 17,000 feet to the highest peak of Ixtaccihuatl. Popocatepetl is usual supposed to be the highest point of North America, but the rece United States survey have transferred this honour to Mount Elias the Alaska coast, which appears to be certainly over 19,000 feet hig

[5] Popocatepetl emits smoke, whence its name, meaning in Azt "Smoking Mountain," from *popoca* "to smoke," and *tepetl* "mou tain." Since the conquest three eruptions have been reported (151 1539 1540); but the geological evidence seems to indicate th there has been no volcanic action for thousands of years. Orizab whose native name means "Star Mountain," has been quiescent sin 1566. Colima still frequently ejects ashes and smoke, but bo Jorullo and Tuxtla are quiescent, the last having been silent since t violent eruption of March 2, 1793. Even the Mal-pays, or bad l that formed Jorullo, has cooled down, and is now again clothed wi vegetation

[6] "It is noteworthy that the seismic waves flow normally along t indicated line from east to west, thereby confirming Humboldt's vie that under about 19° N. there is a deep rent in the earth's crus through which at different periods the underground fires have brok at various points between the Gulf of Mexico and the Revill gigedo group. "Only on the supposition that the volcanoes, whi are on the surface connected by a skeleton of volcanic rocks, are al united under the surface by a chain of volcanic elements in continu activity, may we account for the earthquakes which in the directi mentioned cause the American continent, from the Gulf of Mexico the Pacific Ocean, to oscillate at the same time" (Egloffstein, p. 37

flow through the profound rocky gorges or *barrancas*, as they are here called, which form a characteristic feature of the Mexican table lands.[1] On the east side some of these barrancas, here running mostly west and east, attain depths of 800 to 1000 feet in the mid-cretaceous limestones of that region; and even on the west coast the De Beltran Canon is flanked by sheer rocky walls over 500 feet high. Hence the rivers are almost useless for irrigation purposes, and available as means of communication only for short distances in their lower reaches, where they flow through the narrow alluvial strip of level coast lands to the sea. The Rio Grande del Norte, which is by far the largest, and which forms the entire line between Mexico and Texas, is navigable by large vessels only for a few miles above its port of Matamoras. The Rio Grande de Santiago, the largest on the Pacific side, is almost everywhere obstructed by falls and rapids. On this coast the next in importance is the Mercala, or Rio de las Balsas, which, like the Panuco, Alvarado, Coatzacoalcos, Grijalva, and Usumacinta flowing to the Gulf of Mexico, is subject to sudden rises during the rains.

At this season the waters which find no seaward outlet are collected in the depressions of the plateaus, where extensive tracts remain flooded for several months at a time. But these lacustrine basins of the Anahuac and Chihuahua table lands, standing at elevations of from 4000 to 7000 feet, are, by evaporation under semi-tropical suns, rapidly reduced to their normal level. The diminished size of the Anahuac lakes shows that since the conquest a steady process of desiccation has been going on, due probably to the reckless destruction of the upland forests by the European settler. None of these lakes are of great size except Lake Chapala, which is traversed by the Rio Grande de Santiago, and has a reputed area of about 1300 square miles. Amongst those of the plateau especially noteworthy for their magnificent scenery are Tezcuco and Chalco, in whose sparkling waters are reflected the surrounding volcanic peaks and extinct craters of the Anahuac table land, with a background formed by the Cordilleras, whose snowy summits rise here and there high above the dark pine forests of the lower slopes.

In the higher range the prevailing formations are granite, which seem also to form the foundation of the plateaus, above which rise the traps, basalts, mineral-bearing porphyries, and more recent lavas. Hence Lyell's theory that Mexico consisted originally of granitic ranges with intervening valleys subsequently filled up to the level of the plateaus by subterranean eruptions. Igneous rocks of every geologic epoch certainly to a large extent form the superstructure of the central plateau. But the Mexican table land seems to consist mainly of metamorphic formations, which have been partly upheaved, partly interpenetrated and overlaid by igneous masses of all epochs, and which are chiefly represented by shales, greywacke, greenstones, chlorite schists, and especially unfossiliferous limestone. All these formations are alike remarkable for the abundance and variety of their metalliferous ores, such as silver, silver-blende, copper, and gold. Gneiss and micaceous schists prevail in Oajaca and on all the southern slopes facing both oceans. But the highest ranges are formed mainly of plutonic and volcanic rocks, such as granites, syenites, diorites, mineral-bearing trachytes, basalts, porphyries, obsidian, pearlstone, sulphur, pumice, lavas, tufa, and other recent volcanic discharges. Obsidian (*itztli*) was the chief material formerly used by the natives in the manufacture of their cutting implements, as by the quarries of the Cerro de las Navajas ("Knife near Zimapan. Vast deposits of pumice and the sulphur are found at Huichapa and in many of the But immeasurably the most valuable rocks a argentiferous porphyries and schists of the central and in Sinaloa, unless they are destined to be rivalled auriferous deposits of Sonora.[2] Horizontal and s rocks, of extremely limited extent in the south, are developed in the northern states, and chalk becom prevalent towards the Rio Grande and Rio Gila To this chalk and to the sandstones are probabl referred the sandy plains which cover vast tracts i Mexico, stretching thence far into New Mexico and Here the Bolson de Mapimi, a vast rocky wi inhabited only by wild tribes, occupies a space of 50,000 square miles in Coahuila and parts of the su ing states.

None of the horizontal layers seem to be very ores, which are found mainly in the metamorphic, pa and hypogene rocks of Durango, Chihuahua, and th Apart from Sinaloa and Sonora, which are now k contain vast stores of the precious metals, nearly historical mines lie on the south central plateau a tions of from 5500 to 9500 feet. A line draw the capital to Guanajuato, and thence northw the mining town of Guadalupe y Calvo in Chi and southwards to Oajaca, thus cutting the ma of upheaval at an angle of 15°, will intersect proba richest known argentiferous region in the whol The central group of mines in the three mineral of Guanajuato, Zacatecas, and Catorze (San Luis which have yielded more than half of all the silver found in Mexico, lie between 21° and 24° 30′ N., w area of about 13,000 square miles. Here the Veta lode of Guanajuato alone produced £504,000 1556 and 1803, besides £10,000 of gold. This however, occurs chiefly, not on the plateau in ass with silver, but on the slopes facing the Paci apparently in greatest abundance in Sonora, auriferous region of New California. In recent ti half of the silver produced in the whole world h supplied by Mexico, and the total yield of the metals between 1537 and 1880 was as under:[3]—

	Gold.		
1537 to 1821	£14,000,000	£418,000,000	£432,0
1821 to 1880	10,000,000	180,000,000	190,0
Total . . .	£24,000,000	£598,000,000	£622,0

Of other minerals the most important are coppe in a pure state near the city of Guanajuato, and ated with gold in Chihuahua, Sonora, Guerrero,

[1] "Near the mountain ranges, fr which the water after heavy rains rushes down in innumerable forest streams, these ravines are filled with incredible rapidity as high as 30 feet, the torrent importing (*sic*) trees and bearing away rocks with a thundering noise and irresistible power" (Egloffstein, p. 22).

[2] "On the general character and distribution of the igneous f Von Egloffstein remarks "Intimate relations exist bet metalliferous and non metalliferous porphyries. The metalli phyry is less frequent, but constitutes the most important f bearing the precious metals, . . . embracing the rich lodes of Monte, Pachuca, Chico, Capula, and Santa Rosa, all of grea and magnitude. They further form the mineral districts Mineral del Monte, Oro, Huautla, &c., and part of the mountains of Zim Istapa-del Oro. The lodes found in this porphyry are cha by their magnitude and the consistency of the ores they cont The richest ores of native silver and sulphuret, chloride, an silver are found in the lodes of Real del-Monte, Pachuca, Santa Rosa . . The gold seems to exist in small particles in morphic porphyry mountains, whence it is carried by the rai valleys as the rocks become disintegrated" (pp. 6-8).

[3] *Times* correspondent, December 7, 1882. Guanajuato s still the greatest producer, yielding from £1,500,000 to £ yearly, although the great Valenciana mine is flooded, and of died opened only fifty-two are now worked (Geiger).

Michoacan, and elsewhere; iron in immense masses in Michoacan and Jalisco, and in Durango, where the Cerro del Mercado is a solid mountain of magnetic iron ore; lead associated with silver, especially in Oajaca; tin in Michoacan and Jalisco; sulphur in many craters; platinum recently found in Tlaxcala and Hidalgo; cinnabar also recently in Morelos and Guerrero; "steppe salt" in the sandy districts of the north; "bitter salt" at Tepeyac; coal in limited quantities at various points; bismuth in many parts; marble, alabaster, gypsum, and rock-salt in great abundance throughout the plateau and the sierras. In 1882 there were open altogether 569 mines:—541 silver, 14 gold, 4 copper, 4 lead, 3 salt, 2 coal, and 1 mercury.[1]

Intersected about midway by the Tropic of Cancer, and stretching across seventeen parallels of latitude, Mexico, from its position alone, necessarily enjoys a great diversity of climate. But from its peculiar configuration this feature is affected far more by the relief of the land than by its distance from pole or equator. This is especially true of the more fertile and populous section lying within the torrid zone, where three distinct climatic regions are distinguished, not according to their horizontal, but according to their vertical position. The temperature falling steadily with the elevation of the land, which here rises rapidly from sea-level to nearly 18,000 feet above the surrounding waters, the low-lying coast lands, up to about 3000 feet on the scarps and terraces of the central plateau, are comprised within the first zone of *tierras calientes*, or "hot lands." Within this zone are included all the sandy and marshy tracts fringing the Gulf of Mexico, the lower slopes facing eastwards and exposed to the hot and moist winds from the Caribbean Sea, and most of Yucatan and the Tehuantepec isthmus, besides the narrow strip between the uplands and the Pacific which broadens northwards along the east side of the Gulf of California. Here the mean temperature varies from 77° to 82° Fahr., seldom falling below 60°, but often rising to 105°, and in the sultry districts of Vera Cruz and Acapulco to 110°. The extreme north-western parts of this region come almost within the rainless zone, and the Californian peninsula itself is subject to excessive droughts, rendering it almost uninhabitable. But farther south the climate on both seaboards may be described as humid, hot, and extremely unhealthy, especially for Europeans. Yellow fever and black vomit are here endemic. But these scourges are at least compensated by a magnificent tropical vegetation and extensive virgin forests abounding in valuable timbers, dyewoods, and medicinal and other useful plants. Of the 114 species of trees and cabinet woods, 17 of oil-bearing plants, and over 60 of medicinal plants and dyewoods indigenous to Mexico, and often differing specifically from kindred varieties in Central and South America, by far the larger part are represented in the tierras calientes. Amongst the most important of these forest plants are mahogany, rosewood, copal, caucho (india-rubber), jalap, sarsaparilla, and Here also maize, supplying the staple food of the yields prodigious returns, multiplying from two to four hundred fold, and affording two, three, a four successive crops within the year. Rice, indigo, tobacco, and coffee all thrive well, while sugar, co banana, and several varieties of beans are largely cul The tobacco of Vera Cruz and Tabasco, the coffee of and the cocoa of Oajaca and Chiapas are of un excellence.

To the "hot lands" succeed in vertical posit *tierras templadas*, or "temperate lands," which c all the higher terraces and the central plateaus the between about 3000 and 8000 feet. With a mean t ture of from 62° to 70° Fahr., and oscillating such moderate extremes as 50° and 86°, this region one of the very finest climates on the globe. The and Anahuac table-lands are described by enth travellers as "terrestrial Edens," with a perennia symbolized by the evergreen oak, cedars, and analogous plants, which here attain their greatest tion. The transition from the lower zone is oft gradual; and, while endemic fevers cease altoge altitudes of 2700 and 2800 feet, the tropical flora many parts of the terrace lands, and even of the to heights of 4000 and 5000 feet.[2] A certain un is thus imparted to the Mexican landscape by t range of the maize, wheat, tobacco, vine, coffee, a plantations, as well as by the palms, evergreens, olive, orange, lemon, yucca, and an endless variet cactus family, one species of which forms hedges high on the Anahuac uplands. The central zone i whole drier than the southern lowlands, althou scarps facing seawards are often wrapped in the mists of the intercepted moisture-charged atm currents. The heaviest recorded rainfall (90 to 100 occurs in the healthy Huatusco district of Vera an altitude of 4380 feet.

In the highest zone of *tierras frias*, or "cold embracing all the highlands from about 8000 feet u the rainfall is five times less than on the tierras te Hence snow rests throughout the year only on most elevated peaks of Popocatepetl, Orizaba, Ne Toluca (15,000 feet), and Ixtaccihuatl. Chara both of the tierras frias and templadas is the (*Agave mexicana*), whose fruit is edible, and fermented juice has from time immemorial supp famous *pulque*, or national beverage of the M From the fibre of the henequen, an allied species duced the "Sisal hemp" of commerce, which has i years become the staple export of Yucatan.

Speaking generally, the four seasons are clearly north of 28° N. lat. only. South of that paral merge in the *estacion de las aguas*, or rainy seas May to October, and the *estacion seca*, or dry season prevails for the rest of the year. The rains g begin on the east coast, gradually moving westwa the Pacific the moist atmospheric currents are northwards, whence the striking contrast betw

[1] Lorenzo Castro, *Mexico in* 1882. According to this authority the total yield of the Mexican mines between 1537 and 1880 was £776,276,000, while another estimate based on a report of the Mexican mint gives it at £930,786,000. Of this a large amount has been coined in Mexico, where there were eleven mints at work in 1876, with a total annual yield of about £5,000,000. The total coinage since the conquest has been estimated as high as £600,000,000, not more than 5 per cent. of this being gold. With regard to coal, the existence of which in Mexico has been recently denied by Mr Bigelow in *Harper's Magazine*, official returns for 1882 give a list of over twenty places where it has been found, though nowhere as yet in large quantities. Petroleum also appears to be very abundant in several localities. Amongst other natural products mention should be made of amber, found on the Yucatan coast. Mineral springs are very numerous everywhere on the plateaus and terrace-lands. The most famous are El Peñon and N. Señora de Guadelupe near the capital, and Aguas Calientes farther north.

[2] On the Anahuac plateau, which stretches south of Popoc a mean height of 5000 to 5400 feet, "coffee, sugar, and indigo vated, and most of the tropical fruits grow luxuriantly" (E p. 17). The same authority gives the limits of vegetat region at 12,614 feet, and the snow line at 14,960 feet. He that "nothing is more surprising to the traveller than the v climate under this zone, which vary according to the different above the sea. In a few hours we descended from the cold the fir and the oak, on the heights of Ozumba, to a hot clim *caliente*, where we found the most luxuriant vegetation, that short time through successive changes of the most species of trees, plants, birds, insects" (p. 22).

ooded slopes of British Columbia and the treeless crests f the arid Lower Californian peninsula.

In its fauna no less than in its flora Mexico forms land of transition between North and Central America. n common with the north it has several varieties of the ear, the wolf, coyote, skunk, bison, squirrel, beaver, arten, otter, rattlesnake, heloderm,[1] mocking-bird, and any wild fowl; while its monkeys (five species), puma, guar, ocelot, sloth, tapir, alligators (two species), iguana, oa, scorpions, tarantulas, and numerous brilliantly coloured arrots, trogons, and humming-birds connect it with the outhern regions. Peculiar to Mexico, and distinguishing from most tropical and subtropical lands, are its song- ters, of which, besides the mocking-bird (*cenzontl*), as any as twenty species have been enumerated. The oasts are well supplied with fish and turtles, while the earl fisheries of the Gulf of California continue to be a ource of wealth to that otherwise unproductive territory, ielding in 1875 pearls to the value of £16,000, and 28,000 worth of shells. All the European domestic nimals thrive well, and vast herds of cattle, horses, and neep are found on the well stocked ranchos of the orthern states. Here some of the more prosperous readers own from twenty to thirty thousand head of xen, and next to the precious metals hides and cattle re among the chief articles of export.

But in the south stock breeding yields everywhere to griculture as the chief occupation of the people. Being rgely volcanic, the soil is here extremely fertile wherever ater can be had in sufficient quantities for irrigation urposes. Next to maize, which with beans and chilli rms the almost exclusive food of the Indians, the most portant crop is probably sugar, of which over 60 million ounds are annually produced in the state of Morelos alone. offee is extensively cultivated on the lower slopes, and ow exported in considerable quantities, especially to the nited States. The tobacco and cotton crops are yearly creasing in importance, while from the maguey is xtracted, besides pulque, a spirit called mezcal to the nnual value of about £750,000. The aborigines are rtly employed as free labourers on the plantations, and rtly hold small plots liable to a light Government x. The food crops thus raised were valued in 1873 £14,500,000, the agricultural produce at £30,000,000, nd the landed property at £85,000,000, but the last em was estimated by the minister of finance at fully ree times that sum. The value of arable freehold land as stated in 1882 to be from £1 to £3 per acre, accord- g to its proximity to or remoteness from rivers.

Of the industries strictly so called, those directly connected with gricultural interests have alone acquired any considerable develop- ent. Such are sugar refining, carried on on a vast scale, especi lly in Morelos; brewing and distilling, chiefly from maguey; paper- aking from various pulps and fibres; grist mills and saw-mills, specially in Puebla, Queretaro, Guadalajara, and Saltillo. A few on foundries have been at work for some years, and stout hand oven cotton and woollen fabrics are produced in many of the large owns. The rebozos (shawls) of Leon and Salvatierra have a wide epute, while Texcoco and Puebla are noted for their porcelain and lass ware. Among the petty industries are clay and rag figures, rtificial flowers, wooden toys, and gold filigree work, in the produc- ion of which the natives often display remarkable taste and skill.

But all these manufactured wares are solely intended to supply he local wants, so that the exports have hitherto been restricted lmost exclusively to the produce of the land and of the mines. f the former the chief items are coffee, Sisal hemp, tobacco, ides, lumber, cochineal, indigo, and other dyes, sarsaparilla, anilla, orchil, india rubber. But the precious metals still continue constitute fully two-thirds of all the exports, which in 1882 had total estimated value of about £6,000,000. In the same year an equal sum represented the imports, the leading items of which were cotton, linen, silk, and woollen goods, metals, hardware, machinery, and provisions. Although diplomatic and consular relations with Great Britain have been suspended since 1867, that country still continues to enjoy by far the largest share of the foreign trade, taking about £2,000,000 of the exports, and sending in return about two-thirds of all the imports, for 1882. Next in importance, in descending order, is the trade with the United States, France, Germany, Spain, and Columbia.

Probably four-fifths of the exchanges now pass through Vera Cruz, which, since the opening of the railway to the Anahuac plateau, has become the natural out-port of the capital and all the central states. It is connected by several lines of ocean steamers with Liverpool, Southampton, St Nazaire, and the Atlantic States of North America. On the Pacific seaboard, where the trade is largely in German hands, Acapulco and the other ports also enjoy regular steam communication with San Francisco and Panama. No accurate returns are available of the shipping; but the yearly arrivals in all the Mexican ports are stated to average about five thousand,—not more than one fifth under the national flag.

Till recently the means of internal locomotion were mainly C limited to the wretched bridle paths from the central plateau over m the sierras and terrace-lands down to a few points on both coasts, ti and to twenty four regular lines of diligences under one manage- ment. But since the completion of the line from Vera Cruz to the capital, with a branch to Puebla, the Mexican railway system has acquired a considerable development. The Inter-Oceanic line across the Tehuantepec isthmus is in progress; the Great Central Trunk line running northwards through Chihuahua will ere long effect a junction with the North-American net work; and at the end of 1882 there had been opened to traffic altogether 2219 miles. For that year the number of passengers carried was 8,250,000, and of mer- chandise 273 million tons, with net earnings £940,000, or £800 per mile. Still more developed is the telegraph system, which is now extended to all the state capitals, and through the Mexico-Mata- moras line to the United States and the rest of the world. The 8150 miles open in 1882 forwarded 750,000 messages, or in the proportion of 8 per 100 inhabitants.

For the same year the estimated revenue was £6,140,000, F and expenditure £6,300,000. The foreign debt is stated to be £19,600,000, and the internal about £10,000,000, or altogether at the rate of £3 per head of the population. Most of the foreign debt is owned in England, but the British claims had long been practically repudiated by the Mexican Government. At the end of 1882, however, a semi-official suggestion was made that a settle- ment might be effected by Mexico paying 1 per cent. on the capital for the first ten years, 2 for the second, and 3 there- after, the whole sum, amounting to £16,000,000, to be liquidated in fifty years.[2] The revenue is chiefly derived from the customs, and about £1,750,000 of the expenditure is absorbed by the army, the peace footing of which is 22,500 men of all arms. Beyond a few coastguard steamers maintained mainly for revenue purposes, there is no navy. An indication of financial improvement is afforded by the establishment in 1882 of the Mexican National Bank by a French company with a capital of £4,000,000. This bank is privileged to issue paper money up to £12,000,000, in return allow- ing the supreme executive to overdraw their account up to £2,000,000. A further symptom of revival is presented by the increasing business of the general post-office, which in 1880 forwarded 4,406,000 letters and packages through 873 offices.

Education also has made marked progress since the final I separation of church and state in 1857. In that year the old t university of Mexico, a purely ecclesiastical institution after the model of Salamanca and the Sorbonne, was abolished, or rather was re- placed by special schools of law, medicine, letters, agriculture, mines, sciences, fine arts, and commerce, and a military college. These, as well as numerous lower schools, including two hundred in the capital alone, are all maintained by the state, while national schools are supported by public grants in all the large towns, and higher institutions in the capitals of the several states. There are in all nearly five thousand public schools, besides establishments for the deaf and dumb, the blind, and juvenile delinquents, and numerous charitable foundations maintained by voluntary contri- butions.

Roman Catholicism, which under the Spanish rule was alone I tolerated, continued after the separation to be the state religion till 1857. Since then, while all churches enjoy equal protection, none are officially recognized. The great majority of the *Indios fideles*, mestizoes, and creoles still adhere at least outwardly to the Roman Church, which is administered by a hierarchy of three arch- bishops (Mexico, Morelia, and Guadalajara) and twelve bishops. But by the organic laws of 1856 and 1859 all ecclesiastical estates, at one time comprising over one-third of the soil, were nationalized,

[1] A specimen of this curious creature, the only known venomous ard (*Heloderma suspectum*), reached the London Zoological Gardens in 882; its habitat is the north of Mexico, and New Mexico, Arizona, nd Texas.

[2] This advance towards a settlement was put forward in the *Two Republics* of December 5, 1882, a Mexican journal which reflects the views of the Government on all matters of foreign policy.

he regular clergy suppressed, and their monasteries, together with ll other superfluous ecclesiastical structures, appropriated by the tate. During the last few years American Protestant missions ave claimed some partial success, and the so-called "Church of esus," an undenominational body of a somewhat original type, as found a number of adherents, especially on the Anahuac table-and. But the *Indios bravos*, or uncivilized aborigines, everywhere ollow the old spirit worship, while the Christianity of the Fideles little more than a cloak for the continuous practice of the former ztec heathenism. The pomp of the Roman ritual is supplemented y the feasts of the national worship, and the Pagan deities of the ld cult are still represented by the saints of the Roman calendar.[1]

Mexico constitutes at present a confederation of tates modelled on that of the North-American Union, nd administered according to the constitution of 1857 as mended in 1873–74. By popular suffrage are chosen the resident, the upper house (fifty-two members), and the upreme judiciary for four years, and the lower house (two undred and twenty-seven members) for two years. The enate, abolished in 1853, was restored 1874, and he chief justice is *ex officio* vice president. The federal tates, which are divided into a number of administrative districts, enjoy full autonomy in all local matters. The everal constitutions are modelled on that of the central government, and like it comprise three departments—egislative, executive, and judicial. Each state is repre sented in the federal congress in the proportion of one member for every 80,000 inhabitants, and in the federal senate by two members elected by suffrage in the local congress. All external affairs and questions of general interest are reserved for the central government. The constitution as now established thus represents in theory the complete overthrow of mediaevalism, and the absolute triumph of the new ideas which in the Old World are still in so many places struggling for the ascendency.

It is this struggle between privilege and popular rights that lends its human interest to the otherwise monotonous record of unresisted oppression and apparently aimless revolutions which characterize the early and the later periods of Mexican history, from the overthrow of the native rule down to the present day. The early or colonial period covers exactly three hundred years, from the death in 1521 of Guatemozin, last of the Aztec emperors, to the withdrawal of the last Spanish viceroy, Don Juan O'Donoju, in 1821. During these three centuries the attitude of the masses was one rather of sullen submission than of active resistance to grinding oppression. By the Spanish Government Mexico was looked on merely as a vast metalliferous region, to be jealously guarded against foreign intrusion and worked exclusively for the benefit of the crown. The natives were evangelized chiefly for the purpose of being employed as slaves above and below ground, and thus was introduced from the West Indies the system of *repartimientos*, or distribution of the aborigines on the plantations and in the mines. But, while this system proved fatal to the natives of Cuba and Hayti, where it had to be replaced by negro labour, the hardier populations of the Anahuac plateau successfully resisted its blighting influences. It proved in fact more disastrous to the oppressor than to the oppressed. In those days Spain was commonly compared to a sieve, never the richer for all the boundless wealth drawn from the New World. But the aborigines derived at least some advantage from contact and partial fusion with a people of superior culture. This fusion, which may be regarded as the chief outcome of the colonial administration, has contributed to the formation of the present exceedingly complex Mexican nationality, in which the Indian continues to be the predominating element. Taking the whole population at less than ten millions, its ethnical distribution appears to be at present as under :—

1. Full-blood Indians	5,000,000
2. Mestizoes (half-caste Indians and whites)	3,000,000
3. Creoles (whites of Spanish descent)	1,500,000
4. Gachupines[2] (Spaniards by birth)	50,000
5. Other Europeans and Americans	100,000
6. Full-blood negroes	10,000
7. Zambos or "Chinos" (Indo-Africans)	45,000
8. Mulattoes (Eurafricans)	5,000

Under the Spanish administration, which was marked on the surface by few stirring events, such as warlike expeditions, civil strife, or serious internal troubles, Mexico, or New Spain, formed a viceroyalty at one time stretching from the isthmus of Panama to Vancouver's Island. Antonio de Mendoza, appointed in 1535 after government by *audiencias* had proved a signal failure, was the first of sixty-four viceroys who ruled with almost autocratic power, but scarcely any of whom has left a name in history. Don Juan de Acuña (1722–31) is mentioned as having been the only native American among them, and Don Juan V. G. Pacheco (1789–94) had at least the merit of betraying some regard for the social welfare of his subjects. Under him a regular police, the lighting and draining of towns, and other municipal improvements were introduced.

But down to the early years of the present century all emoluments in church and state, most of the large plantations, of the mines, and of the commerce of the country, continued to be monopolized by the privileged gachupines, whom the creoles and mestizoes had already begun to regard as aliens. Hence the first reactionary movements, stimulated by Napoleon's deposition of King Ferdinand and arrest of the viceroy Hurrigaray in 1808, were aimed rather against odious class distinctions and the intolerable oppression of these aliens than against the abstract rights of the Spanish crown. The long smouldering spirit of discontent at last broke into open revolt in 1810 at Guanajuato, under the leadership of Don Miguel Hidalgo. After his defeat and execution in 1811, the struggle was continued by Morelos, who, like Hidalgo, was a priest, and shared his fate in 1815. But he had already called a national assembly at Chilpanzinco, and by this body Mexican independence was for the first time proclaimed in 1813. A guerilla warfare kept the national spirit alive till a fresh stimulus was given to it by the Spanish revolution of 1820. Under the leadership of the "Liberator" Iturbide, Mexican independence was again proclaimed on February 24, 1821, and the same year the capital was surrendered by O'Donoju, the last of the viceroys. But even after the revolt had thus been crowned with success a change of *personnel* rather than of system was contemplated; nor was Iturbide proclaimed emperor until the Mexican crown had been declined by a royal prince of Spain.

Almost simultaneously with this event the republican standard had been raised by Santa Anna at Vera Cruz (December 1822). Thus the nation had no sooner got rid of foreign rule than it became torn by internal dissension. But henceforth the struggle is not so much against the privileged classes as between Conservative and Liberal principles,—the former represented chiefly by the church and the superstitious populace, the latter by the more enlightened but not less unscrupulous sections of the community. From both the Indios Bravos, that is, about a third of the whole population, hold entirely aloof, and take advantage of the public disorders to continue their aggres-

[1] On the general state of religion in Mexico Bates well remarks:—"The educated classes conform to the outward ceremonies and ordinances of the church, while inwardly believing little or nothing of its dogmas. The lower grades of society are, on the other hand, steeped in the most grovelling superstition, intensified by many traditional Indian reminiscences. This section of the community yields a blind obedience to the clergy, notwithstanding the severe laws with which the Government has endeavoured to counteract the influence of the priests. Even so recently as 1874 a genuine case of witch-burning occurred in Mexico."—*Central America*, p. 34.

[2] From the Aztec *Gatzopin*, centaur; also known as *Chapetones*.

arfare against all alike.[1] Events now follow in quick sion, and as many as three hundred successful or ve revolutions are recorded during the brief but y life of Mexican national independence.[2] But amid onfusion of empires, republics, dictatorships, and ry usurpations, succeeding each other with bewilder- pidity, the thoughtful student will still detect a steady ess towards the ultimate triumph of those Liberal which lie at the base of true national freedom. A abulated summary of the more salient incidents in ventful struggle must here suffice :—

3. Mexican independence acknowledged by Spain ; regency under Iturbide, who (1822) is elected hereditary constitutional emperor ; in December Santa Anna proclaims the republic in Vera Cruz
4 Provisional Government ; Iturbide abdicates ; exiled, withdraws to London, but returning is shot (1824).
First Liberal constitution "Acta Constitutiva de la Federacion Mexicana," then comprising nineteen states and five territories, first president D. Felix Victoria, known as "Guadalupe Victoria."
0 Contested presidencies of Pedraza, Guerrero, and Bustamente
Reaction of the church party, constitution of 18[illegible] abolished, the confederate states fused in a consolidated republic under Santa Anna as president, but practically dictator
Texas refusing to submit secedes, defeats and captures Santa Anna
anta Anna returning resumes office.
Bravo's brief presidency followed by much anarchy.
1. Santa Anna's first dictatorship with two others.
Constitution restored with Santa Anna president, banished same year, he is succeeded by Canalizo.
Herrera president ; disastrous war with United States to recover Texas.
anta Anna again president.
Treaty of Guadalupe ; California and New Mexico ceded to United States.
anta Anna's second dictatorship; treaty of Mesilla (negotiated by Gadsden) ceding extensive territory to United States and reducing Mexico to its present limits ; great financial embarrassment ; "Plan of Ayutla" ; flight of Santa Anna followed by universal chaos.
Provisional Government under President Comonfort.
Constitutional convention ; radical reforms : rupture with Spain.
Liberal constitution of March 11 ; suspended December 1 ; Comonfort dictator ; the reaction supported by the church, large part of the army, and all Conservatives, opposed at Vera Cruz by Vice-president Benito Juarez at the head of the "Puros," or advanced Liberals ; the "War of Reform" begins, and lasts till 1860.
9 In the capital Comonfort is deposed by Zuloaga, who abdicates in favour of Miramon, general of the Conservative forces ; but, declining the presidency, Miramon restores Zuloaga ; British legation violated, in Vera Cruz the United States envoy MacLean acknowledges Juarez, who introduces further Liberal measures.
Capitulation of Guadalajara ; flight of Miramon from the capital, triumph of the Liberals.
Triumphal entry of Juarez into the capital ; further radical reforms, marriage declared a civil contract ; celibacy and ecclesiastical tribunals suppressed ; confiscation of church property valued at £75,000,000 and over a third of the soil ; final separation of church and state ; Spain, France, and England urge claims for losses of their subjects resident in Mexico ; convention of London ; intervention of the allies, who occupy Vera Cruz in December
England and Spain withdraw, their claims having been settled by negotiation, war continued by France.
4. The capital occupied by the French ; Louis Napoleon dreams of a universal fusion of the Latin races ; offers the Mexican imperial crown to the Austrian archduke Ferdinand Maximilian, who accepts, and arrives in June 1864.
After diverse issues the French withdraw ; Maximilian, abandoned to his fate, is captured and shot at Querétaro (June 19).

December 1882 a party of seventy five Mexicans and Americans assacred in the state of Chihuahua by a band of Bravos.
ween 1821 and 1868 the form of government was changed ten over fifty persons succeeded each other as presidents, dictators, erors; both emperors were shot, Iturbide in 1824, Maximilian and according to some calculations there occurred at least three *pronunciamientos*.

1867–69. Various pronunciamientos by Santa Anna and other
1871–72. Juarez president ; he dies in office July 1872 ; succ by his secretary Lerdo de Tejada.
1873–74. The Liberal constitution of 1857, which had been suspended (1858–60 and 1863–67), is now largely ame and continues to be henceforth the organic law of Me
1876. Tejada succeeded by Porfirio Diaz.
1880. Manuel Gonzalez, reigning president

Since 1869 the Liberal party has succeeded in preserving pe home and abroad, while establishing democratic institutions firm basis. A. v. Humboldt's gloomy anticipations[3] have not realized, and for the first time in its chequered history Mexic look forward with some confidence to a bright future. The p spot is the uncivilized Indian element. But with boundless n resources at its disposal, a wise administration may hope to come that difficulty, and gradually effect a complete fusion o antagonistic racial elements.

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III. THE CITY OF MEXICO.

Mexico, the capital formerly of the Aztec empire a the Spanish colony of New Spain, and now of the repu state, and federal district of Mexico, stands on the Ana plateau, 7524 feet above sea-level, 2½ miles from the s west side of Lake Tezcuco (Texcoco), the lowest and la of six basins filling the deepest depression in the hill-enc Mexican valley. Situated in 19° 25′ 45″ N. lat. and 9 W. long., it is 173 miles by rail from Vera Cruz o Atlantic, 290 from Acapulco on the Pacific, 285 from Oa 863 from Matamoros on the United States frontier. M is the largest and finest city in Spanish America, for a square nearly 3 miles both ways, and laid out with pe regularity, all its six hundred streets and lanes runni right angles north to south and east to west, and cov within the walls an area of about 10 square miles, w population (in 1880) of 230,000. Most of the inhabi are pure-blood Indians or mestizoes ; but the foreig chiefly French, English, Germans, Americans, and Spani monopolize nearly all the trade, and as capitalists, ban merchants, and dealers enjoy an influence out o proportion to their numbers. A large portion of natives are mendicants or vagrants, and the disti criminal element (26,470 in 1878) is kept in order police force of 1320 men; yet in that year there we many as 5370 knife-attacks and 3250 robberies.

[3] Consulted shortly before his death as to the future prospe Mexico, with which his name was so intimately associated, Hum ventured to prophesy that "die Vereinigten Staaten werden es r reissen und dann selbst zerfallen."

well-paved, and gas-lit streets present a picturesque
nce with their quaint two- and three-storied stone
gaily painted in white, red, yellow, or green, and
ting everywhere with a background of rugged
or snowy peaks which, owing to the bright atmo
at this elevation, seem quite close, although really
0 miles distant. All the main thoroughfares con
n the central Plaza de Armas (Plaza Mayor, or
quare), which covers 14 acres, and is tastefully laid
h shady trees, garden plots, marble fountains, and
Here also are grouped most of the public buildings,
g above which is the cathedral, the largest and
mptuous church in America, which faces the north
the plaza on the site of the great pyramidal teocalli
ple of Huitzilopochtli, titular god of the Aztecs.
ifice, which was founded in 1573 and finished in
t a cost of £100,000 for the walls alone, forms a
ross 126 feet long and 203 wide, with two great
nd three aisles, twenty side chapels, and a magnifi
gh altar supported by marble columns, and sur
l by a tumbago balustrade with sixty two statues of
ne rich gold, silver, and copper alloy serving as
bra. The elaborately carved choir is also enclosed
bago railings made in Macao, weighing 26 tons, and
at about £300,000. In the interior the Doric style
s, Renaissance in the exterior, which is adorned by a
ne and two open towers 218 feet high. At the foot
left tower is placed the famous calendar stone, the
teresting relic of Aztec culture. The east side of
za is occupied by the old viceregal residence, now
tional Palace, with 675 feet frontage, containing
the Government offices (ministerial, cabinet, treasury),
y headquarters, archives, meteorological department
bservatory, and the spacious hall of ambassadors with
emarkable paintings by Miranda and native artists.
of the National Palace, and apparently forming
s of it, are the post-office and the national museum of
history and antiquities, with a priceless collection
xican remains. Close to the cathedral stands the
de Piedad, or national pawnshop, a useful institu-
ndowed in 1744 by Terreros with £75,000, and now
ing nearly £2,000,000 of accumulated funds.
the cathedral is the Palacio Municipal (city hall),
et by 122, rebuilt in 1792 at a cost of £30,000, and
aining the city and district offices, the corporation jail,
he lonja, or merchants' exchange. Around the
San Domingo are grouped the convent of that
said to contain vast treasures buried within its walls,
inquisition, now the school of medicine, and the
-house. In the same neighbourhood are the church
Jesuits and the school of arts, "an immense work-
ncluding iron and brass foundries, carriage and cart
ag, building and masonry, various branches of joinery
holstery work, and silk and cotton hand weaving"
lehurst). Other noteworthy buildings are the
al picture gallery of San Carlos, the finest in
ca, in which the Florentine and Flemish schools are
epresented, and which contains the famous Las
by Felix Parra; the national library of St Augustine,
ver 100,000 volumes, numerous MSS., and many rare
panish books; the mint, which since 1690 has
coinage, chiefly silver, to the amount of nearly
000,000; the Iturbide hotel, formerly the residence
emperor Iturbide; the Mineria, or school of mines,
ecture-rooms, laboratories, rich mineralogical and
ical specimens, and a fossil horse 3 feet high of the
cene period. Owing to the spongy nature of the
he Mineria and many other structures have settled
the perpendicular, thus often presenting irregular
and a rickety appearance. Among the twenty
scientific institutes mention should be made of the Geogr
phical and Statistical Society, whose meteorological depar
ment issues charts and maps of unsurpassed excellence.

Besides the chief market south of the National Palace there
three others, all well stocked with meat, fish, and especi
vegetables, fruits, and flowers grown mainly on the *chinampas*,
floating gardens of Lakes Chalco and Xochimilco. These garde
which were far more numerous in the Aztec times, are formed
placing layers of turf on the matted aquatic vegetable growths t
height of 2 or 3 feet above the water, and securing them by lo
willow poles driven through them to the bottom, where they ta
root. They form plots 100 to 200 feet long by 20 to 100 broad, a
are firm enough to support the huts of the cultivators. From t
still extant illuminated tribute rolls it appears that the Az
rulers derived a large share of the taxes from these gardens, wh
at that time also covered the brackish waters of Lake Tezcuco.

Before 1860 half of the city consisted of churches, convents, a
other ecclesiastical structures, most of which have been sequestra
and converted into libraries, stores, warehouses, and even stabl
or pulled down for civic improvements. Nevertheless there s
remain fourteen parish and thirty other churches, some of large s
with towers and domes, and their number has now been increas
by six Protestant churches including the Anglican cathedral
San Francisco Street. This is the leading thoroughfare, and
rivalled in splendour only by the new Cinco de Mayo Street runni
from the National Theatre to the cathedral.

The city is supplied by two monumental aqueducts, from Chap
tepec and the south-west, with good water at the rate of 44 gall
per day per inhabitant.

Its industries are varied but unimportant, consisting chiefly
gold and silver work, coarse glazed and unglazed pottery of pecul
form and ornamentation, paper, feather-work remarkable for its ta
and beautiful designs, toys, rosaries, crucifixes, religious pictur
lace, and some weaving.

Mexico enjoys an equable climate, with a temperature varying fr
70° to 50° F., but rendered unhealthy by the exhalations from
lakes and the bad drainage. The death-rate in 1876 was 59
1000, and 45 in 1878, pneumonia being most fatal (12 per cent. of
total). Standing at the lowest level of a lacustrine valley, 1
square miles in extent, and completely encircled by hills with
natural outlet, the city has always been subject to floodings fr
the overflow of the neighbouring freshwater lakes Zumpango
Xaltocan on the north and Xochimilco and Chalco on the sou
which, in the 17th century, laid the whole district under water
1607, and again for five years from 1629 to 1634. To remedy
evil the engineer Martinez began in 1607 the great cutting 13 m
long through the Nochistongo hill in order to draw off
discharge of Lake Zumpango, the highest in the valley, to the ri
Tula, a tributary of the Panuco, flowing to the Atlantic. This wo
which cost the lives of 70,000 natives, was completed in 1789; but
result was not satisfactory, and the city is still often flooded.

The chief public promenades are the Alameda, planted w
stately beeches; the Vega, skirted by the Vega Canal, and ador
with the colossal bust of Guatemozin, the last of the Aztec
perors; the Paseo de la Reforma, a fine avenue 3 miles long runn
south to the famous castle of Chapultepec, a place intimately as
ciated with the names both of Montezuma and Maximilian.
present castle, erected in 1785 by the viceroy Galvez on the site
Montezuma's palace, commands a superb view of the city and s
rounding district, and is approached by avenues of gigan
cypresses (*Cupressus disticha*) dating from Aztec times, growing
height of 120 feet, and measuring from 30 to 40 feet round the st
Other good roads with horse or steam trams lead to Tacubaya
the "Noche Triste" tree, where Cortes is traditionally supposed
have rested after the disastrous retreat from Mexico on the nigh
June 30, 1520, to the pleasant summer suburb of Tacubaya, and
the renowned shrine of Our Lady of Guadalupe, 3 miles to the eas
the border of Lake Tezcuco. Here stands the most famous chu
in Mexico, erected to commemorate the legendary apparitions of
Madonna to the Indian Juan Diego in December 1531, and
visited by thousands of pilgrims or sightseers.

Mexico dates either from the year 1325 or 1327, when the Az
after long wanderings over the plateau were directed by the or
to settle at this spot. For here had been witnessed the auspici
omen of an eagle perched on a nopal (cactus) and devouring a sna
Hence the original name of the city, Tenochtitlan (nopal o
stone), changed afterwards to Mexico in honour of the war
Mexitli. With the progress of Aztec culture the place rapidly
proved, and about 1450 the old mud and rush houses were repla
by solid stone structures erected partly on pile
Lake Tezcuco, and grouped round the central enclosure of the g
teocalli. The city had reached its highest splendour on the ar
of the Spaniards in 1519, when it comprised from 50,000 to 60,
houses, with perhaps 500,000 inhabitants, and seemed to Co
"like a thing of fairy creation rather than the work of mo
hands" (Prescott). It was at that time about 12 miles in circ

every where intersected by canals, and connected with the
d by six long and solidly constructed causeways, as is clearly
y the plan given in the edition of Cortes's letters published
nberg in 1524 (reproduced in vol. iv of H. H. Bancroft's
of the Pacific States, San Francisco, 1883, p. 280). After
st total destruction in November 1521, Cortes employed
0,000 natives in rebuilding it on the same site; but since
e lake seems to have considerably subsided, for although
square miles in extent it is very shallow, and has retired 2½
miles from the city. During the Spanish rule the chief ev
the revolt of 1692, when the municipal buildings were de
Since then Mexico has been the scene of many revolutio
after the battle of Chapultepec (September 13, 1847) the
held by the United States troops till the treaty of Gu
May 1848. But since the disorders ending with the d
Maximilian it has turned to peaceful ways, and has becom
centre of civilizing influences for the surrounding semi-b
peoples.
(A. H

'ERBEER, GIACOMO (1791–1863), first known in
ny as Jakob Meyer Beer, was born at Berlin on
ber 5, 1791,[1] of a wealthy and talented Jewish
His father, Herz Beer, was a banker; his mother,
(*née* Wulf), was a woman of high intellectual
; and two of his brothers distinguished themselves
nomy and literature. He studied the pianoforte,
der Lauska, and afterwards under Lauska's master,
tz. When seven years old he played Mozart's Con-
D Minor in public, and at nine he was pronounced
t pianist in Berlin. For composition he was placed
Zelter, whose lessons were soon exchanged for those
hard Weber, then director of the Berlin opera, by
e was introduced to the Abbé Vogler. Struck by
liant talent, Vogler invited him to Darmstadt, and
) received him into his house, where he formed an
e friendship with Karl Maria von Weber, who,
his senior by eight years, shared the daily lessons
ived from the abbé in counterpoint, fugue, and
ore organ playing. At the end of two years the
uke appointed Meyerbeer composer to the court.
rly works, however, were far from successful, his
pera, *Jephtha's Gelübde*, failing lamentably at
adt in 1811, and his second, *Wirth und Gast*
k), at Vienna in 1814. These checks discouraged
cruelly that he feared he had mistaken his vocation.
heless, by advice of Salieri, he determined to study
ation in Italy, and then to form a new style. But
ce he was so captivated by the style of Rossini that,
ing all thought of originality, he produced a suc-
of seven Italian operas—*Romilda e Costanza*,
mide riconosciuta, *Edoardo e Cristina*, *Emma di*
go, *Margherita d'Anjou*, *L'Esule di Granata*, and *Il*
o in Egitto—which all achieved a success as brilliant
as unexpected. Against this act of treason to Ger-
t Weber protested most earnestly; and before long
eer himself grew tired of his defection, though the
of *Il Crociato* was so great that he was crowned
e stage. An invitation to Paris in 1826 led him
ew his position fairly and dispassionately, and he
ot conceal from himself the fact that he was wast
imitation powers which, rightly used, might make
e immortal. For several years after this he pro
nothing in public; but, in concert with Scribe, he
l the work which first made known the reality of his
ndent genius his first French opera, *Robert le*
This gorgeous drama was produced at the Grand
in 1831, and received with acclamation. It was the
its race, a grand romantic opera, abounding with
of startling interest, with situations more powerfully
ic than any that had been attempted either
erubini or Rossini, with mysterious horrors and
e pomp, and with ballet music such as had never
n heard, even in Paris. Its popularity exceeded all
s expectation; yet for five years after this signal
n Meyerbeer appeared before the public no more.
not doubt that his motive for this retirement was
ermination to produce something greater still; and
in some respects his next opera, *Les Huguenots*, rea
greater, though it fell short of the deep romance whi
dered *Robert le Diable* so incomparably captivating.
The first performance of *Les Huguenots* took p
1836. In gorgeous colouring, in depth of passion,
sistency of dramatic treatment, and in careful deli
of individual character, it is at least the equal of *R*
Diable. In two points only did its interest fall s
that inspired by the earlier work. Meyerbeer had
himself so great a master in his treatment of the
natural that one regretted the unavoidable omis
that powerful element in his second grand opera
more important still, the fifth act of *Les Huguenots*
arranged by the librettist as to render effective
treatment impossible. The substitution of a noisy fu
for a legitimate dramatic situation was fatal to the
pated climax. The music which accompanies this c
of the work is necessarily inferior to all that prec
The true interest of the drama culminates at the
the fourth act, when Raoul, leaping from the w
leaves Valentine fainting upon the ground. The sp
needs not to be told that the former will be shot de
moment he arrives in the street, or that the latt
mourn for him to the end of her days. Neither mu
nor dramatically does anything more remain to b
and therefore it is that those who quit the theatre
the curtain falls for the fourth time carry away wit
a far more perfect ideal than those who remain to t
After the production of *Les Huguenots* Meyerbee
retired from public view, and spent many years in t
paration of two of his greatest works—the greates
except the two we have already mentioned—*L'Af*
and *Le Prophète*. The libretti of both these opera
furnished by Scribe; and both were subjected to co
changes of detail before they satisfied the con
fastidious taste; in fact, the story of *L'Africai*
more than once entirely rewritten.
Meanwhile Meyerbeer accepted the appointm
kapellmeister to the king of Prussia, and spent
years at Berlin, where he produced *Ein Feldla*
Schlesien, a German opera, in which the ma
cantatrice Jenny Lind made her first appeara
Prussia, with unprecedented success. Here also h
posed, in 1846, the overture to his brother Michael's
Struensee. But his chief care at this period was be
upon the worthy presentation of the works of other
began by producing his dead friend Weber's *Eur*
with scrupulous attention to the composer's origina
With equal unselfishness he procured the accepta
Rienzi and *Der Fliegende Holländer*, the first two
of Richard Wagner, who, then languishing in pover
exile, would, but for him, have found it impossi
obtain a hearing in Berlin. With Jenny Lind as
donna and Meyerbeer as conductor, the opera flou
brilliantly in the Prussian capital; but the anxie
this thankless period materially shortened the con
life.
Meyerbeer produced *Le Prophète* at Paris in
and, if it did not at first create so great a sensation
Huguenots, this was simply because it needed to be

[1] Or, according to some accounts, 1794.

In 1854 he brought out *L'Étoile du Nord* at the Comique, and in 1859 *Le Pardon de Ploermel ah*). His last great work, *L'Africaine*, was in active tion at the Académie when, on the 23d of April he was seized with a sudden illness, of which he the 2d of May. *L'Africaine* was produced with attention to the composer's minutest wishes, on 8, 1865, and fully justified the expectation which en raised by his long and painstaking consideration details. Upon this, in conjunction with *Robert le Les Huguenots*, and *Le Prophète*, his fame now entirely rests.

beer's genius has been criticized with widely different re Mendelssohn thought his style exaggerated; Fétis thought of the most original geniuses of the age; Wagner calls miserable music-maker," and "a Jewish banker to whom red to compose operas." But the reality of his talent recognized throughout all Europe; and, in spite of the edged crudity of his system of phrasing, and the inequality too plainly observable even in his greatest works, his name so long as intensity of passion and power of dramatic t are regarded as indispensable characteristics of dramatic (W. S. R.)

ZIÈRES, a fortress of the first class, and the capital department of Ardennes, France, is 161 miles to the ast of Paris by railway, on a peninsula of the which almost entirely surrounds the town, and es it from its more important suburb, Charleville. rtifications, which, as well as the citadel, are the f Vauban, are pierced by four gates, giving access town, the streets of which are narrow and winding. rish church, erected in the 16th century, contains two ions in commemoration respectively of the raising siege of Mézières in 1521 and the marriage of s IX. with the daughter of the emperor Maximilian ich was celebrated at Mézières in 1570. The north uth portals, the glass of the windows, and the lofty gs of the church are worthy of remark. The hôtel contains several interesting pictures relating to the of the town. The iron industry, the only one of portance, is being gradually transferred to Charle- The population in 1881 was 6120.

led in the 9th century, Mézières was at first only a strong- onging to the bishops of Rheims, which afterwards became perty of the counts of Rethel. The town was increased by ve immigrations of the people of Liége, flying first from the Otho, and afterwards from Charles the Bold; and also by ons from the counts of Rethel. Its walls were built in the ntury, and in 1521 it was successfully defended by Bayard the imperialists. The anniversary of the deliverance of the still observed yearly on the 27th of September. The school ary engineering, since transferred successively to Metz and ebleau, was originally founded at Mézières.

ZÖ-TÚR,[1] a corporate town in the Cis-Tisian county -Nagy-Kun-Szolnok, Hungary, situated on the right f the Berettyó, and on the railway from Arad to k, in 47° 1′ N. lat., 20° 39′ E. long. It has Roman ic and Calvinist churches and schools, a judicial or the circuit, and the usual Government offices, but ast of few buildings of special interest. Horses, nd sheep are reared in great numbers on the wide- ing communal lands, which are productive also of , and especially wheat, rape-seed, and maize. On 1st December 1880 the population amounted to (10,265 males, 10,384 females), mostly Magyars ionality.

ZZOFANTI, Giuseppe (1774 1849), cardinal, whose ial linguistic acquirements have become proverbial, orn, September 17, 1774, at Bologna, where his followed the occupation of a carpenter. Educated t one of the "scuole pie," and afterwards at the episcopal seminary of his native city, he was ordai the priesthood in 1797, and in the same year becam fessor of Arabic in the university, but shortly after was deprived on account of his refusal to take the o allegiance to the Government of the Cisalpine Rep In 1803, however, he was appointed assistant librar the institute of Bologna, and soon afterwards was rein as professor of Oriental languages and of Greek. chair was suppressed by the viceroy in 1808, but rehabilitated on the restoration of Pius VII. in 181 continued to be held by Mezzofanti until his removal Bologna to Rome in 1831, when he received certain e astical appointments and the rank of monsignore. while his progress in the acquirement of language been rapid and untiring, and in 1833 he was appoin succeed Mai as chief keeper of the Vatican Library. promotion to the cardinalate, and the duties of direc studies in the Congregation of the Propaganda, follow 1838. He died at Rome, during the absence o pontifical court at Gaeta, on March 15, 1849.

Mezzofanti's peculiar talent, comparable in many respects of the numerous "calculating boys" who have been the won their contemporaries, was not combined with any exce measure of intellectual power, and accordingly produced n that has not perished with him. It seems to be well estal however, that he spoke with considerable fluency, and in som even with attention to dialectic peculiarities, some fifty o languages of the most widely separated families, besides h less perfect acquaintance with many others. See Manavit, *historique sur le Cardinal Mezzofanti*, Paris, 1854; and *Life of the Cardinal Mezzofanti*, London, 1857.

MEZZOTINT. See Engraving.

MIAUTSE. The Miautse or Meaou-tsze of so China are one of the aboriginal tribes of the co At one time they occupied a considerable portion rich and fertile lands which now form the central pr of the empire, but as the Chinese advanced south they were driven, like the Ainos in Japan and the in Britain, into the more inaccessible districts unti were compelled to seek refuge from the invaders mountain ranges, in the provinces of Yunnan, Kwei Kwang se, and Kwang tung, where they are found present day. This line of mountains extends for 400 miles, and, being in many parts high, steep, and r it forms a convenient shelter for them. As early reign of king Seuen (about 800 B.C.) we read of an e tion having been sent to drive them out of Hoo-na since that time they have been periodically attacked to punish them for misdeeds or to make them yi vineyards coveted by Chinese Ahabs. The last imp campaign against them was undertaken by the em K'een lung, who, having completely subjugated the E was desirous of bringing under his yoke these mo tribesmen. But the same success which had attend arms in the north did not follow them to the south first expedition was utterly defeated, and the gen command paid the penalty of discomfiture with hi The leader of a second expedition, having learned w by the fate of his predecessor, purchased the submis the Miautse by a large bribe. As soon as the unsus savages had been thus lulled into security a thir was set in motion against them. This time, being pared, they suffered a crushing defeat, and were co to purchase peace by swearing allegiance to their conq But, though the Chinese thus gained sovereignty ove they have since deemed it wise to content themselv but the shadow of authority. No real jurisdiction exercised over these hardy mountaineers. They are a to govern themselves on their own patriarchal system old men of each tribe manage the affairs of their j and command an obedience which would be utterly to the mandate of any mandarin. In figure the M

[1] ö is a Magyar word, signifying *Field*, prefixed to many agri- localities in Hungary.

en and women, are shorter and darker-complexioned
e Chinese, their faces also are rounder and their
s sharper. In disposition, too, they are very unlike
ivilized neighbours. They are brave, passionate,
ous, revengeful, and indifferent to cold and hunger;
re free and easy in their manners, and are as noisily
as the Chinese are grave and sedate.

are divided into between forty and fifty clans, each of which
guished by a name which is generally derived either from
ysical characteristic, or from some custom, or from the
of the clan, as, for example, "The Black Miau," "the
headed Miau," so named from their manner of dressing
ir, "the six-valley Miau," &c. Among these clans there
le difference of culture, one being in no way removed
ages, while others which have been brought under the influence
ese civilization show themselves apt and ready learners.
y of them, so far as is known, possess any written records.
on jin, or Goblin clan, are said to have books, which, though
now unable to read, they still regard with reverent awe.
ieroglyphic characters used in these books are, according to a
writer, "like knotted worms, and are utterly unintelligible."
los also are said to be a lettered clan, but for the most part
nese content themselves with conveying information and
g records by means of notched sticks. Their language as
heir ethnic characteristics proves them to be closely related to
ese, Annamese, Cambodians, and the inhabitants of Hainan;
hey form part of the race which is spread over the whole of
stern Indo-China. Their social customs are as widely
as their appearance is from those of the Chinese. The
titude is given to the youth of both sexes in the choice of
bands and wives. As among the hill tribes of Chittagong,
tion is commonly made on the mountain-side, where on moon
hts in the "leaping month" the young men and maidens
sing or to play at ball, or to dance round the "devil's stall"
Maypole), and to choose their partners for life. Among some
"couvade" is an established custom. Their funeral rites
rding to the districts, those living within reach of the influ
he Chinese having adopted their customs, while those more
till hang their dead in baskets from trees, or lay them in the
nd disinter them yearly to wash their bones. In dress they
of bright colours, and commonly wear loose but short
sometimes with and sometimes without trousers. The men
bans wound round their hair, which is raised above the
the shape of a spiral shell, and the women either don a
ap, or dress their hair in the shape of a ram's horn. For
ars the relations of the Miautse with the Chinese Govern
ve been generally of a peaceable nature, and in the *Peking*
ot April 1881 there was published a new system of
ent by which it is hoped that the incorporation of the
neers into the empire may become more real and complete
che sot the Miau-tsze, translated by F. C. Bridgman; J. Edkins, *The Miau-
their History*, and "Quaint Customs in Kwei chow," *Cornhill Magazine*,
872.

AH (מִיכָה) is the short form of a name which in
modifications *Micāiāhū*, *Micāièhu*, *Micāiah* is
in the Old Testament, expressing as it does a
ental point of Hebrew faith: Who is like Jehovah?
me was borne among others by the Danite whose
is given in Judg. xvii. *sq.*, by the prophet who
Ahab's expedition to Ramoth Gilead (1 Kings
nd by the subject of the present article, the con-
ary and fellow worker of Isaiah, whose name is
d to the sixth in order of the books of the minor
s.[1]

at once apparent that the book of Micah divides
nto at least two distinct discourses, chap. vi. 1
g a new commencement; and from what we know
ral of the compilation of the prophetic collection we
at once determine whether the second discourse,
has no title, is to be ascribed to the author of the
ately preceding prophecy, or is to be regarded as an
dent and anonymous piece. To decide this question,
be decided, we must begin by a separate study of
ier chapters to which the title in Micah i. 1 directly
. These again fall into two parts. Chaps. i. iii.
e exception of two verses, ii. 12, 13) are a predic-

[1] nfusion between the two prophets of the name has led to the
in the Massoretic text of 1 Kings xxii. 28 of a citation from
2, rightly absent from the LXX.

tion of judgment on the sins of Judah and Ephraim
a majestic exordium Jehovah Himself is represent
coming forth in the thunderstorm (comp. Amos i. 2)
His heavenly palace, and descending on the mounta
Palestine, at once as witness against His people, an
executer of judgment on their sins. Samaria is sent
to destruction for idolatry; and the blow extends to J
also, which participates in the same guilt (chap. i.).
while Samaria is summarily dismissed, the sin of Jud
analysed at length in chaps. ii. and iii., in which the pr
no longer deals with idolatry, but with the corrupti
society, and particularly of its leaders—the gra
aristocracy whose whole energies are concentrate
devouring the poor and depriving them of their
holdings, the unjust judges and priests who for
wrest the law in favour of the rich, the hireling
gluttonous prophets who make war against every
"that putteth not into their mouth," but are ever
with assurances of Jehovah's favour to their patron
wealthy and noble sinners that fatten on the flesh
poor. The prophet speaks with the strongest per
sympathy of the sufferings of the peasantry at the l
of their lords, and contemplates with stern satisfactio
approach of the destroyer who shall carry into exile
luxurious sons" of this race of petty tyrants (i. 16),
leave them none to stretch the measuring line on a fie
the congregation of Jehovah (ii. 5). The centre of co
tion is the capital, the city of Zion, grown great o
blood and wrongs of the provincials, the seat of the
princes, the corrupt judges and diviners. For their
he concludes, Zion shall be plowed as a field, Jeru
shall lie in ruins, and the temple hill return to j
(iii. 12).

The situation thus sketched receives its elucidation
the data supplied by the title (i. 1) and confirmed
rendered more precise by a remarkable passage in Jere
According to the title Micah flourished in the reig
Jotham, Ahaz, and Hezekiah; according to Jere
(xxvi. 18 *sq.*) the prophecy of the destruction of Jeru
just cited was spoken under Hezekiah, and bore fru
the repentance of king and people, by which the judg
was averted. The allusion beyond doubt is to Hezek
work of religious reformation (2 Kings xviii. 4 *sq.*).
hardly possible to separate this reformation from the
ence of Isaiah, which did not become practical in
conduct of the state till the crisis of Sennacherib's inva
and the conclusion that Hezekiah was not from the f
reforming king, which is forced on us by many passa
Isaiah, is confirmed by the prophecy of Micah, which,
Hezekiah's accession, still represents wickedness as s
in the high places of the kingdom. The internal disc
of the realm depicted by Micah are also prominen
Isaiah's prophecies; they were closely connected, not
with the foreign complications due to the approach o
Assyrians, but with the break-up of the old agr
system within Israel, and with the rapid and uncon
sated aggrandisement of the nobles during those
sperous years when the conquest of Edom by Am
and the occupation of the port of Elath by his
(2 Kings xiv. 7, 22) placed the lucrative trade bet
the Mediterranean and the Red Sea in the hand
the rulers of Judah. On the other hand the demo
tone which distinguishes Micah from Isaiah, and
announcement of the impending fall of the capital
deliverance of which from the Assyrian appears to I
as the necessary condition for the preservation of the s
a new and better kingdom), are explained by the fact
while Isaiah lived in the centre of affairs, Micah v
Morasthite or inhabitant of Moresheth Gath, a place
the Philistine frontier so unimportant as to be ment

Micah i. 14.[1] The provincial prophet sees the and the aristocracy entirely from the side of a man oppressed people, and foretells the utter ruin of both. s ruin does not present itself to him as involving ptivity or ruin of the nation as a whole; the gation of Jehovah remains in Judæa when the ors are cast out (ii. 5); Jehovah's words are still to them that walk uprightly; the glory of Israel is to take refuge in Adullam, as in the days when band of broken men was the true hope of the but there is no hint that it is banished from the Thus upon the prophecy of judgment we naturally to follow a prophecy of the redintegration of h's kingship in a better Israel, and this we find in 13 and in chaps. iv., v. Both passages, however, difficulties. The former seems to break the pointed t between ii. 11 and iii. 1, and is therefore regarded ld as an example of the false prophecies on which ked rulers trusted. The thought, however, is one to all true prophecy (comp. Hos. i. 11 [ii. 2], Isa. *sq.*, Zeph. iii. 11, Jer. xxxi. 8), and precisely in nce with chaps. iv., v., even in the details of expres d imagery.[2] It is indeed possible that these verses separate oracle of Micah, which did not originally n its present connexion. The sequence of thought s iv., v., on the other hand, is really difficult, and en rise to much complicated discussion.[3] There is a g feeling among scholars that iv. 11-13 stands in contradiction to iv. 9, 10, and indeed to iii. 12. st two passages agree in speaking of the capture of em, the first declares Zion inviolable, and its capture ossible profanation. Such a thought can hardly be s, even if we resort to the violent harmonistic process gining that two quite distinct sieges, separated by a l of the theocracy, are spoken of in consecutive An interpolation, however, in the spirit of such es as Ezek. xxxviii., xxxix., Joel iii. [iv.], Zech. xiv., conceivable in post-exilic times, and in connexion e growing impulse to seek a literal harmony of all ey on lines very different from the pre-exilic view xxvi., that predictions of evil may be averted by nce. Another difficulty lies in the words "and shalt come even to Babylon" in iv. 10. Micah tionably looked for the destruction of Jerusalem as well as of Samaria in the near future and by the As (i. 9), and this was the judgment which Hezekiah's ance averted. If these words, therefore, belong original context, they mark it as not from Micah but it is easy to see that they are really a later gloss prophetic thought is that the daughter (population) shall not be saved by her present rulers or de strength; she must come down from her bulwark dwell in the open field; there, and not within her ramparts, Jehovah will grant deliverance from her e This thought is in precise harmony with chaps. i. i equally characteristic is what follows in chap. v. opposition to present tyranny expresses itself in rec to the old popular ideal of the first simple Davidic k (iv. 8) to which he had already alluded in i. 15. old days shall return once more. Again guerilla (בת־גדוד) gather to meet the foe as they did in th of Philistine oppression. A new David, like him exploits in the district of Micah's home were still mouths of the common people, goes forth from Bet to feed the flock in the strength of Jehovah. The H Hebrew nations are once more united to their bret Israel (comp. Amos ix. 12, Isa. xvi. 1 *sq.*). The re of Jacob springs up in fresh vigour, inspiring terror the surrounding peoples, and there is no lack of captains to lead them to victory against the Assyri In the rejuvenescence of the nation the old stays oppressive kingship which began with Solomon, the holds, the fortified cities, the chariots and horses so to the life of ancient Israel, are no more known disappear together with the divinations, the sooth the idols, the *maṣṣēbôth* and *ashērîm* of the high Jehovah is king on Mount Zion, and no inventions come between Him and His people.

The elements of this picture, drawn so largely fr most cherished memories of the Judæans, could not produce a wide impression, especially when the inva Sennacherib, although it spared Jerusalem, fulfilled most striking way a great part of Micah's predic judgment. Of this we have evidence, not only in Je but in the political and religious ideas of the Deuteronomy. The picture of the right king (Deu 14 *sq.*) and the condemnation of the high-place follow the doctrine of Micah.

A difficulty still remains in the opening verses of Micah iv. 1-3 and Isa. ii. 2-4 are but slightly modified re of the same text, and as Isa. ii. is older than the prophecy while on the other hand Micah iv. 1 seems the natural co of the passage, it is common to suppose that both copy prophet. But the words have little connexion with the co Isaiah, and may be the quotation of a copyist suggested b On the other hand it has been urged that the passage belo later stage of prophetic thought than the 8th century B.C. is, however, no real difficulty in the idea that foreign nati seek law and arbitrament at the throne of the king of Zio the old prophecy Isa. xvi. 5, and the mention of the temp seat of Jehovah's sovereignty may be illustrated by Isa. vi., heavenly palace (Micah i. 3) at least pictured in the liken temple on Zion. At the same time the Jerusalem of Mi is the Jerusalem of David not of Solomon, the ideas of iv not reappear in chap. v., and the whole prophecy would p more consecutive and homogeneous if iv. 6 (where the dis the suffering are, according to chap. ii., the victims of dom of foreign oppression) followed directly on iii. 12.

The sixth chapter of Micah presents a very different from chaps. i.-v. Jehovah appears to plead with his peopl sins, but the sinners are no longer a careless and oppressi cracy buoyed up by deceptive assurances of Jehovah's help pheries of wine and strong drink; they are bowed do religion of terror, wearied with attempts to propitiate an a by countless offerings, and even by the sacrifice of the f Meantime the substance of true religion—justice, charit humble walk with God—is forgotten, fraud and deceit rei classes, the works of the house of Ahab are observed (w foreign gods). Jehovah's judgments are multiplied ag land, and the issue can be nothing else than its total desola

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[1] Micah lived in the Shephela or Judæan lowland near the he country is clear from the local colouring of i. 10 *sq.*, where er of places in this quarter are mentioned together, and their layed upon in a way that could hardly have suggested itself ut a man of the district. The paronomasia makes the verses , and in i. 14 none of the ancient versions recognizes More-ath as a proper name. The word Morasthite (*Môrashti*) was e obscure to them; but this only gives greater weight to the al pronunciation with *ô* in the first syllable, which is as old XX., and goes against the view, taken by the Targum both on and on Jeremiah, and followed by some moderns (including , that Micah came from Maroshah. When Eusebius places ei near Eleutheropolis it is not likely that he is thinking of ah (Maresa), for he speaks of the former as a village and of the as a ruin 2 miles from Eleutheropolis. Jerome too in the *Paulæ* (*Ep.* cviii.), speaking as an eye-witness, distinguishes um, with the church of Micah's sepulchre, from Maresa. This was after the pretended miraculous discovery of the relics of in 385 A.D.; but the name of the village which then existed *in Mich.*) can hardly have been part of a pious fraud.

[2] figure of the shepherd gathering a scattered flock certainly ot presuppose a total captivity, as Stade (*Z. f. A.T.W.*, i. 161 nes.

[3] besides the commentaries, Noldeke in the *Bibel-lex.*, iv. 214; a by Oort and two by Kuenen in *Theol. Tijdsch.*, 1872; Well-Bleek, *Einleitung*, p. 426; Stade, *l.c.*, and *ibid.*, iii. 1 *sq.* oes so far as to make the whole of Micah iv., v. presuppose the nd to find still later additions in iv. 5-10., v. 5, 6 [v. 4, 5]. recht, *Theol. LZ.*, 1881, col. 443 *sq.*, rejects chap. iv. only. guments cannot be here cited at length, but they are tacitly view in what follows.

nks fit exactly the evil times of Manasseh as described in
XXI. Chap. VII. 1–6, in which the public and private cor-
of a hopeless age is bitterly bewailed. Micah belongs to
e context (comp. vol. XIII. p. 11b). Micah may very well
ed into Manasseh's reign but the title in i. 1 does not cover
ecy which certainly fell after Hezekiah's death, and the
s nothing in common with the earlier part of the book. It
lous present to regard the prophecy, with Ewald, as anony-
Ewald includes the whole of Isaiah xl.–lxvi. to one author.
ern however, remains with justice that the thread is
broken at vii. 6 and that verses 7–20 represent Zion as
taken before the heathen and her inhabitants as pining in
stress of captivity. The hope of Zion's future restora-
on in her patriarchs' and prophets' chastisement and
shown shall not be modified. His oath to the fathers, Israel
forgiven in the end and the heathen humbled. The faith
which breathes in this passage have the closest affinities
book of Lamentations and Isaiah xl.–lxvi.

e see that the book of Micah has suffered from redactors, it is also not
verbal inspiration which has left some parts very obscure. The LXX
ators suffered not for the present Hebrew but their text too was far
of commentators. Much that which deals most fully with the
of the text is found in Ewald (1868). The most elaborate
Pocock's *Commentary* (2d ed., 1693)
Micah's Place to be
see also the literature on the minor
ets generally cited under H
nd W. R. Smith's *Prophets of Israel*
(W. R. S.)

HAEL (מִיכָאֵל, "who is like God?") appears in the
tament as a man's name, synonymous with Micaiah
ah. In the book of Daniel the same name is given
of the chief "princes" of the heavenly host, the
n archangel or "prince" of Israel (Dan. x. 13, 21, xii.
as such he naturally appears in Jewish theosophy
greatest of all angels, the first of the four who
d the throne of God (see GABRIEL). It is as
n angel of Israel, or of the church, the true Israel,
chael appears in Jude 9 and Rev. xii. 7. In the
n Church the festival of St Michael and All Angels
elmas) is celebrated on September 29th, it appears
grown out of a local celebration of the dedication
urch of St Michael either at Mount Garganus in
or at Rome, and was a great day by the beginning
9th century. The Greek Church dedicates
ber 8 to St Michael, St Gabriel, and All Angels.

HAEL, the name of several Byzantine emperors.

AEL I. (Rhangabé) was an obscure nobleman
d married Procopia, the daughter of Nicephorus I.,
n made master of the palace, his elevation to the
was due to a revolutionary movement against his
n-law Stauracius, who reigned only two months
he death of Nicephorus on the battlefield (812).
as the tool of the bigoted orthodox party in the
Michael diligently persecuted the Iconoclasts on
rthern and eastern frontiers of the empire, but
hile allowed the Bulgarians to ravage a great part
donia and Thrace, having at last taken the field
pring of 813, he was defeated near Versinikia, and
Armenian was saluted emperor in his stead in the
ne manner. Michael, after having been compelled
me a monk, was permitted thenceforward to live
ted in the island of Prote, where he died in 845.

AEL II. (The Stammerer), a native of Amorium
ygia, was of humble origin, and began life as a
soldier, but rose by his talents and assiduity to the
general. He was one of those who had favoured
tion to the throne of his old companion in arms
e Armenian in 813, but, detected in a conspiracy
the government of that emperor, had been sentenced
th in December 820, his partisans, however, suc-
in assassinating Leo on the morning of Christmas
nd called Michael from the prison to the throne.
ncipal features of his reign (820–829) were a pro-
struggle (of nearly three years) against his brother
, Thomas, who aimed at the throne, the conquest
e by the Saracens in 823, and the beginning of their
upon Sicily (827). Conciliatory on the whole
in his policy towards the image worshippers (hi
sympathies were iconoclastic), he incurred the wrath
monks by entering into a second marriage with Euph
daughter of Constantine VI., who had previously
the veil. He died in October 829, and was succee
Theophilus his son.

MICHAEL III. (The Drunkard) was the grand
Michael the Stammerer, and succeeded his father The
when only three years of age (842). Until his n
at the age of eighteen the affairs of the empir
managed by the empress regent his mother Theodo
education was shamefully neglected, and it was dur
period that Michael formed the disgraceful personal
which are indicated by his surname. In 861 M
together with his uncle Bardas, undertook an exp
against the Bulgarians, which resulted in the conver
the Bulgarian king, who thenceforth bore the C
name of Michael. The emperor had been less su
in the campaign which he led in person against C
Melitene in 860, but in 863 his uncle Petronas ga
important victory over the Saracens in Asia Minor
year 865 was marked by the first appearance of the R
in the Bosphorus. Michael was assassinated in his
in 867 by Basilius the Macedonian, whom he had ass
with himself in the empire in the previous year.

MICHAEL IV. (The Paphlagonian) owed his
tion to Zoe, daughter of Constantine IX., the
the Macedonian dynasty; this princess was mar
Romanus III., but becoming enamoured of Micha
chamberlain, she poisoned her husband and marr
attendant (1034). Michael, however, being of a
character and subject to epileptic fits, possessed the s
power only in name, and was a mere instrument
hands of his brother, John the Eunuch, who had be
minister both of Constantine and Romanus.
diplomacy was successful in keeping the Arabs
archipelago and Egypt quiet for some time, and
at last able to secure a victory for the imperial
Edessa in 1037. The attempt to recover Sicily
following year with the help of the Normans was l
sperous, and in 1040 the island wholly ceased t
Byzantine province. About the same time, the Bul
having overrun Macedonia and Thrace, and thre
Constantinople, the indolent and infirm emperor,
surprise alike of friends and foes, put himself at th
of the army, and not only drove the enemy beyo
frontier, but followed them into their own territor
died, shortly after his triumph, on December 10, 10

MICHAEL V. (Calaphates or The Caulker),
and successor of the preceding, derived his surnam
his father Stephen, who had originally followed th
pation of a caulker of ships. He owed his el
(December 1041) to his uncle John, whom along w
he almost immediately banished; this led to a
tumult and his dethronement after a brief reign
months (April 1042). He lived for many years afte
in the quiet obscurity of a monastery.

MICHAEL VI. (The Warlike) was already an o
when chosen by the empress Theodora as her su
shortly before her death in 1056. His governme
feeble in the extreme, and he was at last compe
abdicate by Isaac Comnenus, who had defeated his a
Phrygia (August 1057). He also spent the rest of
in a monastery.

MICHAEL VII. (Ducas or Parapinaces) was the
son of Constantine XI. Ducas, by whom along w
brothers Andronicus I. and Constantine XII.
invested with the title of Augustus; this joint su
took place in 1067, but in 1071 it suited the policy
uncle Joannes Caesar to make Michael sole empero

osition Michael, whose "character was degraded, than ennobled, by the virtues of a monk and the g of a sophist,' was by no means fitted, and at two generals of the name of Nicephorus, surnamed ins and Botaniates, simultaneously rebelled against 1078; with hardly a struggle he resigned the purple ired into a monastery, where he afterwards received e of archbishop of Ephesus.

IAEL VIII. (Palaeologus), born in 1234, was the Andronicus Palaeologus Comnenus and Irene the granddaughter of Alexius Angelus, emperor stantinople. At an early age he rose to distinc nd ultimately became commander of the French aries in the employment of the emperors of A few days after the death of Theodore Lascaris 1259, Michael, by the assassination of Muzalon he is believed but not proved to have encouraged), ed to the guardianship, shared with the patriarch s, of the young emperor John Lascaris, then a lad eight years. Afterwards invested with the title of t," he was finally proclaimed joint emperor, and l alone at Nicaea on January 1, 1260. In the g year (July 1261) Constantinople fell into the of the Caesar Alexius Strategopulus, and Michael, got himself crowned anew in the church of St caused his boy colleague to be blinded and sent nishment. For this last act he was excommunicated nius, and the ban was not removed until six years rds (1268), on the accession of a new patriarch. In and 1261 respectively Michael, with the help of IV., concluded peace with Villehardouin, prince of and Michael, despot of Epirus, who had previously cited by the pope to attack him, the friendly inter- had been secured by a promise on the emperor's help forward the reunion of the Eastern and churches. In 1269 Charles of Sicily, aided by Thessaly, again made war with the alleged purpose ring Baldwin to the throne of Constantinople, and Michael so hard that ultimately, yielding to the nities of Gregory X., he caused the deputies of the church to attend the council of Lyons (1274) and accept the "filioque" and papal supremacy. The hus brought about between the two churches was, r, extremely distasteful to the Greeks, and the tion of his "schismatic" subjects to which the r was compelled to resort weakened his power so hat Martin IV. was tempted to enter into alliance harles of Anjou and the Venetians for the purpose nquering Constantinople. The invasion, however, nd Michael so far had his revenge in the "Sicilian s," which he helped to bring about. He died in in December 1282, and was succeeded by his son icus II.

IAEL IX. (Palaeologus) was the son of Andronicus l was associated with him on the throne from 1295, deceased him (1320).

HAELIS, JOHANN DAVID (1717-1791), one of st influential scholars and teachers of last century, d to a family which had the chief part in main- that solid discipline in Hebrew and the cognate ges which distinguished the university of Halle in iod of Pietism. Johann Heinrich Michaelis (1668 was the chief director of Francke's *Collegium ale Theologicum*, a practical school of Biblical and al philology then quite unique, and the author of an ted Hebrew Bible and various exegetical works of ion, especially the *Adnotationes uberiores in Hagio-*, 1720. In his chief publications J. H. Michaelis fellow-worker his sister's son Christian Benedict lis (1680-1764), the father of Johann David, who was likewise influential as professor at Halle, and sound scholar, especially in Syriac. J. D. Michae trained for academical life under his father's eye. was not then the best of universities; a narrow the spirit cramped all intellectual activity, and the eage cious youth, already distinguished by a love for readi a distaste for small pedantries, found much of the t wearisome enough. He acquired, however, a good ledge of the Latin classics, Greek, he tells us, was taught at all, and his knowledge of Greek literatu gained by his own reading in later years, learned his father could teach, and was influenced, especi philosophy, by Baumgarten, the link between t Pietism and Semler, while he cultivated his strong t history under Ludwig. In the winter-semester 1 he qualified as university lecturer. One of his d tions was a defence of the antiquity and divine au of the vowel points in Hebrew. His scholarsh moved in the old traditional lines in which no furth gress was possible, and he was also much exerci religious scruples, the conflict of an independent mi that submission to authority at the expense of encouraged by the type of Lutheranism in which been trained. A long visit to England in 1741 1 him out of the narrow groove of his earlier educatio passing through Holland he made the acquaintance great Schultens, whose influence on his philologica was not immediate, but became all powerful a few later. England offered to him no such commandi sonal influence, and he was not yet able to turn t the stores of the great libraries, but his personal strengthened by contact with a larger life, and hi logical views were turned aside from the pietistic c Michaelis never ceased to regard himself as ess orthodox, though he did not feel able fully to su the Lutheran articles, and more than once declined account to be professor of theology. But his acquired a distinctly rationalistic complexion, a orthodoxy of his Gottingen lectures and publicati dogmatic (delivered from a philosophical chair) is of washed out kind. His really useful work, however other directions; the change of his theological vi important because it relieved him from trammo hampered the free course of his development as a From England Michaelis went back to Halle; but himself out of place, and in 1745 gladly accep invitation to Gottingen as privat docent. In 17 became extraordinary, in 1750 ordinary, profe ssor, Gottingen he remained till his death in 1791. In t years of his new position Michaelis passed through a education. In the young and intellectually v Georgia Augusta he came under the powerful p influence of such men as Gesner and Haller. His i was active in many directions, universal learning was perhaps one of his foibles. Literature—mo well as ancient occupied his attention; one of hi was a translation of four parts of *Clarissa*; and tions of some of the then current English paraphr Biblical books manifested his sympathy with a which, if not very learned, attracted him by its fr His Oriental studies were reshaped by diligent pe the works of Schultens, for the Halle school, wit learning, had no conception of the principles on v fruitful connexion between Biblical and Oriental l can be established. His linguistic work indeed was hampered by the lack of MS material which is felt philological writings, *e.g.*, in his valuable *Supplem* the Hebrew lexicons (1784-92)[1]. He could not

[1] By a strange fortune of war it was the occupation of Gott the French in the Seven Years' War, and the friendly rela

Arabic at Bei ket; and, though for many years the most famous teacher of Semitic languages in Europe, he left of the higher philological faculty, and neither his critical nor his critical work, highly esteemed at the left a permanent mark, with the exception perhaps critical studies on the Pentateuch. His taste were *belles-lettres*, history, and geography, especially geography. Of his early career, in which geography half regrets and not choose the course of profession. Here he fell chiefly under the influence Bochart, in whose footsteps he followed in the *Spicilegium geographiæ Hebræorum post Bochartum* (1741–50). To his impulse we owe not. He consulted Von Haven, Forskål, and He prepared the instructions for their journey, a special set of questions and elucidations to guide researches which place in strong relief his comprehension of all that was then known of the East, and his merit in the knowledge of tangible and natural ...ted with a sober and patient judgment, which chief intellectual characteristic. The best part of knowledge was turned to the profit of Biblical study, exegetical writings, for example, one of the main is what was then the novelty of illustrations from travel. In spite of his doctrinal writings, which time made no little noise, so that his *Compendium mata* (1760) was confiscated in Sweden, and the seat of the North Star was afterward given him in on it was the natural side of the Bible that really ...sted him, and no man did more to introduce the method of studying Hebrew antiquity as an part of ancient Eastern life. The permanent e of his work indeed has not been great, and many are now hardly readable, for, with all his historic ...nd learning, he had no large historic conceptions, hat is closely akin to this defect, was singularly ...t in imagination and poetic sympathy. But the of his mind, his many-sidedness, his singularly ...ve though discursive method of lecturing, and ...ll his power of feeling and inspiring interest in ...nd of fact, was a potent stimulus much needed in ...many of that age, and did not soon die. Different three men are, there is a true historic nexus between ...e great Göttingen Orientalists, Michaelis, Eichhorn, ...ald.

...rsonal character of Michaelis can be read between the lines ...utobiography with the aid of the other materials collected ...ator Hasselquist (*J. D. Michaelis Lebensbeschreibung*, &c., ...To understand the secret of his enormous influence it is ...gh to read his books, now for the most part dull enough ...e must see the upright vivacious laborious man, with a ...le worldly prudence and a good deal of temper, much ...in his manifold academic activities in the university and ...ity of Göttingen, yet ever full of interest in the larger ...t of shrewd judgments and lively talk, with a strong ...ness and decency, yet with a good and warm heart, shining ...m the lecture room, where he dealt forth knowledge with ...e hand from a full store, displaying the method as well as ...ed, all-sided research, not without a touch of the vanity ...ecturer, and loving to leave the chair under a storm of ...at a portentous bear-coat which he acknowledged at the door ...kward. Last of triumph. The same volume contains a ...of his work. Besides those already mentioned it is sufficient to list his New Testament *Libri Initiales* (the first edition, ...eeded the full development of his powers, and is a very book from the later editions), his reprint of Lowth's ...ms with important additions (1758–62), his German ...on of the Bible with notes (1773–92), his *Orientalische ...otes to Erbkam's* (1775–80) and *Neue Or. and Ex. Bib.* ...), his *Mosaisches Recht* (1770–75), and his edition of *Lexicon Syriacum* (1757–80). His *Orientalische Bibliothek* (1791–96) contains much that is interesting for the history ...ng in his time. (W. R. S.)

...th the officers, that procured him the Paris MS. from which ...Abulfeda's description of Egypt.

...*in Actus Apostolorum Syriacos*, 1755.

MICHAUD, Joseph (1767–1839), French histo... and publicist, was born of an old family on June 19, 1... at Albens, Savoy. He was educated at Bourg-en-Bresse, ... afterwards engaged in literary work at Lyons, where ... events of 1792 first called into activity the dislike ... revolutionary principles which manifested itself throughout the rest of his life. In 1791 he went to Paris, where, without means, he took part in editing several royalist journals. In 1794 he started *Le Quotidienne*, for his connexion with which he was arrested after the 13th Vendémiaire, he succeeded in escaping his captors, but was sentenced to death *par contumace* by the military commission. Having resumed the editorship of his newspaper on the establishment of the Directory, he was again proscribed on the 18th of Fructidor, but at the close of two years returned to Paris when the consulate had superseded the Directory. His Bourbon sympathies led to a ... imprisonment in 1800, and on his release he for the time abandoned journalism, and began to write or edit books. Along with his brother and two colleagues he published in 1806 a *Biographie moderne, ou dictionnaire des hommes qui se sont fait un nom en Europe depuis* 1789, the earliest work of its kind, in 1808 the first volume of his *Histoire des Croisades* appeared, and in 1811 he originated the *Biographie Universelle*. In 1814 he resumed the editorship of the *Quotidienne*, and in the same year was elected Academician. In 1815 his brochure entitled *Histoire de quinze Semaines ou le dernier règne de Bonaparte* ... with extraordinary success, passing through twenty-six editions within a very short time. His political services were now rewarded with the cross of an officer in the Legion of Honour and the modest post of king's reader, of which last he was deprived in 1827 for having opposed Peyronnet's "Loi d'Amour" against the freedom of the press. In 1830–31 he travelled in Syria and Egypt for the purpose of collecting additional materials for the *Histoire des Croisades*; his correspondence with a fellow explorer, Poujoulat, consisting practically of discussions and elucidations of various important points in that work, was afterwards published (*Correspondance d'Orient*, 7 vols., 1832–35). The *Bibliothèque des Croisades*, in four volumes more, contained the "pièces justificatives" of the *History*. Michaud died on September 30, 1839, at Passy, where his home had been since 1832. His *Histoire des Croisades* was published in its final form in six volumes in 1841 under the editorship of his friend Poujoulat (9th ed., with appendix, by Huillard-Bréholles, 1856). Michaud, along with Poujoulat also edited and in part wrote *Nouvelle Collection des Mémoires pour servir à l'Histoire de France*, 32 vols., 1836–44. See Sainte-Beuve, *Causeries du Lundi*, vol. vii.

MICHAUX, André (1746–1802), a French botanist best known for his works on the flora of North America and as a botanical traveller. In 1779 he spent some time botanizing in England, and in 1780 he explored Auvergne, the Pyrenees, and the north of Spain. In 1782 he was sent by the French Government on a botanical mission to Persia. His journey began unfavourably, as he was robbed by Arabs of all his equipments except his books, but he gained influential support in Persia, having cured the shah of a dangerous illness. After two years he returned to France with a fine herbarium, and also introduced numerous Eastern plants into the botanic garden of France. In 1785 he was sent by the French Government to North America, and travelled through Canada, Nova Scotia, and the United States as far west as the Mississippi. The outbreak of the French Revolution deprived him of means to continue his work in America, and in 1796 he returned to France. He was shipwrecked and lost most of his collections on the voyage. In 1...

nt to Madagascar to investigate the flora of that and died there in 1802. His work as a botanist iefly done in the field, and he added largely to what eviously known of the botany of the East and of a. He also introduced many plants into Euro otanic gardens. He wrote two valuable works on American plants, the *Histoire des chenes de rique Septentrionale* (1801), with 36 plates, and the *Boreali Americana* (1803), 2 vols., with 51 plates.

'HAUX, François André (1770–1855), son of the ng, was, like his father, employed by the French ment to explore the forests of North America with to the introduction into France of trees valuable ir wood or other products. He was very success carrying out this object. He published in 1810–13 *oire des Arbres forestiers de l'Amérique Septentrionale*, ols., with 156 plates, a work full of information on haracters, uses, distribution, and other points of t in the various species. In 1817–19 a translation appeared under the title *North American Sylva*. o wrote a *Voyage à l'ouest des Monts Alléghanys*, besides articles in scientific magazines.

'HELANGELO (1475–1564). Michelangelo Buon best known simply as Michelangelo, the last and me of the great artists of Florence, was the son of ico Buonarroti, a poor gentleman of that city, and of e Francesca di Neri. Ludovico was barely able to the income of his estate, but made it his boast that never stooped to add to it by mercantile or mechani- suits. The favour of the Medici procured him em nt in some minor offices of state, and in the autumn d he was appointed resident magistrate of Caprese, Casentino, for a period of six months. Thither he ingly repaired with his family, and there, on March 5, his second son Michelagniolo or Michelangelo was Immediately afterwards the family returned to ce, and the child was put to nurse with a marble 's wife of Settignano. His mother's health had , it would seem, begun to fail; at all events in two years from this time, after she had borne her d two more sons, she died. While still a young Michelangelo determined in spite of his father's tion to be an artist. He had sucked in the passion, himself used to say, with his foster-mother's milk. a sharp struggle, his stubborn will overcame his s pride of gentility, and at thirteen he got himself d as a paid assistant in the workshop of the brothers ndaio. Domenico Ghirlandaio, bred a jeweller, had by this time the foremost painter of Florence. In rvice the young Michelangelo laid the foundations skill in fresco with which twenty years afterwards founded his detractors at Rome. He studied also, l the Florentine artists of that age, in the Brancacci , where the frescos of Masaccio, painted some sixty efore, still victoriously held their own; and here, in rel with an ill-conditioned fellow-student, Torrigiani, eived the blow of which his face bore the marks to ing day.

ugh Michelangelo's earliest studies were directed ls painting, he was by nature and predilection much inclined to sculpture. In that art he presently d encouragement and training under the eye of ustrious patron, Lorenzo dei Medici. On the nendation, it is said, of Ghirlandaio, he was trans- before the term of his apprenticeship as a painter xpired, to the school of sculpture established by zo in the Medici gardens. Here he could learn to himself against his great predecessor, Donatello, one se pupils was the director of the school, and to com- he works of that master and his Tuscan contemporaries with the antiques collected for the instruction of the sc Here, too, he could listen to discourses on Platonic steep himself in the doctrines of an enthusiastic philo which sought to reconcile with Christian faith the lo the doctrines of the Academy. Michelangelo remai Christian Platonist to the end of his days; he w from his youth up a devoted student of Dante's powers of mind and hand soon attracted attention secured him the regard and favour of his patron, in spite of his rugged, unsociable exterior, and of a temper at best was but a half-smothered volcano.

Michelangelo had been attached to the school and hold of the Medici for barely three years when, in his great patron Lorenzo died. Lorenzo's son Pie Medici inherited the position, but not the qualities, father; Florence soon chafed under his authority towards the autumn of 1494 it became apparen disaster was impending over him and his adh Michelangelo was constitutionally subject to dar sudden presentiments: one such seized him now without awaiting the popular outbreak which soon fol he took horse with two companions and fled to Bo There, being now in his twentieth year, he was re civ kindness by a member of the Aldovrandi family, a his commission executed two figures of saints, and an angel, for the shrine of St Dominic in the church Petronius. After about a year, work at Bologna f and his name having been included in his absence list of artists appointed to provide a new hall of as for the Great Council of Florence, Michelangelo re home. The strange theocracy established by Savo was now in force, and the whole character of civic Florence was for the time being changed. But Michel was not left without employment. He found a fri another Lorenzo, the son of Pierfrancesco dei Med whom he at this time executed a statue of the boy St Having also carved a recumbent Cupid in imitation antique, it was suggested to him by the same that it should be so tinted and treated as to look real antique, and sold accordingly. Without men the price he put upon the work, Michelangelo for a ment lent himself to the counterfeit, and the piece wa actually sold for a large sum to a Roman collecto cardinal San Giorgio, as a genuine work of antiquity dealer appropriating the profits. When present cardinal discovered the fraud, he caused the dea refund; but as to Michelangelo himself, it was repre to the young sculptor that if he went to Rome, the ar who had just involuntarily paid so high a tribute skill would certainly befriend him. He set forth ingly, and arrived at Rome for the first time at the June 1496. Such hopes as he may have entertai countenance from the cardinal San Giorgio were d dispelled. Neither did the banished Piero dei Medi also was now living at Rome, do anything to hel On the other hand Michelangelo won the favou Roman nobleman, Jacopo Galli, and through him French cardinal Jean de Villiers de la Grolaie, ab St Denis. From the former he received a commis a Cupid and a Bacchus, from the latter for a P Mary lamenting over the body of Christ,—works of probably all three, the last two certainly, are preser

Michelangelo's stay in Rome at this time laste years, from the summer of 1496 till that of 1501, interval had been one of extreme political distrac Florence. The excitement of the French invasio mystic and ascetic regimen of Savonarola, the re which led to his overthrow, and finally the externa and internal dissidences which preceded a new settl had all created an atmosphere most unfavourable

heless Ludovico Buonarroti, who in the troubles of
ad lo t a small permanent appointment he held in
stom , and had come to regard his son Michelangelo
manc day of his house, had been repeatedly urging
come home
pirit of family duty and family pride was the ruling
ple in all Michelangelo's conduct During the best
f his life he submitted himself steadily and without
amm to purchase hard hip and almost superhuman
for the sake of his father and brothers, who were
ll fully ready to be fed and helped by him Having
atter an illness, come home in 1501, Michelangelo
d the request from the cardinal Francesco Picco
to adorn with a number of sculptured figures a
already begun in the cathedral of Siena in honour
most distinguished member of his house, Aeneas
Four only of these figures were ever executed,
e not apparently, or only in small part, by the
hand A work of greater interest in Florence
ad diverted him from his engagement to his Sienese

This was the execution of the famous colossal
of David, popularly known as the Giant It was
out of a huge block of marble on which another
r, Agostino d Antonio, had begun unsuccessfully to
orty years before, and which had been lying idle
ce Michelangelo had here a difficult problem before
Without much regard to tradition or the historical
r of his hero, he carved out of the vast but cramped
of material a youthful, frowning colossus, which
every beholder by its freedom and science of execution
d its victorious energy of expression. All the best
of Florence were called in council to determine on
te it should be set up, and after much debate the
of the Palace of the Signory was chosen, in preference
the neighbouring Loggia dei Lanzi. Here accordingly
e colossal David of Michelangelo took, in the month
1504, the place which it continued to hold even after
until ten years ago, in 1873, it was removed for
e of protection to a hall in the Academy of Fine
Other works of sculpture by the same indomitable
also belong to this period among these another
in bronze, and on a smaller scale; a great rough
St Matthew begun but never completed for the
al of Florence, a Madonna and Child executed on
mmission of a merchant of Bruges, and two in
l bas reliefs of the same subject
ther was Michelangelo idle at the same time as a
Leaving disputed works for the moment out of
e in these days at any rate painted for his and
s common patron, Angelo Doni, the Holy Family
the Uffizi at Florence And in the autumn of
he year of the completion of the David, he received
he Florentine state a commission for a work of
ental painting on an heroic scale. Leonardo da
had been for some months engaged on his great
of the Battle of Anghiari, to be painted on the
the great hall of the municipal council. The
mmon Sodoma now procured for Michelangelo the
sion to design a companion work. Michelangelo
n incident of the Pisan war, when the Florentine
s had been surprised by the enemy in the act of
g: he dashed at the task with his accustomed fiery
and had carried a great part of the cartoon to
tion when, in the early spring of 1505, he broke off
k in order to obey a call to Rome which reached
m Pope Julius II His unfinished cartoon showed
eatly Michelangelo had profited by the example of
r rival, Leonardo, little as, personally, he yielded
charm or could bring himself to respond to his
y. The work of Michelangelo's youth is for the

most part comparatively tranquil in character. His
sculpture, showing a degree of science and perfecti
equalled since the antique, has also something
antique serenity. It bears strongly the stamp of
lectual research, but not by any means that of st
strain. In the cartoon of the Bathers, he on the
hand appropriated and carried further the mastery,
Leonardo had first asserted, over every variety of
action and every extreme of energetic movement.
the qualities afterwards proverbially associated
Michelangelo—his *furia*, his *terribilita*, the tempe
hurricane of the spirit which accompanied his unec
technical mastery and knowledge first found expre

With Michelangelo's departure to Rome early in 1505 t
part of his artistic career may be said to end It will be co
here to recapitulate its principal results in sculpture and p
both those preserved, and those recorded but lost

Settignano Florence, 1489 91. *Head of a Faun*, N
Museum, Florence (?) Condivi describes Michelangelo's fi
in sculpture as a head of an aged faun with a front tooth knoc
this latter point having been an afterthought suggested by
dei Medici The head is commonly identified with one
National Museum at Florence, which, however, bears no r
Michelangelo's style, and is in all probability spurious. *M*
Seated on a step, Casa Buonarroti, Florence This bas-re
genuine example of Michelangelo's early work in the M
school under Bertoldo It is executed in low relief in mut
the technical style of Donatello, but the attitudes and ch
of the figures, and the long-drawn, somewhat tormented
drapery, recall rather the manner of Jacopo della Quercia
Tarquinia, Casa Buonarroti A fine and unquestionably
work in full relief, of probably somewhat later date than t
mentioned, Michelangelo has followed the antique in
ception and treatment of the nude, but not at all in the
ment of the subject, which occurs frequently in works of anc

Bologna, 1491 95. *Kneeling Angel*, supporting the s
St Domine. This is the figure, with crisp hair, short
features, and drapery clinging to show the limbs, on th
hand side of the spectator as he fronts the altar. The
and more engaging figure at the opposite end was long t
be Michelangelo's work, but is really that of Niccolò de
Michelangelo also finished the figure of St Petronius on the
of the same altar, begun by the same Niccolò, and execute
St Proculus which has perished

Florence, 1495 96. *St John in the Wilderness*, Berlin M
During the year between Michelangelo's return from Bolo
his first departure to Rome he executed, as has been narrate
a statue of S. Giovannino for Lorenzo di Pierfrancesco dei
This had for centuries been supposed lost, when in 187
declared to have been found in the possession of Count G
Rossalmini at Pisa Vehement and prolonged discussion
as to the authenticity of the work, and at last it was bou
the Berlin Museum, where its genuineness is with apparent
reason maintained The stripling saint stands naked bu
skin about his loins, holding a honeycomb in his left ha
lifting to his mouth a goat's horn full of honey with hi
Restoration of an antique group of Bacchus and Ampelu
Gallery, Florence. This interesting restoration of an antiqu
by the addition of a head, the lower part of the legs, and the a
figure of an attendant genius a plinth, and mask, is not on
works traditionally ascribed to Michelangelo; but has late
as it seems rightly, been claimed for him on internal ev
Recumbent Cupid, bought by the cardinal San Giorgio
antique. This work, which played an important part in
angelo's history, is unfortunately lost

Rome, 1495 1501 *Kneeling Cupid*, South Kensington M
London. This beautiful statue of an athletic youth knee
the right knee, looking over his right shoulder, with th
hand lowered and the left raised, and having a quiver
ground beside him, is acknowledged on internal grounds
early work of Michelangelo There is some ambiguity ab
character and action of the personage; but the work is
identified with the Cupid which Michelangelo is recorded
executed at this time for Jacopo Galli *Bacchus and Youn*
National Museum Florence. This is unquestionably the "B
commissioned by the same patron. The finely-framed b
limbed youthful god, his weight supported somewhat stagg
on the left leg, holds up a wine cup in his right hand, and
loosely-hanging left hand holds a cluster of grapes, at
child-faun standing a little behind him grasps and nibble
surface highly finished and polished, as in the Berlin St
Virgin Lamenting the Dead Christ, St Peter's, Rome. This
executed for the French abbot of St Denis, is the finest

angelo's early sculptures, and one of the finest of his life
recalls the ideals of some of the earlier Tuscan masters,
ly Jacopo da Quercia; but the execution is of a mastery
oility unprecedented in Italian art. The Virgin, in drapery
nificent design, with her left knee somewhat raised and her
and slightly extended, sits holding on her lap the dead
– a figure of splendid frame and modelling as well as of
ble pathos and dignity in expression.

nce, 1501–6. *Four Saints decorating the Shrine of Pius II.*, cathedral of Siena. These figures represent the only part Michelangelo ever completed of his contract with the cardiccolomini and his heirs. They are evidently carried out by nd of pupils only. *Virgin and Child*, Liebfrauenkirche.

This pleasing group has been since the days of Albert attributed to Michelangelo, and bears the manifest stamp design, though its execution may be partly by inferior It is placed close to the tombstone of a member of the nom (or Moskeron) family. We know that Michelangelo d at this time, for one of this very family, a work which the biographers describe as having been in bronze, a medal- that metal, says explicitly Vasari, but it is probably really ible group in question. *Virgin and Child*, Royal Academy, This beautiful unfinished circular relief is identified with corded to have been executed by the master for Taddeo *Virgin and Child*, National Museum, Florence, a similar also unfinished, originally ordered by Bartolommeo Pitti *id David*, Academy of Arts, Florence. Of this colossal which in spite of its and subject has still, and style, a considerable artistic affinity with the earlier s and St John enough has been said. *Figure of David*, statue in bronze. Several extant works have been pointed probably identical with this lost statue; but the claims of ave been generally acknowledged.

TING. *Holy Family*, Uffizi, Florence. This circular picture, for Angelo Doni, and mentioned by the earliest biographers, only perfectly well-attested panel-painting of Michelangelo exists. His love of restless and somewhat strained actions is ted by the action of the Madonna, who kneels on the ground g up the child on her right shoulder. His love of the nude introduction (wherein he follows Luca Signorelli) of some se purposeless undraped figures in the background. *Virgin ild with Four Angels*, National Gallery, London. This hed painting, marked by great grace as well as severity of and design, was formerly attributed to Domenico Ghirlandaio, ow commonly held to be the earliest extant picture by Michel

Of his manner, especially in the design and treatment of the , it bears evident marks; but the execution seems like that e weaker pupil or companion, perhaps Ridolfo Ghirlandaio naccei. *Entombment of Christ*, National Gallery, London. eture, also unfinished, has in like manner been much con-

Its composition is unfortunate; weaker hands have dis some portions of the work, but the extraordinary excellence er portions, and the grandeur of some of the actions, it probable that the work is one begun and afterwards ned by Michelangelo himself. *Cartoon of the Battle of ri.* Of this famous lost work (begun, though apparently pleted, in the period now engaging us) the only authentic is contained in two early engravings, one by Marcantonio e other by Agostino Veneziano. An elaborate drawing of igures at Holkham Hall, well known and often engraved, o be a later *copia* destitute of real authority.

helangelo had not been long in Rome before Pope devised fit employment for him. That capacious eadstrong spirit, on fire with great enterprises, had ved the idea of a sepulchral monument to commemorate his glory when he should be dead, and to be ed according to his own plans while he was still He entrusted this congenial task to Michelangelo. esign being approved, the artist spent the winter of 6 at the quarries of Carrara, superintending the ation and shipment of the necessary marbles. In the he returned to Rome, and when the marbles arrived with all his energy at the preparations for the work. while the pope followed their progress eagerly, as all kindness to the young sculptor. But presently isposition changed. In Michelangelo's absence an who was no friend of his, Bramante of Urbino, had elected by Julius to carry out a new architectural e, commensurate with the usual vastness of his conns, namely the rebuilding of St Peter's church. To fluence and the malice of Bramante Michelangelo attributed the unwelcome invitation he now received interrupt the great work of sculpture which he had begun, in order to decorate the Sixtine chapel with fr Soon, however, schemes of war and conquest interpo divert the thoughts of Julius, not from the progress own monument merely, but from artistic enter altogether. One day Michelangelo heard him say at to his jeweller that he meant to spend no more mon pebbles either small or great. To add to the artist's confiture, when he went to apply in person for payment due, he was first put off from day to day, and a actually with scant courtesy dismissed. At this ni mood got the mastery of him. Convinced that n employment only but his life was threatened, he sad took horse and left Rome, and before the messeng the pope could overtake him was safe on Flore territory. Michelangelo's flight took place in April Once among his own people, he turned a deaf ear overtures made from Rome for his return, and throughout the summer at Florence, how occupied v not distinctly informed, but apparently, among things, on the continuation of his great battle cartoon

During the same summer Julius planned and exe the victorious military campaign which ended unopposed entry at the head of his army into Bo Thither, under strict safe-conduct and promises of re favour, Michelangelo was at last prevailed on to h himself. Julius received the truant artist kindly, as i between these two volcanic natures there existed a m affinity, and ordered of him his own colossal liken bronze, to be set up, as a symbol of his conq authority, over the principal entrance of the church Petronius. For the next fifteen months Michel devoted his whole strength to this new task. The at which he undertook it left him, as it turned out, any margin to subsist on. Moreover, in the technic of metal casting he was inexperienced, and an ass whom he had summoned from Florence proved m dinate and had to be dismissed. Nevertheless his prevailed over every hardship and difficulty, and o 21st of February 1508 the majestic bronze colos the seated pope, robed and mitred, with one hand gr the keys and the other extended in a gesture of be tion and command, was duly raised to its station ov church porch. Three years later it was destroyed revolution. The people of Bologna rose against authority of Julius; his delegates and partisans wer out, and his effigy hurled from its place. The wo Michelangelo, after being trailed in derision throug streets, was broken up and its fragments cast int furnace.

Meanwhile the artist himself, as soon as his wor done, had followed his reconciled master back to The task that here awaited him, however, was after the resumption of the papal monument, but the exe of the series of paintings in the Sixtine chapel whi been mooted before his departure. Painting, he averred, was not his business; and he entered misgiving and reluctance upon his new undert Destiny, however, so ruled that the work thus thrust him remains his chief title to glory. His history is indomitable will and almost superhuman energy, yet that hardly ever had its way, and of energy contr at war with circumstance. The only work which in life he was able to complete as he had conceived this of the decoration of the Sixtine ceiling. The had at first proposed a scheme including figures o twelve apostles only. Michelangelo would be conten nought so meagre, and furnished instead a design of hundred figures, embodying all the history of creatio

first patriarchs, with accessory personages of prophets
oyls dreaming on the new dispensation to come, and,
ition, those of the forefathers of Christ. The whole
be enclosed and divided by an elaborate framework
ted architecture, with a multitude of nameless human
supporting its several members or reposing among
shape mediating, as it were, between the features
inanimate framework and those of the great dramatic
ophetic scenes themselves. Michelangelo's plan was
ed by the pope, and by May 1508 his preparations
execution were made. Later in the same year he
oned a number of assistant painters from Florence,
d in the tradition of the earlier Florentine school,
were unable, it seems, to interpret Michelangelo's
s in fresco either with sufficient freedom or sufficient
unity of style to satisfy him. At any rate he soon
ed them, and carried out the remainder of his
l task alone, except for the necessary amount of
mechanical and subordinate help. The physical
ons of prolonged work, face upwards, upon this vast
e of ceiling were adverse and trying in the extreme.
ter four and a half years of toil the task was
hed. Michelangelo had during its progress been
d alike by delays of payment and by hostile intrigue.
solute need of funds for the furtherance of the
king had even constrained him at one moment to
off work, and pursue his inconsiderate master as far
gna. Ill wishers at the same time kept casting
on his capacity, and vaunting the superior powers
hael. That gentle spirit would by nature have been
's enemy, but unluckily Michelangelo's moody, self-
rated temper prevented the two artists being on
f amity such as might have stopped the mouths of
f makers. Once during the progress of his task
angelo was compelled to remove a portion of the
ing and exhibit what had been so far done, when
et alike upon friends and detractors was overwhelm
Still more complete was his triumph when, late in
tumn of 1512, the whole of his vast achievement
closed to view.

ain field of the Sixtine ceiling is divided into four larger
ng with five smaller fields. The following is the order of the
depicted in them (1) the dividing of the light from the
, (2) the creation of sun, moon, and stars, and of the
; (3) the creation of the waters; (4) the creation of man;
creation of woman, (6) the temptation and expulsion;
gmatical scene, said to represent the sacrifice of Cain and
t rather resembling the sacrifice of Noah; (8) the deluge;
runkenness of Noah. The figures in the last three of these
on a smaller scale than those in the first six. In numbers
7, and 9 the field of the picture is reduced by the encroach
the architectural framework and supporters. These sub-
flanked at each end by the figure of a seated prophet or
erately, two other prophets are introduced at each ex-
of the series, making seven prophets and five sibyls in all. In
es to front and left of the prophets at the two extremities
Death of Goliath, the Death of Judith, the Brazen Ser-
nd the Punishment of Haman. In the twelve lunettes
he window and the similar number of triangular vaulted
over them, are mysterious groups, or pairs of groups, of
which from Michelangelo's own time have usually been
as Ancestors of Christ. The army of nameless architectural
subordinate figures is too numerous to be here spoken of.
k represents all the powers of Michelangelo at their best.
ing all the accessory allurements of the painter's art, he
centrated himself upon the exclusive delineation of the
form and face at their highest power. His imagination
ceived, and his knowledge and certainty of hand have enabled
realize, attitudes and combinations of unmatched variety
ndeur, and countenances of unmatched expressiveness and
But he has not trusted, as he came later to trust, to science
uired knowledge merely, neither do his personages, so far
did afterwards, transcend human possibility or leave the
actual life behind them. In a word, his sublimity, often
s of the occasion, is here no more than equal to it; more-
s combined with the noblest elements of grace and even of
ss. As for the intellectual meanings of his vast design, over and above those which reveal themselves at a first g
by a bare description,—they are from the nature of the
exhaustible, and can never be perfectly defined. What
soul of this great Florentine, the spiritual heir of Dan
the Christianity of the Middle Age not shaken in his mi
expanded and trans-cendentalized, by the knowledge and
Plato, whatever the soul of such a man, full of suppresse
ness and righteous indignation, and of anxious questio
coming fate, could conceive, that Michelangelo has expr
shadowed forth in this great and significant scheme of pa
The details it must remain for every fresh student to inte
his own manner.

The Sixtine chapel was no sooner complete
Michelangelo resumed work upon the marbles f
monument of Julius. But four months only had
when Julius died. His heirs immediately entered
summer of 1513) into a new contract with Miche
for the execution of the monument on a reduce
What the precise nature and extent of the original
had been we do not know, but the new one was ex
and magnificent enough. It was to consist of a
quadrilateral structure, two courses high, projectin
the church wall, and decorated on its three unattache
with statues. On the upper course was to be pla
colossal recumbent figure of the pope under a
and beside it mourning angels, with prophet
allegoric personages at the angles, sixteen figu
all. The lower course was to be enriched with
four figures in niches and on projecting pedesta
the niches, Victories trampling on conquered Pro
in the pedestals, Arts and Sciences in bondage
entire work was to be completed in nine years
During the next three years, it would seem, Miche
brought to completion three at least of the p
figures, and they are among the most famous of a
ing works of the sculptor's art,— namely, the Mos
in the church of S. Pietro in Vincoli at Rome a
two "Slaves" at the Louvre.

The Moses, originally intended for one of the angles of t
course, is now placed at the level of the eye, in the centr
principal face of the monument as it was at last finishe
deplorably reduced and altered scale, by Michelangelo
assistants in his old age. The prophet, heavily bearded and
with only his right arm bare, sits with his left foot draw
his head raised and turned to the left with an expressio
dignation and menace, his left hand laid on his lap and h
grasping the tables of the law. The work, except in on
places, is of the utmost finish, and the statue looks like on
prophets of the Sixtine ceiling done in marble. The "Sl
the Louvre are youthful male figures of equally perfect ex
nude but for the band which passes over the breast of one
right leg of the other. One, with his left hand raised to
and his right pressed to his bosom, and his eyes almost
seems succumbing to the agonies of death; the other, with
bound behind his back, looks upward still hopelessly str
There is reason to believe that all three of these figures were
between 1513 and 1516. The beginnings of other figures o
intended for the same monument are to be found at Florenc
they were no doubt made and then abandoned some years
viz., four rudely blocked figures of slaves or prisoners, in
of the Boboli gardens, and the so-called Victory in the
Museum, an unfinished group of a combatant kneeling
crushing to death a fallen enemy; with these may be as
a wax model known as Hercules and Cacus in the Sout
sington Museum, and the figure of a crouching man at St
burg.

By this time (1516) Michelangelo's evil star wa
in the ascendant. Julius II. had been succeeded
papal throne by a Medici under the title of Leo X
Medici, too, had about the same time by force and
re-established their sway in Florence, overthrowing t
institutions that had prevailed there since the
Savonarola. Now on the one hand this family w
hereditary friends and patrons of Michelangelo;
other hand he was a patriotic son of republican Fl
so that henceforward his personal allegiance a
political sympathies were destined to be at conflict.

f his art, as has been thought, the pain and per- of this conflict have cast their shadow. For the the consequence to him of the rise to power of the was a fresh interruption of his cherished work on b of Julius. Leo X. and his kinsmen insisted that ngelo, regardless of all other engagements, must and carry out a great new scheme for the enrich- f their own family church of San Lorenzo in e. The heirs of Julius on their part showed an odating temper, and at the request of Leo allowed ree years'-old contract to be cancelled in favour of , whereby the scale and sculptured decorations of ian monument were again to be reduced by nearly Unwillingly Michelangelo accepted the new com thus thrust upon him for the church façade at e; but, having once accepted it, he produced a of combined sculpture and architecture as splendid bitious in its way as had been that for the monu- Julius. In the summer of 1516 he left Rome for to superintend the excavation of the marbles. elangelo was now in his forty second year. Though han half his life was yet to come, yet its best ad, as it proved, been spent. All the hindrances e had encountered hitherto were as nothing to hich began to beset him now. For the supply of ls for the façade of San Lorenzo he had set a firm ns to work, and had himself, it seems, entered into f partnership with them, at Carrara, where he knew rries well, and where the industry was hereditary ll understood. When all was well in progress there is own eye, reasons of state induced the Medici Florentine magistracy to bid him resort instead ain new quarries at Pietrasanta, near Serravalle in itory of Florence. Hither, to the disgust of his old t Carrara and to his own, Michelangelo accordingly ransfer the scene of his labours. Presently he found so impeded and enraged by the mechanical difficulties g and transporting the marbles, and by the disloyalty ompetence of those with whom he had to deal, that fain to throw up the commission altogether. The ts for the façade of San Lorenzo were rescinded in 1518, and the whole magnificent scheme came to . Michelangelo then returned to Florence, where ls of work poured in on him from many quarters. g of France desired something from his hand to eside the two pictures he possessed by Raphael. horities of Bologna wanted him to design a façade r church of St Petronius; those of Genoa to cast a n bronze of their great commander, Andrea Doria. l Grimani begged hard for any picture or statue he ave to spare; other amateurs importuned him for n as a pencil drawing or sketch. Lastly his friend rtisan Sebastian del Piombo at Rome, ever eager to the feud between the followers of Michelangelo se of Raphael, besought him on Raphael's death to at once to Rome, and take out of the hands of the aster's pupils the works of painting still remaining ne in the Vatican chambers. Michelangelo complied ne of these requests. All that we know of his doing time was the finishing a commission received and t in hand four years previously, for a full-sized of a nude Christ grasping the Cross. This statue, ted and sent to Rome in 1521 (with some last touches by subordinate hands in Rome itself), stands now in rch of Sta Maria sopra Minerva; there is little in e Christian spirit as commonly understood, although, e parts which Michelangelo himself finished, there me accomplishment of design and workmanship.

next twelve years of Michelangelo's life (1522–34) ent at Florence, and again employed principally in the service of his capricious and uncongenial patro Medici. The plan of a great group of monume deceased members of this family, to be set up i mortuary chapel in San Lorenzo, seems to have been f and preparations to have been made by Michelang its execution, as early as 1519. It was not, howeve 1524, after Leo X. had died, and his successor Adri had been in his turn succeeded by another Medicean Clement VII., that any practical impulse was given work. Even then the impulse was a wavering one. Clement proposed to associate another artist, San with Michelangelo in his task. This proposal be Michelangelo's peremptory demand abandoned, C next distracted the artist with an order for a new tectural design, – that, namely, for the proposed M or "Laurentian" library. When at last the plans sepulchral monuments took shape, they did not incl had been at first intended, memorials to the foun the house's greatness, Cosimo and Lorenzo the Magn or even to Pope Leo X. himself, but only to two y members of the house lately deceased, Giuliano, Nemours, and Lorenzo, duke of Urbino. Miche brooded long over his designs for this work, and w engaged on its execution – his time being partly also up by the building plans for the Medicean library political revolutions interposed to divert his industr 1527 came to pass the sack of Rome by the Au and the apparently irretrievable ruin of Pope Clement Florentines seized the occasion to expel the Medi their city, and set up a free republican governmen more. Naturally no more funds for the work i Lorenzo were forthcoming, and Michelangelo, invitation of the new signory, occupied himself while with design for a colossal group of Sams the Philistines, to be wrought out of a block of which had been rough hewn already for another p by Baccio Bandinelli. Soon, however, he was ca help in defending the city itself from danger. Clem his enemy Charles V. having become reconciled, bot were now bent on bringing Florence again under the the Medici. In view of the approaching siege, Miche was appointed engineer in chief of the fortification spent the early summer of 1529 in strengthening defences of San Miniato, from July to September absent on a diplomatic mission to Ferrara and Returning in the middle of the latter month, he fou cause of Florence hopeless from internal treache from the overwhelming strength of her enemies. his dark seizures overcame him, and he departed suddenly for Venice. Not cowardice, but despair city's liberties, and still more of his own profession specters amid the turmoil of Italian affairs, was the of his departure. For a while he remained in negotiating for a future residence in France. Then the siege was still in progress, he returned once Florence; but in the final death struggle of her libe bore no part. When in 1530 the city submitted conquerors, no mercy was shown to most of those w taken part in her defence. Michelangelo believed in danger with the rest, but on the intervention of Valori he was presently taken back into favo employment by Pope Clement. For three years still remained at Florence engaged principally on t pletion of the Medici monuments, and on the continu the Medicean library, but partly also on a picture for the duke of Ferrara.

The statues of the Medici monument take rank beside t and the Slaves as the finest work of Michelangelo's cent in sculpture; moreover, though some of the figures are un they constitute as actually executed a complete scheme

of a Madonna and Child (left imperfect because the marble
rt in bulk), and of the two famous monumental groups, each
ng of an armed and seated portrait-statue in a niche, with
blematic figures reclining on each side of a sarcophagus
The portraits are treated not realistically but typically. In
Lorenzo seems to be typified the mood of brooding and
rated inward thought preparatory to warlike action; in
Giuliano, the type of alert and confident practical survey
tely preceding the moment of action. To this contrast of
lit ative and active character corresponds to some extent a
in the emblematic group accompanying the portraits. At
of the Duke Giuliano recline the figures of Night and Day,—
er a female, the latter a male personification—the former
an attitude of deep but uneasy slumber, the latter (whose
d face are merely blocked out of the marble) lifting himself
t wrathful and disturbed awakening. But for Michelangelo's
g grandeur of style, not for the sense which his works con
compulsive heat and tempest of thought and feeling in the
t thus conceived them, both these attitudes might be charged
travagance. Varied, but far less violent, are those of the
panion figure that recline between sleep and waking on
ophagus of the tomb of Lorenzo. Of these, the male figure
n as Evening and the female as Morning (*Crepuscolo* and
. In Michelangelo's original idea, figures of Earth and
were to be associated with those of Night and Day on the
nt of Giuliano, and others of a corresponding nature, no
ith those of the Morning and Evening Twilight on that of
, these hence afterwards fell out of the scheme. Michel-
obvious and fundamental idea was, as some words of his
nd, to exhibit the elements, and the powers of earth and
lamenting the death of the princes, it is a question of
terest, but not to be discussed here, what other ideas of
personal and deeper kind may have conflicted or come into
on with these, and found expression in these maje tic
f art, whereof no one who looks upon them can escape the

helangelo had never ceased to be troubled by the heirs
cutors of Julius, as well as by his own artistic con
and ambition, concerning the long postponed comple
the Julian monument. Agreement after agreement
en made, and then from the force of circumstances
In 1532, on the completion of the Medicean monu-
t Florence, he entered into a new and what he firmly
to be a binding contract to complete the work, on a
ee more very greatly reduced, and to set it up in the
of S. Pietro in Vincoli in Rome. But once more
hands of the pope diverted his purpose. Clement
that Michelangelo must complete his decorations
Sixtine chapel by painting anew the great end
ove the altar, adorned until then by frescos of
no. The subject chosen was the Last Judgment,
helangelo began to prepare sketches. For the
o years he lived between Rome and Florence, and
autumn of 1534, in his sixtieth year, settled finally
the remainder of his life at Rome. Immediately
rds Pope Clement died, and was succeeded by a
under the title of Paul III. Even more than his
s or, Paul insisted on claiming the main services of
ngelo for himself, and forced him to let all other
ment's stand. For the first seven years after the
return to Rome, his time was principally taken up
e painting of the colossal and multitudinous Last
nt. This being completed in 1541, he was next
led to undertake two more great frescos, one of the
sion of Paul and another of the Martyrdom of Peter,
w chapel which the pope had caused to be built in
tican, and named after himself *Cappella Paolina*.

resco of the Last Judgment in the Sixtine chapel is probably
t famous single picture in the world. In it Michelangelo
more than ever the omnipotence of his artistic science, and
y daring of his conceptions. The work exhibits the
unclothed human forms in every variety and extremity of
unattempted action and predicament. But of moderation,
as of beauty and tenderness, it is almost entirely devoid.
r from the complexion of his own thoughts, and the
digmatio that was native to his breast, or from the influ-
the passionate and embittered theological temper of the
Michelangelo has here neglected the consolatory aspects of
nity, and insisted on its terrific aspects almost exclusively.

Neither in the qualities of colour and execution is the wor
as the condition of either admits comparison, comparable f
to the earlier and far more nobly-inspired frescos of the
It is to these, and not to the Last Judgment, that the stud
turn if he would realize what is best and greatest in th
Michelangelo.

The frescos of the Pauline Chapel are on their part in
injured as to be hardly susceptible of useful study or c
In their ruined state they bear evidence of the same tender
made the art of Michelangelo in its latest phase so d
an example to weaker men,—the tendency, that is, to
energy and violence of action both in place and out, for "
ness" *quand même*, and to design actions not by help
study from nature, but by scientific deduction from the
laws of structure and movement. At best these frescos c
have been happy examples of Michelangelo's art.

During the fifteen years (1534-49) when Miche
was mainly engaged on these paintings, he had
last been enabled to acquit himself, although in a
that can have been satisfactory to none concerned
engagements to the heirs of Julius. Once m
influence of the pope had prevailed on them to a
compromise altogether to their disadvantage.
agreed that the Moses executed thirty years before
be the central figure of the new scheme; assistan
employed to carve two smaller flanking figures of
personifications; and the three were in 1545 set u
Pietro in Vincoli in combination with an archi
structure of rich but incongruous design. Dur
same years the long pent human elements of fervo
tenderness in Michelangelo's nature had found v
utterance such as they had never found before.
occasionally practised poetry in youth, and there a
of some transient love passage during his life at l
But it was not until towards his sixtieth year t
springs of feeling were fairly opened in the heart
solitary, this masterful and stern, life-wearied and
hardened man. Towards that age we find him be
to address impassioned sonnets, of which the senti
curiously comparable to that expressed in some of
speare's, to a beautiful and gifted youth, Tommaso C
Soon afterwards he made the acquaintance of th
accomplished, and high-souled lady, Vittoria Colonna
of the Marquis Pescara. For twelve years until he
which happened in 1547, her friendship was the grea
of Michelangelo's life. On her, in all loyalty and re
he poured out all the treasures of his mind, and all
prisoned powers of tenderness and devotion. He
for her a crucifixion of extraordinary beauty, of whic
imitations but not the original have come down to
was the chief inspirer of his poetry,—in which, alo
her praises, the main themes are the Christian relig
joys of Platonic love, and the power and mysteries
Michelangelo's poetical style is strenuous and conc
like the man. He wrote with labour and much sel
tion; we seem to feel him flinging himself on the
of language with the same overwhelming ener
vehemence,—the same impetuosity of temperame
bined with the same fierce desire of perfection
which contemporaries describe him as flinging hi
the material of marble.

And so the mighty sculptor, painter, and poet
old age. An infirmity which settled on him in 15
the death of Vittoria Colonna in 1547, left him b
health and heart. But his strength held on for
year longer yet. His father and brothers were d
his family sentiment concentrated itself on a
Leonardo, to whom he showed unremitting practic
ness, coupled with his usual suspiciousness and f
of temper. In almost all his relations the old n
tinued to the end to manifest the same loyal and r
heart, accompanied by the same masterful, moo
estranging temper, as in youth. Among the a

the younger generation he held a position of absolute ascendency and authority; nor was his example, as we have said, by any means altogether salutary for them. During the last years of his life he made but few more essays in sculpture, and those not successful, but was much employed in the fourth art in which he excelled, that of architecture. A succession of popes demanded his services for the embellishment of Rome. For Paul III. he built the palace called after the name of the pope's family the Farnese. On the death of Antonio da San Gallo he succeeded to the onerous and coveted office of chief architect of St Peter's Church, for which he remodelled all the designs, living to see some of the main features, including the supports and lower portion of the great central dome, carried out in spite of all obstacles according to his plans. Other great architectural tasks on which he was engaged were the conversion of a portion of the Baths of Diocletian into the church of Sta Maria degli Angeli, and the embellishment and rearrangement of the great group of buildings on the Roman Capitol. At length, in the midst of these vast schemes and responsibilities, the heroic old man's last remains of strength gave way. He died on the threshold of his ninetieth year, on the 18th of February 1564.

For the bibliography of Michelangelo, which is extensive, see the useful though very imperfect compilation of Passerini, *Bibliografia di Michelangelo Buonarroti*, &c., Florence, 1875. The most important works, taken in chronological order, are the following. P. Giovio, supplement to the fragmentary *Dialogus de viris litteris illustribus*, written soon after 1527, first published by Tiraboschi, *Storia della Letteratura italiana*, Modena, 1871; G. Vasari, in *Vite degli più eccellenti architettori, pittori, e scultori*, &c., Florence, 1550; A. Condivi, *Vita di Michelangelo Buonarroti*, 1553; this account, for which the author, a pupil and friend of the master's, had long been collecting materials, was much fuller than that of Vasari, who made use of it in rewriting his own life of Michelangelo for his second edition, which appeared after the master's death (1568). The best edition of Vasari is that by Milanesi, Florence, 1878–83; of Condivi, that by Gori and Manette, Pisa, 1746. The first additions of importance were published by Bottari, *Raccolta di lettere sulla pittura*, &c., Rome, 1754 (2d ed., by Ticozzi, Milan, 1822); the next by Gaye, *Carteggio inedito*, 1840. Portions of the correspondence preserved in the Buonarroti archives were published by Guasti in his notes to the *Rime di Michelangelo Buonarroti*, 1863, and by Daelli in *Carte Michelangelesche inedite*, Milan, 1865. Complete biographies of Michelangelo had been meanwhile attempted by J. Harford, London, 1857, and with more power by Hermann Grimm, *Leben Michelangelo's*, Hanover (5th ed., 1879). A great increment of biographical material was at length obtained by the publication in the four hundredth year after Michelangelo's birth, of the whole body of his letters preserved in the Buonarroti archives,—*Lettere di Michelangelo Buonarroti*, ed. G. Milanesi, Florence, 1875. This material was first employed in a connected narrative by A. Gotti, *Vita di Michelangelo*, Florence, 1875. Next followed C. Heath Wilson, *Life and Works of Michelangelo Buonarroti*, Florence, 1876, the technical remarks in which, especially as concerns the fresco paintings, are valuable. Lastly, the combined lives of Michelangelo and Raphael by Professor A. Springer in Dohme's series of *Kunst u. Künstler*, Leipsic, 1878, contain the best biography of the master which has yet appeared. Of the poems of Michelangelo the best edition is that already referred to,—G. Guasti, *Rime di Michelangelo Buonarroti*, 1863; in earlier additions the text had been recklessly tampered with, and the rugged individuality of the master's style smoothed down. An edition with German translations was published by Hasenclever, Leipsic, 1875; for the English student the translations by Mr J. A. Symonds, in *Sonnets of Michelangelo and Campanella*, London, 1878, are invaluable. (S. C.)

MICHELET, JULES (1798–1874), one of the most voluminous and remarkable writers of France, and one who only lacked a keener power of self-criticism to make him one of the greatest, was born at Paris, August 21, 1798. He belonged to a family which had Huguenot traditions, and which was latterly occupied in the art of printing. His father was a master printer, but seems not to have been very prosperous, and the son at an early age assisted him in the actual work of the press. A place was offered him in the imperial printing office, but his father was able to send him to the famous Collège or Lycée Charle where he distinguished himself. He passed the un examination in 1821, and was shortly after appoint professorship or rather mastership of history in the Rollin. Soon after this, in 1824, he married. The of the Restoration and the July monarchy was one most favourable to rising men of letters of a sor scholastic cast that has ever been known in Fran Michelet had powerful patrons in Villemain, Cous others. But, though he was an ardent politician from his childhood embraced republicanism and a variety of romantic free-thought), he was first of al of letters and an inquirer into the history of th His earliest works were school books, and they w written at a very early age. Between 1825 and produced divers sketches, chronological tables, modern history. His *Précis* of the subject, publi the last mentioned year, is a sound and careful b better than anything that had appeared before written in a sober yet interesting style. In the sa he was appointed maître de conférences at the Normale. Four years later, in 1831, the *Introd l'Histoire Universelle* showed a very different style, ing no doubt the idiosyncrasy and literary power writer to greater advantage, but also displaying the visionary qualities which make Michelet the most s ing but the most untrustworthy (not in facts, w never consciously falsifies, but in suggestion) historians. The events of 1830 had unmuzzled h had at the same time improved his prospects, and in a better position for study by obtaining for him in the Record Office, and a deputy professorshi Guizot in the literary faculty of the university soon afterwards he began his chief and monument the *Histoire de France*, which occupied him for abo years, and of which we shall speak presently. accompanied this with numerous other works, el erudition, such as the *Œuvres Choisies de Vico*, the J *de Luther écrits par lui même*, the *Origines d Français*, and somewhat later the *Procès des Te* 1838 was a year of great importance in Michel He was in the fulness of his powers, his studies his natural aversion to the principles of author ecclesiasticism, and at a moment when the revived of the Jesuits caused some real and more pretende he was appointed to the chair of history at the Co France. Assisted by his friend Quinet, he began a polemic against the unpopular order and the p which it represented, a polemic which made their and especially Michelet's, one of the most popula of the day. He published, in 1839, a History Roman Republic, but this was in his graver and manner. The results of his lectures appeared volumes *Le Prêtre, la Femme, et la Famille* and *L* These books do not display the apocalyptic styl borrowed to a certain though no very great exte Lamennais, characterizes Michelet's later works, contain in miniature almost the whole of his curiou politico-theological creed a mixture of sentime communism, and anti-sacerdotalism, supported by eccentric arguments, but urged with a great eloquence. The principles of the outbreak of 1 in the air, and Michelet was not the least impo those who condensed and propagated them: m original lectures were of so incendiary a kind course had to be interdicted. But when the actu tion broke out Michelet, unlike many other men did not attempt to enter on active political life, an devoted himself more strenuously to his litera Besides continuing the great history, he undert

out, during the years between the downfall of Louis
e and the final establishment of Napoleon III., an
astic *Histoire de la Revolution Française*. Despite
use of its enthusiasm, this is by no means Michelet's
ok. The events were too near and too well known,
rdly admitted the picturesque sallies into the blue
e which make the charm and the danger of his
work. In actual picturesqueness as well as in general
y of picture, the book cannot approach Carlyle's;
s a mere chronicle of the events it is inferior to half
n prosaic histories older and younger than itself.
p d'état lost Michelet his place in the Record Office,
ugh not in any way identified with the republic
stratively, he refused to take the oaths to the
But the new *regime* only kindled afresh his
can zeal, and his second marriage (with Mademoiselle
Malairet, a lady of some literary capacity, and of
can belongings) seems to have further stimulated
ver. While the history steadily held its way, a
of extraordinary little books accompanied and
fied it. Sometimes they were expanded versions of
oles, sometimes what may be called commentaries
panion volumes. In some of the best of them
science, a new subject with Michelet, to which his
believed to have introduced him, supplies the text.
-t of these (by no means the best) was *Les Femmes
Revolution* (1854), in which Michelet's natural and
ble faculty of dithyrambic too often gives way to
and not very conclusive argument and preaching.
next, *L'Oiseau* (1856), a new and most successful
as struck. The subject of natural history was treated,
m the point of view of mere science, nor from that
nment, nor of anecdote, nor of gossip, but from that
author's fervent democratic pantheism, and the
though, as was to be expected, unequal, was often
nt. *L'Insecte*, in the same key, but duller, followed.
succeeded by *L'Amour* (1859), one of the author's
opular books, and not unworthy of its popularity,
rhaps hardly his best. These remarkable works,
amphlets half moral treatises, succeeded each other
le at the twelve months' interval, and the succession
not unbroken for five or six years. *L'Amour* was
ed by *La Femme* (1860), a book on which a whole
e of French literature and French character might
uded. Then came *La Mer* (1861), a return to the
history class, which, considering the powers of the
and the attraction of the subject, is perhaps a little
inting. The next year (1862) the most striking
Michelet's minor works, *La Sorcière*, made its
nce. Developed out of an episode of the history,
ll its author's peculiarities in the strongest degree,
nightmare and nothing more, but a nightmare of
t extraordinary verisimilitude and poetical power.
remarkable series, every volume of which was at
work of imagination and of research, was not even
shed, but the later volumes exhibit a certain fall
. The ambitious *Bible de l'Humanité* (1864), an
al sketch of religions, has but little merit. In *La
me* (1868), the last of the natural history series, the
of staccato style are pushed even further than by
Hugo in his less inspired moments, though as is
ble in the hands of such a master of language as
et the effect is frequently grandiose if not grand.
ls (1869), the last of the string of smaller books
ed during the author's life, is a tractate on educa-
ritten with ample knowledge of the facts and with
helet's usual sweep and range of view, but with
declining powers of expression. But in a book
ed posthumously, *Le Banquet*, these powers reappear
ir fullest. The picture of the industrious and
famishing populations of the Riviera is (whether
fact or not) one of the best things that Michelet ha
To complete the list of his miscellaneous works, two
tions of pieces, written and partly published at d
times, may be mentioned. These are *Les Soldats
Révolution* and *Légendes Démocratiques du Nord*.

The publication of this series of books, and the c
tion of his history, occupied Michelet during both c
of the empire. He lived partly in France, partly in
and was accustomed to spend the winter on the I
chiefly at Hyères. At last, in 1867, the great work
life was finished. As it is now published it fills n
volumes. The first of these deals with the early
up to the death of Charlemagne, the second wi
flourishing time of feudal France, the third with th
century, the fourth, fifth, and sixth with the H
Years' War, the seventh and eighth with the establi
of the royal power under Charles VII. and Louis XI
16th and 17th centuries have four volumes apiece
of which is very distantly connected with French
proper, especially in the two volumes entitled *Ren
and *Réforme*. The last three volumes carry on the
of the 18th century to the outbreak of the Revo
The characteristics which this remarkable history
with Michelet's other works will be noted presentl
present it may be remarked that, as the mere divi
subjects and space would imply, it is planned o
original principles. Michelet was perhaps the
historian to devote himself to anything like a pictu
history of the Middle Ages, and his account is s
most vivid though far from the most trustworth
exists. His inquiry into manuscript and printed auth
was most laborious, but his lively imagination, a
strong religious and political prejudices, made him
all things from a singularly personal point of
Circumstances which strike his fancy, or furnish con
texts for his polemic, are handled at inordinate
while others are rapidly dismissed or passed over alto
Yet the book is undoubtedly the only history of
which bears the imprint of genius, and in this respe
not soon likely to meet a rival.

Uncompromisingly hostile as Michelet was to the
its downfall and the accompanying disasters of the
once more stimulated him to activity. Not only
write letters and pamphlets during the struggle, bu
it was over he set himself to complete the vast task
his two great histories had almost covered by a *His
the Nineteenth Century*. He did not, however, live t
it further than Waterloo, and the best criticism
perhaps contained in the opening words of the intro
to the last volume—"l'âge me presse." The new r
was not altogether a restoration for Michelet, a
professorship at the Collége de France, of which
tended that he had never been properly deprived, v
given back to him. He died at Hyères on the
February 1874, and an unseemly legal strife betw
representatives took place as to his funeral.

The literary characteristics of Michelet are among th
clearly marked and also among the most peculiar in Frenc
ture. A certain resemblance to Lamennais has been alread
and to this may be added an occasional reminiscence of the
of Bossuet. But in the main Michelet, even in the minor c
style, is quite original and individual. His sentences and pa
are as different as possible in construction and rhythm f
orderly architecture of French classical prose. A very
device of his (somewhat abused latterly) is the omissio
verb, which gives the sentence the air of a continued inte
Elsewhere he breaks his phrase, not finishing the regula
at all. In these points and many others the resemblanc
contemporary Carlyle is very striking; and, different
their points of view, their manners of seeing were by no
unlike. History to Michelet is always picturesque; it is
of tableaux. Allusion has been already made to the singu

Lake Superior
Lake Michigan
Lake Huron
Lake Erie
Lake St Clair
Wisconsin
Indiana
Ohio
Scale of Miles
County Towns
Railroads
Longitude West from Washington

n which these tableaux are drawn, a perspective so strange
ader unacquainted with the actual size and relation of the
epresented is certain to be deceived. Nothing indeed is
rom Michelet's purpose than deceit. Although a strong
n, an ardent anti-sacerdotalist, and a patriot of fanatical
m, he is always scrupulously fair as far as he understands
is doing. For instance, his hatred for England and
nen is one of the most comically intense passions in litera-
is never tired of exclaiming against their diabolical pride,
ous jealousy of France, their calculating covetousness, and
In his excited imagination the long drama of European
s a kind of conflict of Ormuzd and Ahriman, in which
t is needless to say, plays the first part and England the
Yet he is never unfair to English fortitude and coolness,
ter the childish fashion of some of his countrymen) slurs
glish victories, and often expresses genuine admiration
t is true, with a shudder or two of aversion) for the master-
and constantly advancing prosperity of the English people.
ll his dislike to the priesthood, he never is chary of praise
r monk whenever it can fairly be given, and, with all his
nism, he is never weary of worshipping the heroism of a
g. But his poetical fashion of dealing with events, his
ion of trivial incidents into great facts of history, his fixed
ecially in reference to the intellectual and social condition
val times, the evils of which he enormously exaggerates,
bding prejudices of a general kind combine to distort his
n the strangest fashion. A laborious person might pick
ntemporary authors a notable collection of erroneous views
Michelet is not so much the author as the suggester, for it
his brilliant exaggerations are torn from their context and
in some quite other context as sober gospel that they are
leading to those who do not know the facts, and most
to those who do. This is especially the case in regard to
. Michelet began his great work too early to enjoy the
the resurrection of old French literature which has since
ce; and though his view of that literature partakes of the
enthusiasm which colours his view of everything French,
ndingly incorrect in detail. The most remarkable passage
haps is the passage in his *Renaissance* relating to Rabelais,
and Du Bellay, a passage so widely inconsistent not only
d criticism but with historic fact that the author (a very rare
h him) makes a kind of half apology for it elsewhere. Of
of the age of chivalry proper, the chansons de gestes, the
n romances, the early lyrics and dramas, he evidently knew
, and chose to subordinate what he did know to his general
f the time. Even much later his praise and blame, though
ntly honest, are quite haphazard. Unless, therefore, the
gifted with a very rare faculty of applying the "grain of
what he reads, or unless he be well acquainted with the
cts before coming to Michelet's version of them, he will
ertainly be misled. But despite this grave drawback
ttends all picturesque history) the value of Michelet merely
storian is immense. Not only are his separate tableaux,
derful geographical sketch of France in the beginning of
, the sections devoted to the Templars, to Joan of Arc, to
issance, to the Camisards, almost unequalled, but the in-
and stimulating effect of his work is not to be surpassed.
onstruction is often hazardous and conjectural, sometimes
and demonstrably mistaken, and nearly always difficult
entirely to the ascertained facts, it is always possible in
ways instinct with genius, and always life-like. There are
ones in Michelet: they are at anything only too stirring
y. These criticisms apply equally to the minor books,
hese are necessarily fuller of the author's somewhat weari-
paganda, and less full of brilliantly painted facts. The
lt of Michelet as of not a few other modern authors is the
tively improvised and ephemeral character of too much of
. His immense volume is, much of it, mere brilliant
teering, much more mere description equally brilliant but
iable to pass. Nevertheless he is (especially in French, the
par excellence of measured and academic perfection) so
ristic and singular a figure in his turbid eloquence and
shing insight that he is never likely to lose a place, and a
one, in literary history.

t all Michelet's works, the exceptions being his translations,
ions, &c., are published in uniform size and in about fifty
partly by Marpon and Flammarion, partly by Calmann

(G. SA.)

HELL, JOHN, an eminent English man of science
8th century. He received his university education
een's College, Cambridge. His name appears
in the Tripos list for 1748-49; and in 1755 he was
tor in that examination. He was a fellow of his
and became successively Woodwardian professor
gy (in 1762) and rector of Thornhill in Yorkshire.
He was elected a member of the Royal Society in the same year as Henry Cavendish (1760). He died in 1793. In 1750 he published at Cambridge a small work of some eighty pages, entitled *A Treatise of Artificial Magnets, in which is shown an easy and expeditious method of making them superior to the best natural ones*. Besides the description of the method of magnetization which still bears his name, this work contains a variety of acute and accurate magnetic observations, and is particularly distinguished by a lucid exposition of the nature of magnetic induction. He is now best known as the original inventor of the torsion balance, which afterwards became so famous in the hands of its second inventor Coulomb. Michell described it in his proposal of a method for obtaining the mean density of the earth. He did not live to put his method into practice; but this was done by Henry Cavendish, who made, by means of Michell's apparatus, the celebrated determination that now goes by the name of Cavendish's experiment (*Phil. Trans.*, 1798).

Michell's other contributions to science are—"Conjectures concerning the Cause and Observations upon the Phenomena of Earthquakes," *Phil. Trans.*, 1760, "Observations on the Comet of January 1760 at Cambridge," *Ib.*, 1760, "A Recommendation of Hadley's Quadrant for Surveying," *Ib.*, 1765, "Proposal of a Method for measuring Degrees of Longitude upon Parallels of the Equator," *Ib.*, 1766; "An Inquiry into the Probable Parallax and Magnitude of the Fixed Stars," *Ib.*, 1767; "On the Twinkling of the Fixed Stars," *Ib.*, 1767, "On the Means of Discovering the Distance, Magnitude, &c., of the Fixed Stars," *Ib.*, 1784.

MICHELOZZI, MICHELOZZO (1391-1472?), was a Florentine by birth, the son of a tailor, and in early life a pupil of Donatello. He was a sculptor of some ability in marble, bronze, and silver. The statue of the young St John over the door of the Duomo at Florence, opposite the Baptistery, is by him; and he also made the beautiful silver statuette of the Baptist on the altar frontal of San Giovanni. Michelozzi's great friend and patron was Cosimo I. dei Medici, whom he accompanied to Venice in 1433 during his short exile. While at Venice, Michelozzi built the library of San Giorgio Maggiore, and designed other buildings there. The magnificent Palazzo dei Medici at Florence, built by Cosimo, was designed by him, it is one of the noblest specimens of Italian 15th-century architecture, in which the great taste and skill of the architect has combined the delicate lightness of the earlier Italian Gothic with the massive stateliness of the Classical style. With great engineering skill Michelozzi shored up, and partly rebuilt, the Palazzo Vecchio, then in a ruinous condition, and added to it many important rooms and staircases. When, in 1437, through Cosimo's liberality, the monastery of San Marco at Florence was handed over to the Dominicans of Fiesole, Michelozzi was employed to rebuild the domestic part and remodel the church. For Cosimo I. he designed numerous other buildings, mostly of great beauty and importance. Among these were a guest house at Jerusalem for the use of Florentine pilgrims, Cosimo's summer villa at Careggi, and the strongly fortified palace of Cafaggiuolo in Mugello. For Giovanni dei Medici, Cosimo's son, he built a very large and magnificent palace at Fiesole. In spite of Vasari's statement that he died at the age of sixty-eight, he appears to have lived till 1472. He was buried in the monastery of San Marco, Florence. Though skilled both as a sculptor and engineer, his fame chiefly rests on his architectural works, which claim for him a position of very high honour even among the greatest names of the great 15th-century Florentines.

MICHIGAN, one of the States of the American Union, situated in the region of the great lakes. It lies between 41° 42′ and 47° 32′ N. lat., and 82° 24′ and 90° 31′ W. long., the centre of the State being 670 miles north of west from New York, the nearest point on the seaboard. The area is 58,915 square miles. The State consists of two

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divisions, known as the Upper and the Lower
ula. The Upper or Northern Peninsula is bounded
N., E., and S. by Lakes Superior, Huron, and
an, and on the W. by the river St Mary and the
f Wisconsin. The Lower Peninsula is bounded on
, N., and E. by Lakes Michigan, Huron, St Clair,
rie, and the St Clair and Detroit rivers, and on the
e States of Ohio and Indiana. The general contour
Lower Peninsula approaches that of a horse-shoe,
n average width of about 200 miles from east to
nd a length of about 300 miles from north to south.
face gradually rises in gentle undulations from the
nding lake to an elevation of about 400 feet above
Huron, no point reaching an altitude of more than
et. The Upper Peninsula is much more rugged in
r and surface, at some points reaching an elevation
t 1100 feet. The territory was originally covered
rests, with only here and there a small open prairie.
unds on five inland lakes, with areas varying from
res to several miles. The rivers are not large
to be navigable, but they afford ample water-power,
particularly valuable for floating down the logs of
mbering districts. The coast line of the State is not
n about 1600 miles in length, and along the whole
distance vessels of 2000 tons may pass without
sight of land.

gical Formation. The Lower Peninsula occupies
ntral part of a great basin, the borders of which
to the east as far as London, Ontario, and to the
far as Madison, Wisconsin. Within these limits
veller starting in any direction from the centre of
ate encounters successively the out cropping edges
er and older strata. The whole series has been
to a nest of wooden dishes; it embraces not
he Laurentian and Huronian systems but also
merous groups that go to make up the Silurian,
evonian, the Carboniferous, and the Quaternary
. These several formations are covered almost
ally with a drift of finely comminuted and triturated
borne thither by moving glaciers and floating
s, or washed to its present position by currents
er, while the surface was still submerged. This
aterial varies in thickness, sometimes extending to
of 200 or 300 feet. While the lower formations
almost inexhaustible deposits of copper, iron,
, and salt, the surface soil is pre-eminently fertile,
all the mineral constituents necessary for the most
ut growth of plants. There are limited areas of
nd somewhat sterile drift soil; but even these
hown themselves under proper treatment to be
of yielding a rich vegetation. For the most
he drift soil is composed of a mixture of clay
nd and gravel. It is easily cultivated, is retentive
ture, and is sufficiently porous to prevent the injury
s by excessive rains.

ate and Natural Products. The mean temperature
sing, the capital of the State, as determined by
ations extending through eighteen years, is 46·71
or about the same as that of Berlin. During the
r months the mean temperature is nearly the same as
Vienna; in the winter it is nearly that of Stockholm.
nual rainfall during the eighteen years previous to
was about 31 inches. This is very evenly distributed
hout the year, though a little more than half the
falls in the five months from May to October.
erage snowfall in the centre of the State is about 4
ough it is seldom that more than 12 inches lie on the
at any one time. The winter temperature is much
d by the open water of the adjacent lakes. The
winds are commonly from the west and north west;
but in sweeping across the open waters of Lake Mic
they are so far softened as to make the climate
milder than that found in the same latitude on the we
side of the lake. This peculiarity is specially favoura
the growth of fruits. Peaches are grown successfully
the 45th parallel, and figs thrive in the open air in lat.
The modifying influence of the lake winds also gives
variety to the flora. The predominant woods are oak, m
beech, elm, ash, cherry, hickory, walnut, basswood, and
All these grow luxuriantly in the vast forests of the S
and afford an abundant supply of the best timber. The
165 species of trees and shrubs indigenous to Mich
and the entire flora of the State makes a list of
species.

Cereals and Fruits. The most important crop of Mic
is wheat, and the average yield per acre, as shown b
latest census, is greater than that of any other State i
Union. The acres own in 1879 were reported as 1,822
and the amount produced as 35,532,543 bushels.
figures show that Michigan is fourth in rank of the w
producing States, the number of bushels grown
exceeded by the crops of Illinois, Ohio, and Indiana
1879 the yield in bushels of the other principal cere
shown by the following figures: Indian corn, 32,461
oats, 18,190,793; barley, 1,204,316; rye, 294,918;
wheat, 413,062; clover seed, 313,063; pease, 538
The crop of potatoes in the same year was 8,02
bushels, and the hay amounted to 1,051,115 tons
the fruits grown in the State apples are the most impo
and these are believed to be unsurpassed in excelle
any country in the world. The sales in 1880
1,831,936 bushels, a considerable quantity going t
markets of Europe. Next in importance is the peach
annually gathered from more than fifty of the count
the State. In 1880 the peach orchards were report
covering 12,908 acres, and the fruit sold as amount
113,118 bushels. The long coast-line of Lake Mic
affords easy access to market even for the most peris
fruits. Besides the facilities thus afforded, the rai
that now thread the State, with an aggregate leng
March 1882 of 4332 miles, afford abundant mea
rapid transportation. As the fruit belt extends from
to south more than 200 miles, the danger of disa
competition in the markets is obviated by prolongat
the season of ripening. At the meeting of the
Horticultural Society held in 1881 it was reported
the average value of the peach crop per acre was
$125. The ten volumes of the *Transactions* of the
Horticultural Society published since its organizati
1870 show that the development of fruit culture
the last decade has been much more rapid than i
other State.

Lumber. The timber produce in Michigan is of su
quality, and the amount is so great that about two-
of the best lumber sold in New York, Philadelphi
Boston go out from its mills. The logs are borne
the lakes, rivers, and small watercourses to the boo
mills situated at convenient points, where the lum
sawed and shipped for the different markets of the
Of these manufacturing districts those known a
Saginaw, the Grand River, and the Muskegon valle
the most important. The Saginaw receives the wat
the Tittabawasse, the Cass, the Flint, the Shiawass
Bad, the Pine, the Chippewa, the Tobacco, and
numerous tributaries, draining a vast region that still
an undiminished supply of pine. The forests of the w
parts of the State are easily accessible by the Grand
and its tributaries, while those still farther north
natural outlet through the numerous streams that flo
Lake Michigan. On the banks of these watercourse

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f the largest and finest mills of the world In 1854, he first effort was made to collect statistics of this y, it was found that there were only sixty one mills ration, and that the entire annual product was only 0,000 feet Eighteen years later, in 1872, it was ted that the annual product was not less than 000 feet of oak, 12,700,000 of staves, 300 000 000 00,000,000 shingles, and 2, 00,000 000 of wood The number of saw mills had already reached about the number of persons employed 20,000 and the represented $25,000,000 In 1881 the manufacture lumber amounted to 3,919,500,000 feet the value h exceeded $60,000,000 The aggregate value of est products of the State was estimated in 1881 ve reached more than $1,000,000,000 *Tenth Census*, No 6, issued December 1, 1881, estimated the t of standing white pine of merchantable quality at ,000,000 feet, and the amount of standing hard at 700 000,000 cords Besides the amount the authority estimates the amount of hemlock at 000,000 feet with 7,000,000 cord of hard wood ate of 70,000,000 of cedar and tamarack It is le that before many years the hard wood produced State will approach in value the figure representing ue of the pine now sent to the markets of the world robable that Michigan for many years to come will n its precedence as a lumber producing State.

ral Resources Of the mineral products of Michigan st important is iron As early as 1847 the report first State geologist, Dr Douglass Houghton called on to the presence of hematite on the shores of able time after this it was not found in such ties as to make it certain that mining could be made ble Before 1860, however, it became known that n the Upper Peninsula not only existed in vast ties, but also that it was of superior quality From me iron mines were rapidly developed, until in they had come to exceed in value though not in t, even the products of Pennsylvania In 1880 oduct was 1,834,712 tons, with a value at the mines 034,648, as against the yield in Pennsylvania of 57.5 tons, with a value of $5, 17,079 The product higan in 1882 was 2,948, 07 tons of ore, with a value of about $25,000,000 The Michigan ds are of extraordinary richness 62 9 per cent the average of the first class ores, while the furnace often show a much higher yield

t in importance to the iron mines are those of copper are also situated in the Northern Peninsula, in the ain range of trappean rocks which crown the point l extending northwards into Lake Superior This ary peninsula or cape, known as Keweenaw Point o an average height of about 600 feet above the lake, ghest pinnacles reaching nearly double that altitude oint contains what are believed to be the richest -mines ever discovered, the metal is not found as , but as virgin copper almost chemically pure It ly to be separated from its rocky matrix, when it is for the market The largest of the copper mines, Calumet, has built up an industry which employs nen, and its total product of refined copper in 1882 o less than 50,770,719 lb, or one eighth of the production of copper in the world In quality the of the Lake Superior district is such that it commands the highest price at home and abroad Its tenacity arkable, and therefore it is eagerly sought after for ges by all the great military powers. In 1882 the -mines paid dividends amounting to $2,900,000, ing an aggregate of $28,248,000 since they were d.

Within a few years the salt works of Michigan have come to exceed those of any other State in the The first well was sunk in 1859-60, but in 1882 the duction was found to have exceeded that of the works in New York, and to have amounted in the to no less than 3,204,921 barrels. The extraordinary development of this industry is due to several causes careful system of inspection by State authority has its salt unsurpassed in purity. The salt basin is now accessible by navigable waters, so as to have the advantage of cheap transportation, but the wells are situated great lumber-producing districts, and the manufacture thus carried on at very small expense, in connection with the saw mills. The power is furnished by the engines, the exhausted steam is used for the evaporation of brine during the day, and during the night evaporation is still carried on by means of refuse wood and dust, while the staves for barrels are made from refuse timber By this system the best quality of salt is obtained at a minimum expense. The chief reservoir of salt is a series of sand-stones and shales constituting the Waverly group. This salt producing rock covers no less than 8000 square miles, and it is safe to presume that the supply is inexhaustible. The average depth of the wells is about 800 feet, but in some localities wells sunk to nearly 2000 feet have been remunerative. Important salt works have recently been developed in the western part of the State.

There are also certain other minerals of considerable importance. Deposits of gypsum, easily accessible and practically inexhaustible in quantity, and superior in quality are found in several localities both in the eastern and in the western parts of the Lower Peninsula. In the county of Grand Rapids the deposit crops out at the surface, with an average depth of from 10 to 70 feet extends over an area of 10 or 12 square miles. The rock is easily quarried and is either ground for use as a fertilizer or calcined for plaster of Paris. The deposits of coal are supposed to cover about 8000 square miles, but as yet the production at any one point has not been very considerable. In quality the coal is highly bituminous, and is not sufficiently pure to be useful for smelting or for the manufacture of gas. For these reasons the stock of coal in the State is practically untouched. If future explorations and developments should make these deposits available, a new era in the manufacture of iron will be the result. At present the coal for smelting the Lake Superior ores is brought chiefly from Ohio and Pennsylvania Quarries of limestone and of sandstone have been opened in various parts of the State. The brown stone of the Upper Peninsula is of excellent quality, and is capable of receiving a fine finish. The supply is inexhaustible, and the access afforded to the quarries by water gives promise of a thriving industry. The grindstones taken from the Huron Bay quarries are of superior quality, and the slates found in unlimited quantities on the shores of the Huron Bay are unsurpassed in point of durability and colour. Clay and sands of commercial value are found in great abundance. Though the manufacture of glass is yet in its infancy, sands in large quantities have been discovered in Wayne county suitable for the manufacture of plate glass of excellent quality. Brick and tile clays are found in all parts of the State. Though native silver has been found in small quantities in the Upper Peninsula, the systematic working of this metal has not yet been carried on with such results. The *Report* of the commissioner of mineral statistics for 1882 shows that, except as to coal, Michigan is the foremost of all the States in mineral wealth.

Fisheries.— The geographical position of Michigan explains the fact that its fresh-water fisheries are the most productive in the United States. The most important varieties of fish are lake

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, bass, pickerel, herring, brook-trout grayling, and white-
eneral laws for the protection of fish have been passed; and
ommission has been maintained for some years for the
of propagating the best varieties and planting them in
daptated to their natural development. Up to the close of
e commissioners had planted about 80,000,000 young white-
00,000 silver eels, 1,000,000 lake trout, 2,000,000 salmon,
,000 brook trout, besides smaller numbers of shad, grayling,
d bass. Excellent results have followed, especially in the
ation of white-fish, salmon and eels. In 1879 the total
was 21,913,100 lb, of which 2,902,250 lb were white-fish,
st valuable lake-fish known to epicures and to commerce.
winter large quantities preserved by freezing are taken to
markets, where they are readily sold at a high price.

ational Institutions. As early as 1785 the law of congress
rovided for the sale of land north of the Ohio river reserved
support of public schools "section 16" of each township.
ndamental law devoted to educational purposes one thirty
f all the lands of that vast domain known as the north-
territory. The "Ordinance of 1787," by which this
was organized, further provided that "school and the
of education shall for ever be encouraged." In 1826 this
eneral action was supplemented by a grant to Michigan of
nships of land for the founding and support of a university.
hen Michigan became a State in 1837, its educational policy took
form. The constitution provided, not only that the grant
tion 16" should be devoted exclusively to the support of
of the primary grade, but also that the State and not each
should be the custodian of the lands so appropriated.
stitution expressly provided that the proceeds from the
"school lands" should be held by the State as a perpetual
e interest of which should be annually applied to the sup
primary schools. The land devoted to school purposes in
n under these provisions amounted to 1,077,709 acres, of
n September 1881, 675,000 acres had been sold. On the
lized by these sales, $3,095,679, the State pays interest at
ent, and the resulting income, amounting to $216,645, is
distributed to the schools. This source is supplemented
al taxes, so that in 1881 the total sum realized from all
for the primary schools was $3,611,778.

chools organized under State law are known as graded and
l. In the small districts where the schools are under the
of but one or two teachers, grading is impracticable. Of
l districts there were in 1881 6170, attended by 215,570
, while the graded schools were 491 in number, with an
ce of 152,043. The school census includes all children
the ages of five and twenty, amounting in 1881 to 548,317, of
ere was an average attendance of 391,491. To all children
l age the public schools are free, though a fee may be re-
n advanced studies in the high schools. The immediate
tration of the schools is entrusted to school officers elected
by the tax payers of the individual districts. The State
tion requires that a free school shall be in session at least
onths of every year in each district. In districts of more
and less than 800 children, the law requires at least five
of school, while in districts of more than 800 children,
ion must be not less than nine months in length. In the
chools the division is into primary schools, grammar schools,
h schools, each of these divisions retaining the scholar
ly four years. At the end of the course the student is ready
university, to which, under certain restrictions provided by
self, he is admitted on diploma from the high
The university of Michigan, situated at Ann Arbor, was
ed for instruction in 1841. It now (1883) consists of the
ent of literature, science, and the arts, the department
ine, the department of law, the college of homœopathic
, the school of pharmacy, the college of dental surgery,
school of political science. Connected with the medical
ents are the State hospitals. In 1881-82 there were 86
of instruction and 1571 students. The total income for the
379 80 from Federal grant, State grants, and fees was
9. The general control of the university is placed in the
eight regents elected by popular suffrage at the biennial
elections, two regents being chosen at each election. The
school, situated at Ypsilanti, and generously supported by
e, may be said to complete the school system.

Public and Reformatory Institutions. A school for the deaf,
nd blind, instituted under an Act passed in 1848, is situated
, about 60 miles north-west of Detroit: in February 1882 it
9 pupils. In 1879 a distinct school for the training of the
as established at Lansing. The "State public school for
nt and neglected children" is devoted to the systematic
n of such children as otherwise would have to be maintained
ounty poorhouses. The pupils are divided into "families"
thirty each, and are cared for in separate cottages, each
being under the charge of a "cottage manager." The
eceives dependent children of sound health, and free from
contagious disease; and it is made the duty of the officers
charge of the poor to send all such children between the
three and twelve to it. This institution, the pioneer of i
and one of the most useful of charitable schools, is situated
water, 132 miles south-west of Detroit. In February 18
were 320 children and 21 officers and teachers. The "
School" at Lansing is designed to reclaim juvenile offend
have been convicted of some offence. A farm of 224 acres c
with the school is, in considerable part, tilled by the boy
number of inmates in February of 1882 was 325. A simila
at Adrian has recently been instituted for girls. There a
asylums for the insane at Kalamazoo (715 patients) and
(499 patients). The legislature of 1881 provided for the e
ment of an additional asylum in one of the northern counti
Lower Peninsula.

Population. In 1837 the State had 174,647 inhabitant
numbers according to the different census returns from 1
given in the following table:—

Years	Total			Density per Square
1840	212,267	113,588	98,479	
1850	397,654	209,897	187,757	
1860	749,113	394,694	354,419	12
1870	1,184,059	617,745	566,314	20
1880	1,636,937	862,678	774,259	

At the last census 388,508 of the inhabitants were of foreig
97,340 being natives of the United Kingdom, 89,085 Germa
16,115 Scandinavians. In point of population the State
was twenty-third in 1840, now stands ninth in the Union.

The following are the principal cities in the State, wit
lation at the census of 1880:—Detroit, 116,340; Grand Rap
32,016; Bay City, 20,693; East Saginaw City, 19,016;
City, 16,105; Muskegon City, 11,262; Saginaw City, 10,52
Huron, 8883, Flint City, 8410; Lansing (the State
8319; Ann Arbor, 8061, Adrian City, 7849; Battle Creek
Manistee, 6930; West Bay City, 6397; Alpena City
Ishpeming, 6039.

History and Government.—The State of Michigan is pa
territory that was first settled by the French, and until th
Canada into the hands of the British after the middle of
century was under the government of New France. The
was explored by Jesuit missionaries in the 17th centu
although it was known at an early period that the lan
of exceptional excellence, very little progress was made in
ing the resources of the territory until after the compl
the first half century of the American Union. The s
employed by the general government to inspect the lan
report as to their fitness for settlement by the soldiers of
of 1812 appear to have derived their impressions almost exc
from the low lands in the south-eastern corner of the territor
report, accordingly, was not favourable; and consequently
of immigration that had already begun to set in flowed
past Michigan into the territories farther west. It was la
this reason that the early development of Indiana, Illinoi
and Wisconsin was somewhat more rapid than that of M
But gradually the false impressions concerning the soil and
were dispelled; and within the past few years the increas
population and the growth of wealth have been very
In 1851 the valuation of the State for purposes of taxation
excludes much valuable property) was $30,976,270; i
$172,055,808; in 1871, $630,000,000; at 1881, $810,0
The State constitution, adopted in 1837 at the time of a
to the Union, has been modified in some minor particulars
most respects it remains unchanged. The governor is el
two years, with no restriction as to re-election. The le
meets biennially in the first week of January, and usually c
in session till May. The supreme court consists of four
chosen by popular vote for terms of eight years, one being
every second year. Judges have been so frequently re-elec
the office may be said to be practically a permanent one,
provision for termination in case of need. The State is divi
twenty-two judicial districts, in each of which a circuit cour
the trial of causes of original jurisdiction, and of causes
from the justice courts. The judges of the circuit courts
elected by popular suffrage. On political questions voting
to all naturalized citizens of the male sex more than two
years of age unless prevented by some natural disqualificati
school meetings the right of suffrage is extended so as to
tax-payers of either sex.

Authorities.—Frederick Morley, *Michigan and its Resources*, compi
authority of the State, 2d ed., Detroit, 1882; *Watling's Atlas of
with an Account of the Topography, Climate, and Geology of the State*
Winchell, LL.D; James V. Campbell, *Outlines of the Political
Michigan*; *Reports of the Secretary of the State Pomological Society of
from 1871 to 1880*; *Report of the Commissioner of Education for 1880*;

eport of the Superintendent of Public Instruction of the State of Michigan ear 1881; *Reports of the Geological Survey of the State of Michigan*, 4 vols.; *Special Report of Commissioner of Mineral Statistics*, March *restry Bulletins* for 1881. (C. K. A.)

CHIGAN, Lake. See St Lawrence.

CHIGAN CITY, a town of the United States, in e county, Indiana, on the south-east shore of Lake gan, 40 miles east-south-east of Chicago. As a ort and a junction for several railroads, it is a of considerable prosperity. It is the largest lumber t in the State, and one of the largest in the west, as numerous manufacturing establishments. The rn State prison (with 577 convicts at the close of is one of the principal buildings. The population sed from 3985 in 1870 to over 10,000 in 1883.

CHMASH (מִכְמָשׂ, מִכְמָס), the scene of one of the triking episodes in Old Testament history (1 Sam. comp. vol. xii. p. 403), was a place in Benjamin, 9 Roman miles north of Jerusalem (*Onom.*, ed. Lag., 0). Though it did not rank as a city (Josh. xviii.), Michmash was recolonized after the exile (Neh. xi. nd, favoured by the possession of excellent wheat *Mishna*, Men. viii. 1), was still a very large village ás) in the time of Eusebius. The modern Makhmas e a small place.

historical interest of Michmash is connected with the cal importance of the position, commanding the north side Pass of Michmash, which made it the headquarters of the nes and the centre of their forays in their attempt to quell t rising under Saul, as it was also at a later date the head- s of Jonathan the Hasmonæan (1 Mac. ix. 73). From en to Mount Ephraim there are two main routes. The pre- avan road keeps the high ground to the west near the water- nd avoids the Pass of Michmash altogether. But another he importance of which in antiquity may be judged of from 28 *sq.*, led southwards from Ai over an undulating plateau to ash. Thus far the road is easy, but at Michmash it descends very steep and rough valley, which has to be crossed before ding to Geba.[1] At the bottom of the valley is the Pass of ash, a noble gorge with precipitous craggy sides. O he crag is crowned by a sort of plateau sloping backwards ound-topped hill. This little plateau, a ut a mile east of esent village of Makhmás, seems to have been the post of ilistines, lying close to the centre of th insurrection, yet ing unusually good communication with their establishments nt Ephraim by way of Ai and Bethel, and at the same time nding the routes leading down to the Jordan from Ai and ichmash itself.

CKIEWICZ, Adam (1798–1855), Polish poet, was n 1798, near Nowogrodek, in the present government nsk, where his father, who belonged to the schlachta ser nobility, had a small property. The poet was ted at the university of Vilna; but, becoming ed in some political troubles there, he was forced minate his studies abruptly, and was ordered to live time in Russia. He had already published two small es of miscellaneous poetry at Vilna, which had been rably received by the Slavonic public, and on his l at St Petersburg he found himself admitted to the g literary circles, where he was a great favourite both his agreeable manners and his extraordinary talent provisation. In 1825 he visited the Crimea, which ed a collection of sonnets in which we may admire the elegance of the rhythm and the rich Oriental ring. The most beautiful are *The Storm*, *Bakchi-* and *Grave of the Countess Potocka*.

1828 appeared his *Konrad Wallenrod*, a narrative describing the battles of knights of the Teutonic with the heathen Lithuanians. Here, under a thin Mickiewicz represented the sanguinary passages of and burning hatred which had characterized the long of the Russians and Poles. The objects of the poem, gh evident to many, escaped the Russian censors, and it was suffered to appear, although the very n taken from Machiavelli, was significant: "Dovete adu sapere come sono duo generazioni da combattere bisogna essere volpe e leone." After a five years' ex Russia the poet obtained leave to travel: he had se made up his mind never to return to that country or l so long as it remained under the government o Muscovites. Wending his way to Weimar, he there the acquaintance of Goethe, who received him cord and, pursuing his journey through Germany, he en Italy by the Splügen, visited Milan, Venice, and Flo and finally took up his abode at Rome. There he the third part of his poem *Dziady*, the subject of wh the religious commemoration of their ancestors pra among Slavonic nations, and *Pan Tadeusz*, his l poem, by many considered his masterpiece. A gr picture is drawn of Lithuania on the eve of Napo expedition to Russia in 812. In 1832 Mickiewi Rome for Paris, where his life was for some time in poverty and unhappiness. He had married a lady, Selma Szymanowska, wh became insane. In he was appointed to th newly founded chair of Sla languages and literatu in the Collége de France, which he was especially qualified to fill, as he was the chief representative of Slavonic literature, Pou having died in 1837. He was, however, only destin hold it for a little more than three years, his last l having been given on the 28th of May 1844. His had become more and more disordered under the inf of religious mysticism. His lectures became a med religion and politics, and thus brought him under the c of the Government. A selection of them has been pub in four volumes. They contain some good sound crit but the philological part is very defective, for Mick was no scholar, and he is obviously only well acqu with two of the literatures, viz., Polish and Russia latter only till the year 1830. A very sad picture declining days of Mickiewicz is given in the memo Herzen. At a comparatively early period the unfor poet exhibited all the signs of premature old age; po despair, and domestic affliction had wrought their upon him. In 1849 he founded a French news *La Tribune des Peuples*, but it only existed a year. restoration of the French empire seemed to kind hopes afresh; his last composition is said to have Latin ode in honour of Napoleon III. On the ou of the Crimean War he was sent to Constantinople to in raising a regiment of Poles to take service again Russians. He died suddenly there in 1855, and his was removed to France and buried at Montmorency.

Mickiewicz is held to have been the greatest Slavonic poe the exception of Poushkin. Unfortunately in other parts of he is but little known; he writes in a very difficult langua one which it is not the fashion to learn. There were both and irony in the expression used by a Polish lady to a fo "Nous avons notre Mic ez à nous." He is one of the b nets of the so-called romantic school. The Poles ha roamed under the yoke of the classicists, and the country t legends and picturesque stories which only awaited the oet to put them into shape. Hence the great popularity his countrymen of his ballads, each of them being connect some national tradition. Besides *Konrad Walle* a *Tadeu* attention may be called to the poem *G* , desert the adventures o a Lithuanian chieftainess i Teuto knights. It is said by Ostrowski to have insp brave Emilia Plater, who was the heroine of th ellion and after having fought in the ranks of the insurgents, grave in the forests of Lithuania. A fine vigorous Oriental *Farys*. Very good too are the odes to Y uth and to t torian Lelewel; the former did much to stimulate the effort Poles to shake off their Russian conquerors. It is enough of Mickiewicz that he has obtained the proud position of th sentative poet of his country; her customs, her superstiti history, her struggles are reflected in his works.

[1] Isa. x. 28 describes the invader as leaving his heavy baggage hmash before pushing on through the pass.

KLE, William Julius (1734–1788), son of the
r of Langholm, Dumfriesshire, holds a respectable
mong the imitative minor poets of the 18th century.
rote a poem on *Knowledge*—carefully versified,
g a moral on the vanity of intellectual pride—
age of eighteen, entered into business as a brewer
father's request and against his own inclinations,
became bankrupt, went to London on outlook for
ts a man of letters, solicited patronage in vain,
a living hardly by writing for magazines, made
mpression in 1760 by "a poem in the manner of
r" called the *Concubine* (afterwards *Syr Martyn*),
pointed corrector to the Clarendon Press, and finally
place among the leading poets of that very barren
y a translation of the *Lusiad* of Camoens into heroic
ts (specimen published 1771, whole work 1775).
t was the repute of the work that when Mickle
ted secretary to Commodore Johnstone visited
in 1779 the king of Portugal gave him a public
on. As a translator of Camoens Mickle has been
ded, but he aimed, not at close rendering of the
l, but at making a poem which should be worthy of
nent place in English literature. This ambition
not capable of fulfilling, though he had great
and vigour. It may be doubted whether the
able forms which he imitated were the best suited
natural gifts. He shows delight in lively action, a
of dramatic effect, and, in the *Concubine*, the sub-
of which might have been conceived by Crabbe,
rable fulness of detail in coarse realistic painting.
ly, if the Scottish poem *There's nae luck about the*
as Mickle's, he mistook his medium. Scott read
mired Mickle's poems in his youth, and, besides
g *Kenilworth* on the ballad of *Cumnor Hall*, was a
al influenced by him in style. Mickle's prose is
nd vigorous.

ROMETER, an instrument generally applied to
es and microscopes for measuring small angular
s with the former or the dimensions of small
with the latter.

re the invention of the telescope the accuracy of
nical observations was necessarily limited by the
hat could be distinguished by the naked eye. The
etween two objects, such as stars or the opposite
of the sun, was measured by directing an arm
ed with fine "sights" (in the sense of the "sights"
e) first upon one of the objects and then upon the
er by employing an instrument having two arms
rnished with a pair of sights, and directing one
sights upon one object and the second pair upon
er. The angle through which the arm was moved,
he latter case, the angle between the two arms, was
f upon a finely graduated arc. With such means no
gh accuracy was possible. Archimedes concluded
s measurement that the sun's diameter was greater
7 and less than 32′; and even Tycho Brahe was so
by his measures of the apparent diameters of the
l moon as to conclude that a total eclipse of the sun
possible.[1] Maestlin in 1579 determined the relative
rs of eleven stars in the Pleiades (*Historia Cœlestis*
Baretti, Augsburg, 1666), and Winnecke has shown
ly Notices R. A. S., vol. xxxiv. p. 116) that the
le error of these measures amounted to about

The invention of the telescope at once extended
possibilities of accuracy in astronomical measurem
The planets were shown to have visible disks, and
attended by satellites whose distance and position
relative to the planet it was desirable to measure
became, in fact, essential to invent a "micrometer
measuring the small angles which were thus for the
time rendered sensible. There is now no doubt
William Gascoigne, a young gentleman of Yorkshire
the first inventor of the micrometer. Crabtree, a frie
his, taking a journey to Yorkshire in 1639 to see Gasc
writes thus to his friend Horrocks. "The first thin
Gascoigne showed me was a large telescope amplifie
adorned with inventions of his own, whereby he ca
the diameters of the sun and moon, or any small an
the heavens or upon the earth, most exactly throug
glass, to a second." The micrometer so mentione
into the possession of Mr Richard Townley of Lanca
who exhibited it at the meeting of the Royal Society
on the 25th July 1667.

The principle of Gascoigne's micrometer is tha
pointers, having parallel edges at right angles t
measuring screw, are moved in opposite directions
metrically with and at right angles to the axis
telescope. The micrometer is at zero when the two
are brought exactly together. The edges are then sepa
till they are tangent to the opposite limbs of the d
the planet to be measured, or till they respectively
two stars, the angle between which is to be deter
The symmetrical separation of the edges is produce
measured by a single screw; the fractions of a revo
of the screw are obtained by an index attached to on
of the screw, reading on a dial divided into 100
parts. The whole arrangement is elegant and inge
A steel cylinder (about the thickness of a goose-
which forms the micrometer screw, has two thread
upon it, one-half being cut with a thread double the
of the other. This screw is mounted on an oblong
which carries one of the measuring edges; the other
is moved by the coarser part of the screw relatively
edge attached to the box, whilst the box itself is m
relatively to the axis of the telescope by the finer
This produces an opening and closing of the
symmetrically with respect to the telescope axis.
steed, in the first volume of the *Historia Cœlesti*
inserted a series of measurements made by Gasc
extending from 1638 to 1643. These include the m
distances of some of the stars in the Pleiades, a few ob
tions of the apparent diameter of the sun, others
distance of the moon from neighbouring stars, and a
number of measurements of the diameter of the moon
Bevis (*Phil. Trans.*, 1773, p. 190) also gives resu
measurements by Gascoigne of the diameters of the
Jupiter, Mars, and Venus with his micrometer.

Delambre gives[3] the following comparison between t
sults of Gascoigne's measurements of the sun's semi-dia
and the computed results from modern determination

			Gascoigne.	*Conn. d. Te*
October	25 (o.s.)	.....	16′ 11″ or 10″	16′ 10″
,,	31	,, ...	16′ 11″	16′ 11″
December	2	,, ...	16′ 24″	16′ 16″

Gascoigne, from his observations, deduces the gr
variation of the apparent diameter of the sun to be
according to the *Connaissance des Temps* it amou
32″·3.[3] These results prove the enormous advance att
in accuracy by Gascoigne, and his indisputable title t
credit of inventing the micrometer.

Huygens, in his *Systema Saturnium* (1659), des
a micrometer with which he determined the app

[1] nt, *History of Physical Astronomy*, p. 449.
[2] is an astonishing accuracy when the difficulty of the objects
ered. Few persons can see with the naked eye—much less
—more than six stars of the Pleiades, although all the stars
by Maestlin have been seen with the naked eye by a few
ls of exceptional powers of eye-sight.

[3] Delambre, *Hist. Ast. Moderne*, vol. ii. p. 590.

diameters of the principal planets. He inserted a slip of metal, of variable breadth, at the focus of the telescope, and observed at what part it exactly covered the object under examination; knowing the focal length of the telescope and the width of the slip at the point observed, he thence deduced the apparent angular breadth of the object. The Marquis Malvasia in his *Ephemerides* (Bologna, 1662) describes a micrometer of his own invention. At the focus of his telescope he placed fine silver wires at right angles to each other, which, by their intersection, formed a network of small squares. The mutual distances of the intersecting wires he determined by counting, with the aid of a pendulum clock, the number of seconds required by an equatorial star to pass from web to web, while the telescope was adjusted so that the star ran parallel to the wires at right angles to those under investigation.[1] In the *Phil. Trans.*, 1667, No. 21, p. 373, Auzout gives the results of some measures of the diameter of the sun and moon made by himself, and this communication led to the letters of Mr Townley and Dr Bevis above referred to. The micrometer of Auzout and Picard was provided with silk fibres or silver wires instead of the edges of Gascoigne, but one of the silk fibres remained fixed while the other was moved by a screw. It is beyond doubt that Huygens independently discovered that an object placed in the common focus of the two lenses of a Kepler telescope appears as distinct and well defined as the image of a distant body; and the micrometers of Malvasia, Auzout, and Picard are the natural developments of this discovery. Gascoigne was killed at the battle of Marston Moor on the 2d July 1644, in the twenty fourth year of his age, and his untimely death was doubtless the cause that delayed the publication of a discovery which anticipated, by twenty years, the combined work of Huygens, Malvaison, Auzout, and Picard in the same direction.

As the powers of the telescope were gradually developed, it was found that the finest hairs or filaments of silk, or the thinnest silver wires that could be drawn, were much too thick for the refined purposes of the astronomer, as they entirely obliterated the image of a star in the more powerful telescopes. To obviate this difficulty Professor Felice Fontana of Florence (*Saggio del real gabinetto di fisica e di storia naturale*, 1755) first proposed the use of spider webs in micrometers,[2] but it was not till the attention of Troughton had been directed to the subject by Rittenhouse that the idea was carried into practice.[3] In 1813 Wollaston proposed fine platinum wires, prepared by surrounding a platinum wire with a cylinder of silver, and drawing out the cylinder with its platinum axis into a fine wire.[4] The surrounding silver was then dissolved by nitric acid, and a platinum wire of extreme fineness remained. But experience soon proved the superiority of the spider web; its perfection of shape, its lightness and elasticity, have led to its universal adoption.

Beyond the introduction of the spider line it is unnecessary to mention the various steps by which the Gascoigne micrometer assumed the modern forms now in use, or to describe in detail the suggestions of Hooke,[5] Wren, Smeaton, Cassini, Bradley, Maskelyne, Herschel, Arago, Pearson, Bessel, Struve, Dawes, &c., or the successive productions of the great artists Ramsden, Troughton, Fraunhofer, Ertel, Simms, Cooke, Grubb, Clarke, and Repsold. It will be sufficient to describe those forms with which the most important work has been done, or which have survived the tests of time and experience.

Before astronomical telescopes were mounted parallactically, the measurement of position angles was seldom attempted. Indeed in those days, the difficulties attached to such measures, and to the measurement of distances with the filar micrometer, were exceedingly great, and must have taxed to the utmost the skill and patience of the observer. For, on account of the diurnal motion, the direction of the axis of the telescope when directed to a star is always changing, so that, to follow a star with an altazimuth mounting the observer requires to move continuously the two handles which give slow motion in altitude and azimuth.

Sir William Herschel was the first astronomer who measured position angles, the instrument he employed is described in *Phil. Trans.*, 1781, vol. lxxi. p. 500. It was used by him in his earliest observations of double stars (1779-83); but, even in his matchless hands, the measurements were comparatively crude, because of the difficulties he had to encounter from the want of a parallactic mounting. In the case of close double stars he estimated the distance in terms of the disk of the components. For the measurement of wider stars he invented his lamp micrometer, in which the components of a double star observed with the right eye were made to coincide with two lucid points placed 10 feet from the left eye. The distance of the lucid points was the tangent of the magnified angles subtended by the stars to a radius of 10 feet. This angle, therefore, divided by the magnifying power of the telescope gives the real angular distance of the centres of a double star. With a power of 460 the scale was a quarter of an inch for every second.

The Modern Filar Micrometer.

When equatorial mountings for telescopes became more general no filar micrometer was considered complete which was not fitted with a position circle.[6] The use of the spider line or filar micrometer became universal, the methods of illumination were improved; and micrometers with screws of previously unheard-of fineness and accuracy were produced. These facilities, coupled with the wide and fascinating field of research opened up by Sir William Herschel's discovery of the binary character of double stars, gave an impulse to micrometric research which has continued unabated to the present time. A still further facility was given to the use of the filar micrometer by the introduction of clock work, which caused the telescope automatically to follow the diurnal motion of a star, and left the observer's hands entirely at liberty.[7]

The modern filar micrometer has now assumed forms of five types.

Type A.—Micrometers in which there are two webs, each movable by a fine screw with a divided head. This is the usual English form of filar micrometer.

Type B.—Micrometers in which one web is movable by means of a fine screw with a divided head, and the other by a screw without a divided head. The latter screw, in ordinary use, is only employed to change the coincidence reading of the two webs, for eliminating the errors of the micrometer screw. This is the ordinary German form of micrometer as originally made by Fraunhofer and since by Merz, and employed by the Struves and other principal Continental astronomers down to the present day.

Type C.—A similar form of micrometer to B, except that the coincidence-point cannot be changed,—there being no second screw to alter the position of the fixed web.

Type D.—A micrometer somewhat similar in general construction to form B, except that, in addition to means of changing the zero point, there is a screw head by which a fine movement can be given to the whole micrometer box, in the direction of the axis of the micrometer screw. This is the modern form of micrometer as constructed by Repsold.

Type E.—Micrometers fitted with two eye-pieces for measuring angles larger than the field of view of an ordinary eye-piece.

The micrometer of type A is due to Troughton; it is represented in figs. 1, 2, 3. Fig. 1 is a horizontal section in the direction of the axis of the telescope. The eye-piece *ab* consists of two plano-convex lenses *a*, *b*, of nearly the same focal length, and with the two

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[1] *Mém. Acad. des Sciences*, 1717, p. 78 *sq.*

[2] In 1782 (*Phil. Trans.*, vol. lxxii. p. 163) Sir W. Herschel writes:—"I have in vain attempted to find lines sufficiently thin to extend them across the centres of the stars, so that their thickness might be neglected." It is a matter of regret that Fontana's suggestion was unknown to him.

[3] Quekett in his *Treatise on the Microscope* ascribes to Ramsden the practical introduction of the spider web in micrometers. The evidence appears to be in favour of Troughton.

[4] *Phil. Trans.*, 1813, pp. 114-118.

[5] Dr Hooke made the important improvement on Gascoigne's micrometer of substituting parallel *hairs* for the parallel edges of its original construction (Hooke's *Posthumous Works*, p. 497).

[6] Herschel and South (*Phil. Trans.*, 1824, part iii. p. 10) claim that the micrometer by Troughton, fitted to their 5 feet equatorial telescope, is the first position micrometer constructed capable of measuring position angles to 1′ of arc.

[7] So far as we can ascertain the first telescope of large size driven by clockwork was the 9 inch equatorial made for Struve at Dorpat by Fraunhofer; it was completed in 1825. The original idea appears to be due to Passement (*Mém. Acad.*, Paris, 1746). In 1757 he presented a telescope to the king, so accurately driven by clockwork that it would follow a star all night long.

sides facing each other. They are placed at a distance apart n the focal length of *o*, so that the wires of the micrometer, nust be distinctly seen, are beyond *b*. The eye piece slides e tube *cd*, which screws into the brass ring *cl*, through nings in which the oblong frame, containing the micrometer passes. These slides are shown in fig. 2, and consist of rks *k* and *l*, into which the ends of the screws *o* and *p* are fitted. The slides are accurately fitted so as to have no lateral shake, but yet so as to move easily in the direction greatest length of the micrometer box. Motion is communi- the forks by female screws tapped in the heads *m* and *n*

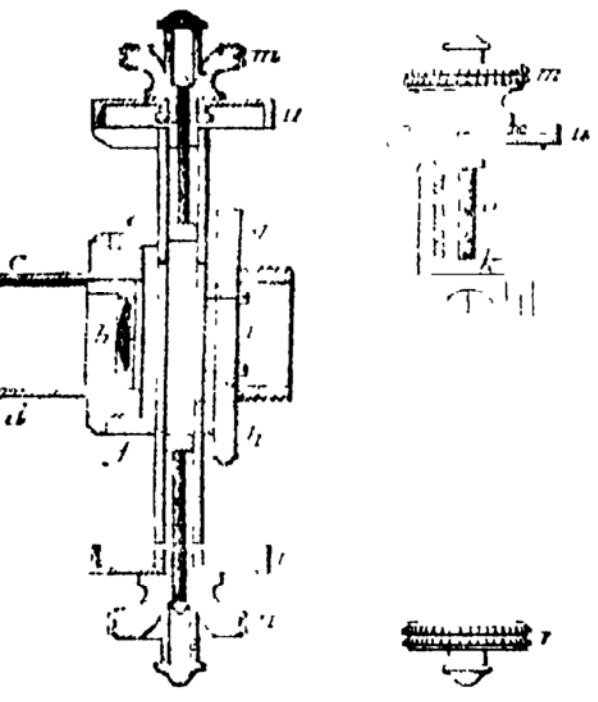
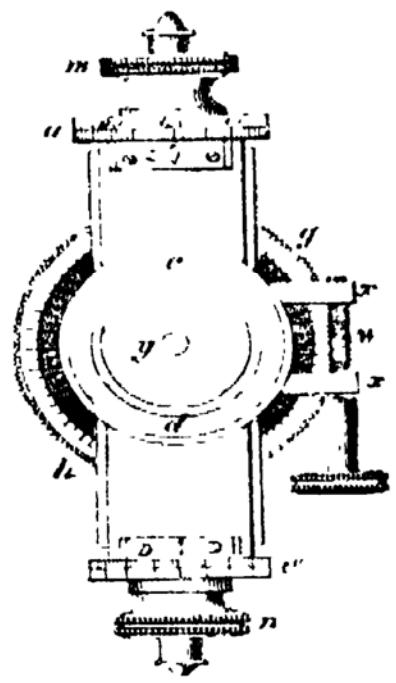


Fig. 1.

Fig. 3



on the screws *o* and *p* respectively. Two pins *a*, *a*, with springs coiled round them, pass loosely through holes in the *l*, and keep the bearings of the heads *m* and *n* firmly against the ends of the micrometer box. Thus the smallest of either head communicates to the corresponding slide mo- nch, if the screws are accurate, is proportional to the amount which the head is turned. Each head is graduated into al parts on the drums *r* and *s*, so that, by estimation, the can easily be carried to $\frac{1}{1000}$th of a revolution. The total of revolutions is read off by a scale attached to the side of but not seen in the figure.

spider webs are stretched across the forks, one (*v*) being d in a fine groove cut in the inner fork *k*, the other (*w*) in a groove cut in the outer fork *l*. These grooves are simultane- t *in situ* by the maker, with the end of an engine capable fine straight line, so that the webs when accurately laid rooves are perfectly parallel. A wire *xx* is stretched across re of the field, perpendicular to the parallel wires. Each web must pass the other without coming in contact with fixed wire, and without rubbing on any part of the brass. Should either fault occur (technically called "fiddling") it o accurate measurement. One of the most essential points od micrometers is that all the webs shall be so nearly in the ne as to be well in focus together under the highest powers d at the same time absolutely free from "fiddling." For ng position angles a brass circle *qh* (fig. 3, fixed to the tele- the screw *z*, has rack teeth on its circumference that receive n of an endless screw *w*, which, being fixed by the arms *xx* blong box *mn*, gives the latter a motion of rotation round of the telescope, an index upon this box points out on uated circle *m* the angular rotation of the instrument

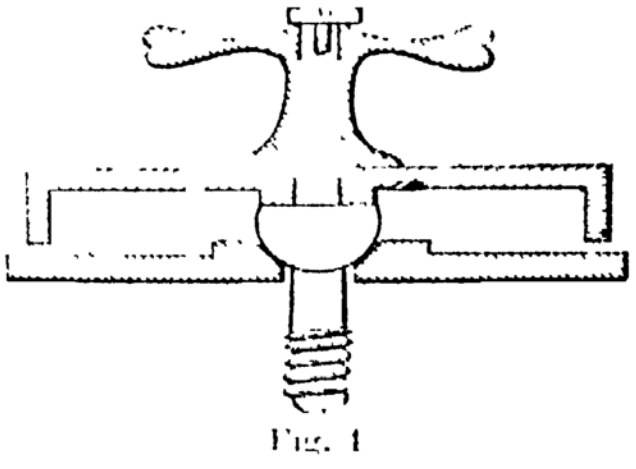


Fig. 4

ngle micrometer still be essential feature of on's general construc- ove described. The English artists have ot changed the mode communicating motion to les, by attaching the permanently to th eter head and tappin crometer screw into . Instead of making ulder of the screw a ing surface, they have e screw a spherical bearing resting in a hollow cone (fig. ed to the end of the box. The French artists still retain on's form. Simms, Troughton's successors, and Cooke (of or symmetry and more effectual elimination of "the loss of alled by the Germans "todter Gang," and sometimes in "back-lash"), have provided two pins with spiral springs, like *q* and *r* (fig. 2), one on each side of the screw which each slide.

Grubb of Dublin, with the intention of avoiding the vari pressure exerted by the spiral springs when the slide is at distances from the head of the screw, has adopted the following plan. Where the screw enters the slide he has a nut *n* attached to a strong spring *pp* (fig. 5), the pressure of which exerts a constant tension in the axis of the screw, tending to bring the threads into close contact, in opposite directions, with their bearings in the nut *n* and the slide *q*. The pressure of this spring is regulated by the screws *s*, *s*, tapped into the thickened ends of the springs. For maintaining the spherical shoulder of the screw in close and constant pressure on its conical bearing he has attached a conical bearing to the spring *p'p'* (fig. 6). The pressure of this on the upper part of the spherical shoulder is regulated by the screws *s'*, *s'*, passing through elongated holes in the spring *p'p'*, and tapped into the end of the box.

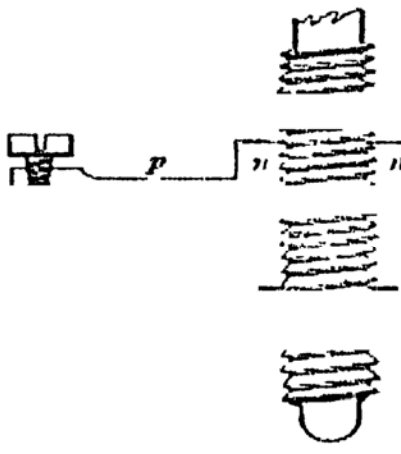


Fig. 5.

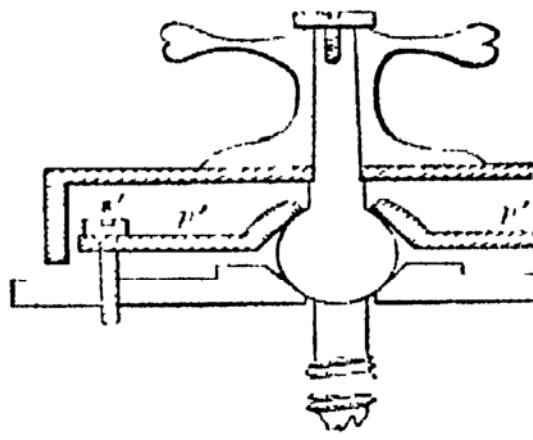


Fig. 6.

The screws of micrometers are generally made with 50 threads to the inch. Troughton's method of reading the of whole revolutions by a silver scale is inconvenient, becau or even $\frac{1}{50}$th of an inch is too small a quantity to read eas the naked eye, especially with the faint illumination t desirable to use when measuring faint objects. Different r including the "comb" (see below) and various kinds of "co have been introduced with more or less success; but rece Repsolds of Hamburg have contrived a plan at once so ample and so efficient that it will be unnecessary to describe those methods which this plan is certain to supersede (see below, type D). Grubb has introduced a modification in the form of the slides with a view to avoid the friction of one slide aga other. On the inner side of the brass plate which forms the of the box *cc*, the side opposite to the eye-piece) four V furrows are placed (fig. 7); and at each end of the slides junctions (fig. 8, end view) which fit into these furrows. T are kept down in their places by springs attached to them press upon the inner side of the lid of the box.

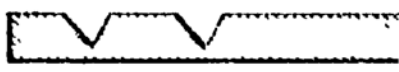


Fig. 7.

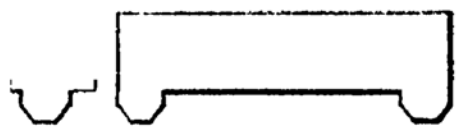


Fig. 8.

Troughton's mode of giving rotation to the position circl abandoned. A much quicker motion in position angle t be obtained without slow motion is often desirable, s observing very close double stars, the uncertainty of each ing may amount to several degrees in the most accurate ments. The plan of a pinion working in a toothed v often employed, but that also is too slow. Most moder meters are now fitted with a clamp and slow motion screw 9, type B). This permits observation of position angles close objects by simple rotation of the box with the hand; w slow motion, after clamping, permits the more delicate mo that are required in measuring the position angle of objects apart.

The Cookes and Grubb have for years almost invariab ferred the position circle from the micrometer to the telesco The whole eye-end with its focussing arrangements rotates, rotation can be measured by a circle attached to the but the tube. There is considerable convenience in this arran One position circle only is required for all the micromet may be employed with the instrument; and the orient reticulated diaphragms, or the adjustment of the directio slit of a spectroscope, may also be accomplished by the sam But, after a very extended experience of all the various existing mountings, the present writer does not hesitate to decided preference for a position circle attached to the micro a rigid attachment of the eye-end to the telescope tube,—havi seen an eye-end attached to a position circle on the butt e telescope-tube in which, after the wear and tear of a fe

, is known as Ramsden's eye-piece, it was made originally by him.

some looseness or shake could not be detected. This is a fatal fault, especially in those delicate observations of difference of declination which have latterly formed so prominent a feature in refined micrometric research. On the other hand, in some good old micrometers at the Royal Observatory, Cape of Good Hope, that are fitted with attached position circles, there is no trace of shake or wear after fifty years of work.

The micrometer of type B represented in fig. 9[1] is the original Merz micrometer of the Cape Observatory, made on Fraunhofer's model. S is the head of the micrometer screw proper, s that of the screw moving the slide to which the so-called "fixed web" is attached, *s'* that of a screw which moves the eye-piece E. C is the clamp and M the slow motion in position angle. L, L are tubes attached to a larger tube N; the latter fits loosely on a strong hollow cylinder which terminates in the screw V. By this screw the whole apparatus is attached to the telescope. The

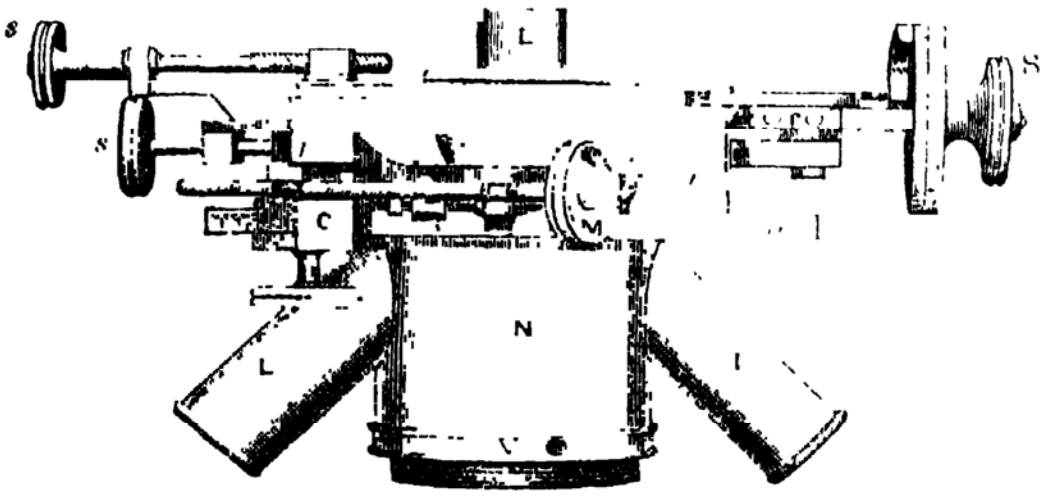


Fig. 9.

nozzles of small lamps are inserted in the tubes L, L, for illuminating the webs in a dark field; the light from the lamps is admitted through apertures in the strong hollow cylinder above mentioned (for illumination, see below). In this micrometer the three slides moved by S, *s*, and *s'* are simple dovetail. The lowest of these slides reposes upon a foundation-plate *pp*, into one end of which the screw *s* is tapped. In the middle of this slide a stiffly fitting brass disk is inserted, to which a small turn-table motion may be communicated by an attached arm, acted on by two fine opposing screws accessible to the astronomer; and by their means the "fixed wire" may be rendered strictly parallel with the movable wire.

The micrometer screw is mounted on the slide which carries the movable web. Fig. 10 shows a plan of this slide; the divided drum of the screw is omitted for sake of clearness. The screw S has a shoulder at *κ*, carefully fitted and ground to a bearing so as to work sweetly in a hole in the very strong spring *σσ*; the other extremity of the screw is formed into a pivot, which fits a hole in the brass piece *ββ*. The end of this pivot, hardened, polished, and slightly rounded—rests on the flat surface of an agate *a*, which is imbedded in the end of the slide, and kept firmly in its place by the brass piece *ββ*. By careful adjustment of the screws *θ*, *θ* sufficient pressure may be left upon *κ* to slightly bend the strong spring *σσ* and thus eliminate all end-shake without preventing easy action of the screw. The screw passes at the same time through the bush B (shown in plan and elevation, fig. 10) attached to *pp* (fig. 9); and there is a fine saw cut, which can be narrowed by the small screw *τ*, to close the bush upon the micrometer screw with a view of preventing "loss of time." The spider web *ω* is cemented on the further side of the thin plate *νννν*, the varnish being applied in the countersunk holes shown by the dotted circles *μ*, *μ*. The slide is countersunk to about half its thickness within the area indicated by *oooo*, in order to allow the adapter of the eye-piece to come sufficiently close to the webs. The eye-piece was originally moved by a pinion working in a rack *r* (fig. 9); but the screw *s'* applied by Simms was found by Maclear to be more convenient for the purpose. Beyond this, and the graduation of the edge of the circle with more strongly cut divisions than those originally engraved on the face of the circle, the instrument remains and is figured in its original form. Pistor and Martius (Berlin) have also made excellent instruments of the above type. There is a celebrated micrometer of their make, with which, in the hands of Brunnow at Dunsink (Dublin), some of the most perfect and refined investigations ever made in practical

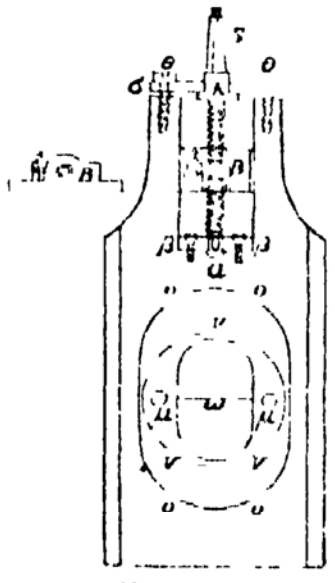


Fig. 10.

[1] When it is remembered that the measurements of the Struves, Dembowski, Secchi, the Bonds, Maclear, and of most modern Continental astronomers have been made with Fraunhofer or Merz micrometers, it is not too much to say that fig. 9 represents the instrument with which three-fourths of the astronomical measurements of the last fifty years have been made.

astronomy have been executed. In this micrometer the screw s mounted on its own slide and has a divided head precisely l the screw S (fig. 9). The plate *pp* is elongated towards s, and corresponding bush B is attached to this elongation. The screw is shifted to another part of the eye-piece slide, so that it does interfere with the increased diameter of the screw *s*. Fraunhofer micrometer in this form belongs to type A, but is quoted un type B for convenience of description.

It is not necessary to give a figure representing type C. Su micrometers have been generally constructed on Troughton's ty (figs. 1, 2, 3) with the omission of one of the screws, and w one or more of the modifications described in detail under type Some have also been made similar otherwise to the Fraunhofer c struction, by omitting the screw *s* with its corresponding sl and attaching the fixed wire to a circular plate in *pp*.

Good instruments have been made on type C by Clark (Cambrid Massachusetts), by Stemheil (Munich), and by the great Fren artists Secretan, Froment, Brunner, Eichens; and good work has be done with them. But it is necessary that the errors of the scr should be very carefully determined, since, in type C, such erro cannot be eliminated by employing different parts of the screw measure the same angle. There is a noteworthy description micrometer that forms a link between types C and D, of which t most famous example (by Clark) is attached to the great Washin ton telescope. It is essentially a micrometer of type C, with a sli (or fork) and a screw of the English form of construction. But t instrument is provided with a screw as at *s* (fig. 9), which, inste of changing the position of the fixed wire, moves the whole micr meter box in the direction of the axis of the measuring-screw. Th the fixed wire can be set exactly on one star by the screw *s* wh the other star is immediately afterwards bisected by the moval wire, and that without disturbing the reading for correction of the wires. No one, unless he has previously worked with such an arrangement, can fully appreciate the advantage of bri ing up a star to bisection by the fixed wire by moving the microme box with a delicate screw motion, instead of having to change t direction of the axis of a huge telescope for the same purpo When it is further remembered that the earlier telescopes were provided with the modern slow motions in right ascension, a that the Struves, in their gigantic labours among the double sta used to complete their bisections on the fixed wire by a pressure the finger on the side of the tube, one is puzzled whether most wonder at the poor adaptation of means to ends or the marvell patience and skill which, with such means, led to such results." should be added that Dawes practically adopted a modification Clark's micrometer by using a slipping piece, and bolting one the heads of his micrometer (*Mem. R. A. S.*, vol. xxxv. p. 13 His slipping piece gave motion to the micrometer by two slid one in right ascension the other in declination, so that "either the webs can be placed upon either of the components of a doub star with ease and certainty."

All micrometers used, in conjunction with a micro-scope, for re ing the divisions of transit circles, heliometer scales, &c., are of t type C. The reading micrometer is shown in fig. 11. C is t objective, D the micrometer box, E the gra nated head of the screw, G the milled he by which the screw *c* is turned, A an ey piece sliding in a tube B, *aa* (fig. 12) the sli

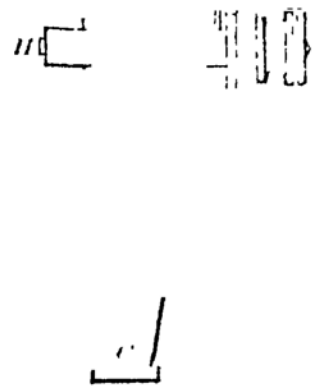


Fig. 11.

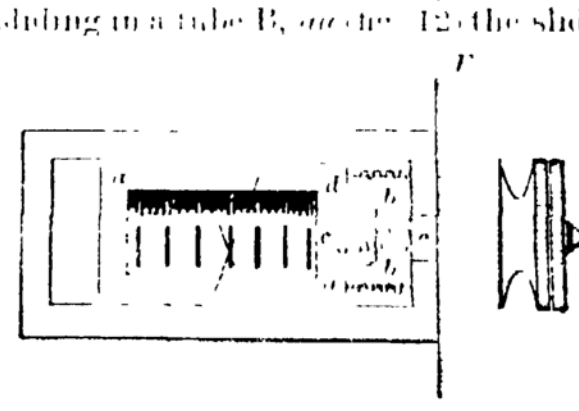


Fig. 12.

and *b*, *b* the spiral springs. The focal length of the objec and the distance between the optical centre of the lens and webs are so arranged that images of the divisions are formed the plane of the webs, and the pitch of the screw is such that division of the scale corresponds with some whole number of volutions of the screw.

There is what is technically called a "comb" inserted in t micrometer box at *d* (fig. 12),- its upper surface being nearly in plane of the wires. This comb does not move with reference to box, and serves to indicate the whole revolution of which a fracti is read on the head. In fig. 12 a division is represented bisected cross webs, and five revolutions of the screw correspond with division of the scale. In all modern reading micrometers the cr webs of fig. 12 are replaced by parallel webs embracing the divis

[2] The late Professor Watson used to say quaintly and with truth, "After the best part of the micrometer is the man at the small end!"

g. 13). The means for changing the length of the tube and the stance of C from the scale are omitted in the figure. These appli-nces are required if the "run" has to be accurately ljusted. By "run" is meant the difference between the ntended whole number of screw-revolutions and the etual measure of the space between two adjacent di-isions of the scale in turns of the screw divided by the umber of intended revolutions. In delicate researches wo divisions of the scale should always be read, not merely for increased accuracy but to obtain the corrections for "run" from the observations themselv

Fig. 13.

Fig. 14 represents an important type of reading micrometer by the Repsolds. Here the web-frame r mounted on the screw itself The muting plane of motion is at p, where the end of the micrometer crew bears upon the hardened flattened end of the screw s, and is ept in bearing against this plane by the spiral spring q Rotation

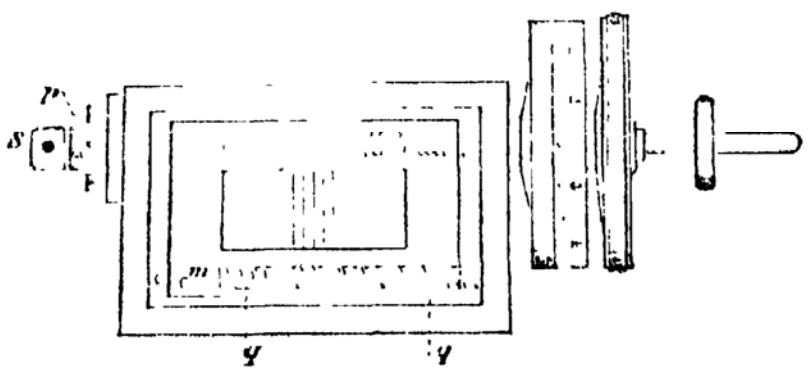


Fig. 14.

f the wire-frame is prevented by the small stud m which passes nough the web frame and projects slightly on both sides of it, st barely touching the inner surfaces of the top and bottom of the icrometer box. The web-frame thus rests solely on the screw and n the point m, and therefore follows it absolutely and accurately.

The comparative merits of the various micrometers are discussed y Lord Lindsay and Mr Gill (*Dunecht Publications*, vol. ii. pp. 3–55, 1877). If the screw of the Repsold micrometer is bent, so hat, for example, the end of the frame next the screw head is raised nd that next the end p lowered, a twist will be given to the web-ame, and the centre of the wire will be moved nearer to the micro-eter head than it should be, while the reverse effect will follow when he head has been turned through 180°. The effect of a similar rror on the other micrometers described would be of a much less mount. They are, however, liable to errors of another character , as in Troughton's original micrometer, the shoulder is square, he hole in the end of the box may be left sufficiently wide to allow or a small error in the parallelism of the screw matrix with the otion of the slide, but the smallest bend in the screw causes the houlder no longer to bear flat, but to ride on its edge, thus intro-ucing an extremely uncertain form of error. If the shoulder is pherical, fitting into a hollow cone on the end of the box, as in the icrometers of Simms, Cooke, and Grubb, an almost inconceivable ccuracy of construction is implied in drilling the matrix of the crew in the slide so that its axis and that of the cone shall be in he same straight line, and both parallel to the motion of a point n the slide. Any departure from perfect accuracy in this respect as the effect of bringing different portions of the spherical boulder o bear on different parts of the cone for different revolutions, and ntroduces errors of a character by no means easy to deal with. In ddition to these objections there always is the greater objection f employing as a delicate contact-measuring surface one that is xposed where oil is used. Dust and oil will arrange themselves in ayers of variable and uncertain thickness and defeat all attempts o secure absolutely consistent results. In Repsold's micrometer he *point d'appui* is a small hardened and polished bearing, requir-ng little lubrication, and perfectly protected from dust, the errors f the screw (some of them exaggerated, certainly) are faithfully eproduced, and consequently determinable, and beyond this the ork to be done by the screw is reduced to a minimum,—no slide-iction having to be overcome. If we are to regard as the most erfect instrument, "not that which has absolutely the smallest rrors, but that which reproduces its errors with the most perfect onsistency," undoubtedly Repsold's form of micrometer is best.

In order to avoid the examination of the screw-errors produced y the non-symmetrical portion of the screw in Repsold's micro-eter, Stone, in December 1879, exhibited at the Royal Astronomical ociety, and described (*Monthly Notices*, p. 240), a modification of epsold's instrument. But, both in his statement of the comparative erits of the Troughton and Repsold micrometers and in the ew form which he figures, Stone overlooks a strong point in the Rep-old form, and in that proposed by Lord Lindsay and Gill three years reviously,[1]—namely, the avoidance of all friction of the slide, and he elimination of all error or strain that may occur from a want of arallelism in the axis of the matrix and the motion of the slide. he Lindsay-Gill micrometer will be better understood from the ollowing description. In fig. 15 Ss is the micrometer screw, its

[1] *Dunecht Publications*, vol. ii., footnote p. 55, Dunecht, 1877.

cylindrical axis is nicely ground to fit a hole in the side of the box at a;[2] the same axis, but ground to a somewhat smaller cylinder, fits neatly but smoothly a hole in the web-frame at b. A screw, cut on the same axis, is tapped into the web-frame at s, and the axis terminates in a pivot which fits a hole in a brass plate cc. The end of the pivot—hardened and slightly rounded rests on a flat agate[3] bearing a, which is imbedded in the plate B, and securely held *in situ* by pressure of the plate cc. The plate B is firmly attached to the bottom of the box. q, q are spiral springs mounted on pins. Both springs and pin pass freely through the web-frame at p, p, and the pins (but not the springs) pass freely through the frame at n, n.[4] The parallel webs for observing the division (fig. 13) are mounted on the forked end of the frame at ww.

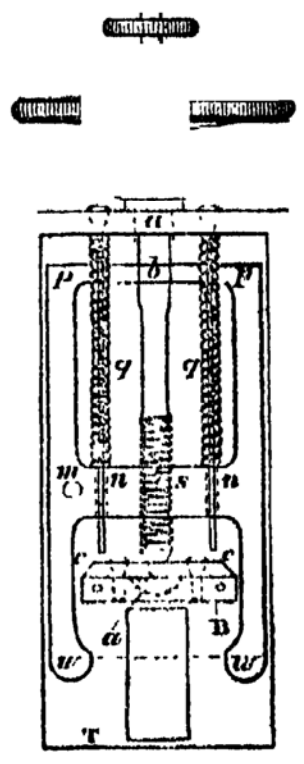
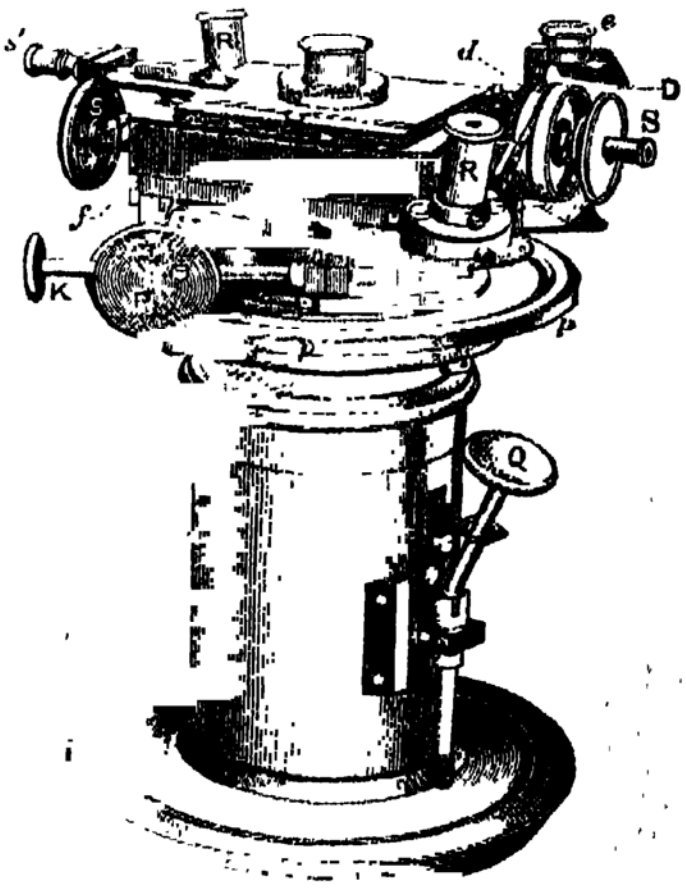


Fig. 15.

The web-frame is narrower and thinner than the breadth and height of the interior of the box, and is only prevented from rotating by the delicate touch of the projecting ends of the pin m on the inner surfaces of the top and bottom of the box. It appears that a frame so mounted fulfils all theoretical conditions of accuracy. It is perfectly free to follow the motion of the screw and accurately to reproduce its errors, notwithstanding any reasonable faults of workmanship; and no permissible shake or fouling of the bearing at a can produce sensible error in the distance between the bearing surface of the agate plane and the spider webs. The motion is produced with the minimum of friction; and the "feel" of the screw is therefore as delicate and perfect as it is possible to make it.

The micrometer of type D shown in fig. 16 has recently been made by the Repsolds for the Cape Observatory. As this instrument combines all their most recent modifications, we describe it in detail. Fig. 17 represents the same micrometer with the upper side of the box removed. The letters in the description refer to both figures.



S is the head of the micrometer screw, s that of the screw by which the micrometer box is moved relative to the plate f (fig. 16), s' that of the screw which moves the eye-piece slide. K is the clamp in position angle, P the slow motion screw in position angle; pp is the position circle, R, R its two readers. The latter are in fact little microscopes carrying a vernier etched on glass, in lieu of a filar micrometer. These verniers can be read to 1′, and estimated to 0′·2. D is the drum-head which gives the fraction of a revolution, d that which gives the whole number of revolutions, I is the index or pointer at which both drums are read. This index is shown in fig. 17, but only its mode of attachment (X, fig. 17) in fig. 16. The teeth of the pinion z, fig. 17, are cut on the axis of the micrometer screw. The drum d and its attached toothed wheel are ground to turn smoothly on the axis of the screw. The pinion z and the toothed wheel d are connected by an intermediate wheel and pinion Y; the numbers of teeth in the wheels and pinions are so proportioned that twenty-four revolutions of the micrometer screw produce one revolution of the drum and wheel d. (This is the description of Repsold's counter referred to under type A.) The divisions of both drums are conveniently read, simultaneously, by

[2] There would be some advantage in allowing the screw's axis to pass with a little shake through the hole in the end of the box at a, and then, extending the length of the larger cylinder, transfer the bearing from a to a well-fitting hole in a piece fixed like B to the bottom of the box. This form would also give some facilities of construction, and all the oiled surfaces would be perfectly protected.

[3] Sapphire is better; the agate bearing of such a screw has been found very sensibly worn.

[4] If it is desired to prevent possible contact of these pins with the frame, the ends of the pins may be made to enter guiding holes in cc.

the lens e; at night the lamp which illuminates the webs and the position circle also illuminates the drum-heads (see on illumination below). $\alpha\alpha\alpha\alpha$ is the web-frame (fig. 17), $\beta\gamma$ is a single rod consisting of two cylinders accurately fitting in the ends of the micrometer box, the larger cylinder being at β. There is a hole in the web-frame which smoothly fits the larger cylinder at β', and another which similarly fits the smaller cylinder at γ'. A spiral spring, coiled round the cylinder γ, resting one end on the shoulder formed by the difference of the diameters of the cylinders β and γ and the other on the inside of the web-frame, presses the latter continuously towards γ. Contact of the web-frame of the micrometer with the side of the box at γ would therefore take place, were it not for the micrometer screw. This screw fits neatly in the end of the box at ϵ, passes loosely through the web frame at ϵ', is tapped into the frame at ζ', and its end rests on a flat hardened surface at ζ. Rotation of the web-frame about $\beta\gamma$ is prevented by the heads of the screws at m; the head of the screw on the lower side of the frame reposes on the plane $\nu\nu$, that on the upper side (fig. 17) touches lightly on the inner surface of the lid of the box. Such rotation can obviously be controlled within limits that need not be further considered. But freedom of rotation in the plane of the paper

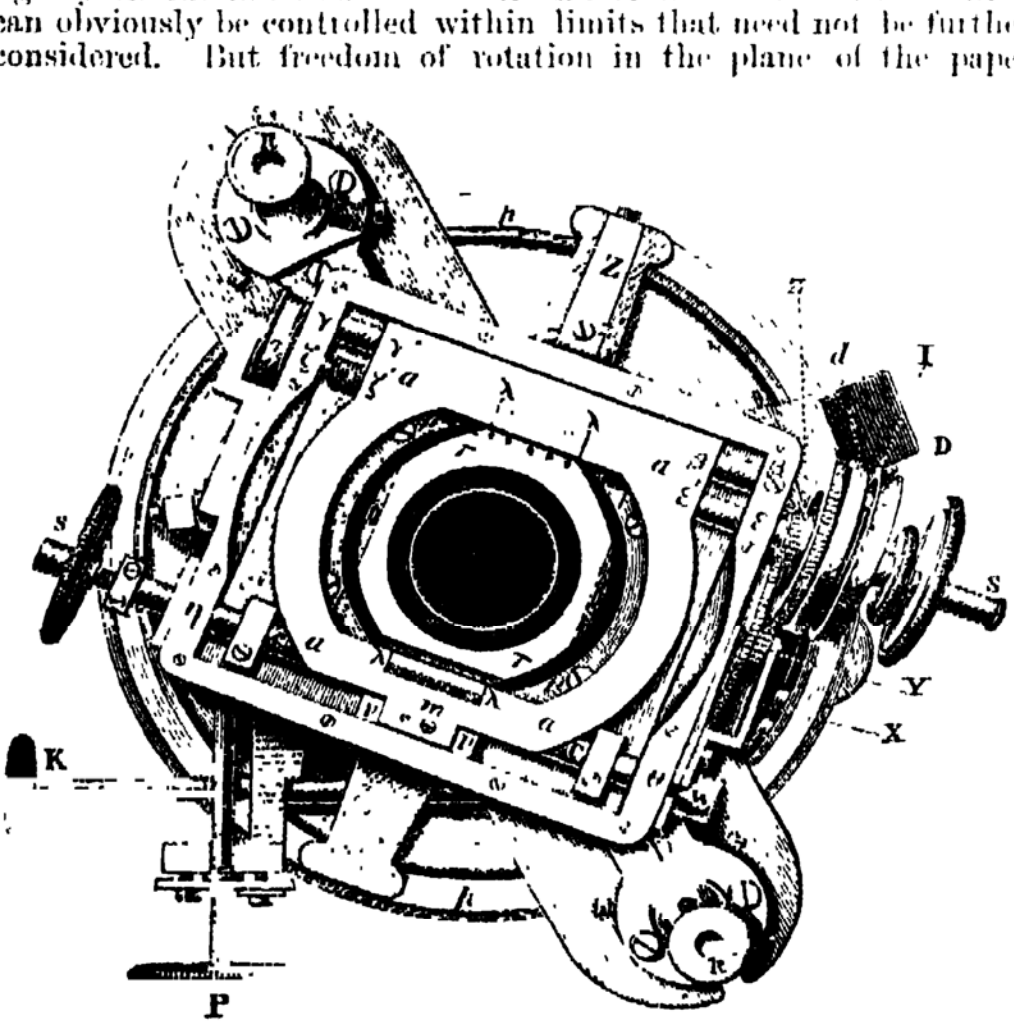


Fig. 17.

(fig. 17) is only prevented by good fitting of the holes β', γ'; and, since the weight of the slide is on one side of the screw, misfit here will have the effect of changing the reading for coincidence of the movable with the fixed web in reverse positions of the micrometer. With the Cape micrometer a systematic difference has been found in the coincidence point for head above and head below amounting to 0″·14. This corresponds, in the Cape instrument, with an excess of the diameters of the holes over those of the cylinders of about $\frac{1}{1000}$th of an inch,—a quantity so small as to imply good workmanship, though it involves a systematic error which is very much larger than the probable error of a single determination of the coincidence point. The obvious remedy is to make all measures on opposite sides of the fixed web before reversing in position angle,—a precaution, however, which no careful observer would neglect. In measuring differences of declination, where the stars are brought up by the diurnal motion, this precaution cannot be adopted, because it is necessary always to bisect the preceding star with the fixed web. But in $\Delta\delta$ measures index error can always be eliminated by bisecting both stars with the same web (or different webs of known interval fixed on the same frame), and not employing the fixed web at all. Had the spring q been placed as in fig. 14, and the cylinders β and γ been made to bear like the pivots of a transit on segmental bearings in the frame at β' and γ', it is probable that the difference in coincidence points would not have existed. Such a modification appears advisable, unless this construction, by leaving the end m less free, should make the "feel" of the screw less sweet and perfect. The discordance in zero when known to exist is really of no consequence, because the observations can be so arranged as to eliminate it.

The box is mounted on a strong hollow steel cylinder CC (fig. 17) by holes η, θ in the ends of the box, which fit the cylinder closely and smoothly. The cylinder is rigidly fixed in the studs C, C, and these are attached to the foundation plate f. The cylinder contains towards η a sliding rod, and towards θ a compressed spiral spring. There is thus a thrust outwards of the spring upon the hollow cap W (attached outside the box), and a thrust of the rod upon the end of the screw s. The position of the box relative to the plate f, in the direction of measurement, depends therefore on the distance between the end of the screw s and the fixed stud C. A screwing in of s thus causes the box to move to the left, and *vice versâ*. Rotation of the box round CC is prevented by downward pressure of the spring Z on a projection attached to the side of the box. The amount of this pressure is regulated by the screw z.

The short screw whose divided milled head is σ shifts the zero of the micrometer by pushing, without turning, the short sliding rod whose flat end forms the *point d'appui* of the micrometer screw at ζ. The pitch of the screw σ is the same as that of the measuring screw (50 threads to the inch), and its motion can be limited by a stop to half a revolution.

The five fixed webs are attached to the table $\tau\tau$, which is secured to the bottom of the box by the screws ρ. The three movable webs are attached to the projections $\lambda\lambda$ on the frame $\alpha\alpha$. The plane surfaces $\tau\tau$ and $\lambda\lambda$ are composed of a bronze of very close texture which appears capable of receiving a finish having almost the truth and polish of an optical surface. It seems also to take a very clean V cut, as the webs can be laid in their furrows with an astonishing ease and precision. These furrows have apparently been cut *in situ* with a very accurate engine, for not the slightest departure from parallelism can be detected in any of the movable webs relative to the fixed webs. Extraordinary care has evidently been bestowed in adjusting the parallelism and distance of the planes τ and λ, so that the movable wires shall almost, but not quite, touch the surface τ. The varnish to fix the webs is applied, not on the surface τ as is usual, but on a bevel for the purpose,[1] the position of the webs depending on their tension to keep them in their furrows. The result is that no trace of "fiddling" exists, and the movable and fixed webs come sharply together in focus with the highest powers. Under such powers the webs can be brought into apparent contact with such precision and delicacy that the uncertainty of measurement seems to be as much in the estimation of the fraction of the division of the head as in the accuracy of the contact. It is a convenient feature in Repsold's micrometer that the webs are very near the inner surface of the top of the box, so that the eye is not brought inconveniently close to the plate when high powers are used.

Micrometers of the type E have been invented by Alvan Clark and Grubb. Clark's micrometer was exhibited at the June meeting of the Royal Astronomical Society in 1859 (*Monthly Notices R. A. S.* vol. xix.). It is capable of measuring angles up to about one degree. It is "furnished with two eye-pieces, composed of small single lenses, mounted in separate frames, which slide in a groove and can be separated to the required distance. A frame carrying two parallel spider lines, each mounted separately with its own micrometer screw, slides in a dovetailed groove in front of the eye pieces, and by a free motion in this frame each web can be brought opposite its own eye-len- In using this micrometer, the first step is to set the position-vernier to the approximate position of the objects to be measured. Then the eye-lenses are separated till each is opposite its own object. The frame containing the webs and their micrometer screws is then slid into its place; and the webs, having been separated nearly to their proper distance by their free motion in the frame, are placed precisely on the objects by their fine screws, the observer's eye being carried rapidly from one eye-lens to the other a few times, till he is satisfied of the bisection of each of the objects by its own web. The frame is then removed for reading off the measure by means of an achromatic microscope, on the stage of which it is placed." The advantages which Clark claims are these:

"1. Distances can be observed with great accuracy up to about one degree, and the angles of position also.

"2. The webs, being in the same plane, are perfectly free from parallax, and are both equally distinct, however high the magnifying power may be.

"3. The webs are also free from distortion and from colour.

"4. A different magnifying power may be used on each of the objects,—which may be advantageous in comparing a faint comet with a star."

It appears to us that the method of removing a slide in order to measure the interval between the webs is liable to objection, not only because of the risk to the webs, but because the taking of measurements of such a different character with a different instrument is inconvenient and troublesome. It is true that the intervals between the webs could be measured by an assistant, and two or more different slides be employed to save time; but astronomers will probably generally prefer the method introduced by Grubb described below. It is understood that Clark has since improved this instrument by an ingenious arrangement of prisms which permits both webs, even though separated one degree in a large telescope, to be seen in the same eye piece. The arrangement is not described, and is said to be, as yet, somewhat troublesome to arrange previous to measurement, though when arranged it gives very good results.

Grubb (*Scientific Proceedings of Royal Dublin Society*) thus describe

[1] The marks of varnish so applied will be seen in fig. 17

hat he calls his "duplex micrometer," shown in perspective in fig. :—"A plate of glass about 2½ inches square is ruled with twenty-ne lines in one direction $\frac{1}{10}$th inch apart, and two lines in the other rection 2 inches apart. The extreme lines of the set therefore rm a perfect square of 2 inches. These lines are ruled with xceeding accuracy and care, but provision is left for ascertaining ny errors that remain either as to distance or want of perfect quareness. Along ne side of the square mounted a micro-eter frame in the rdinary way, actu-ted by a screw of ne hundred thread o the inch. The icrometer frame carries eleven line orresponding exact to each alternate ne in the gla eticule, so that when e first spider line made coincident ith the first dia-ond line on the lass the last spider

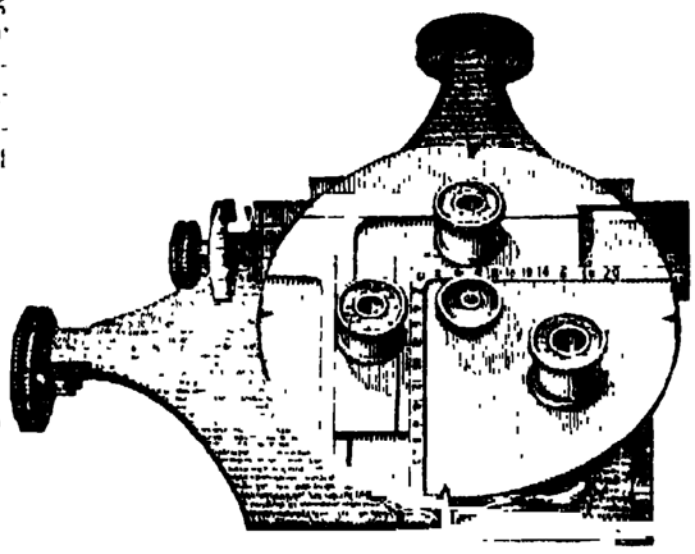


Fig. 18.

ne will be coincident with the last line on the glass, and each of e spider lines will be coincident with all the odd numbers of iamond lines, 1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21. Over this glass late is placed a brass cap in which two eye-pieces are mounted, ne sliding in a groove at right angles to the other, so that, hile one has its journey backwards and forwards on the horizontal ne, the other has its journey on the vertical line, according to ow the cap is placed, for this cap is capable of rotation to meet arious circumstances.

"*How to Use the Instrument.*—1. The two stars are brought on the orizontal line, and the distance measured from centre to centre long that line. This distance is measured by counting the number spaces on the glass, adding the residue as measured by the icrometer screw. Thus the screw is never used for larger measures an $\frac{1}{10}$th inch, and therefore errors of screw and temperature errors e much reduced. In bisecting, one star is brought into the field one eye-piece, and a bisection is made with one of the diamond ne—by moving the micrometer by one or other of its slipping piece rews. Then the other eye-piece is moved till the second star is en, and a bisection is made with the nearest spider line by moving e micrometer head. Then the eye can be moved back to the first ye-piece, and the bisection checked, and again back to the other ye-piece. When it is seen that both are satisfactory the measure n be read off. 2. The micrometer is turned round till the orizontal line becomes parallel to the path of apparent motion of e star. This is easily found by stopping the clock and allowing e star to run along the horizontal wire. Now the other star will e found to cross the vertical line somewhere, while the first star is n the horizontal line. This second star is then bisected on the ertical line, while the first star is bisected by one of the spider nes; thus the difference in right ascension is found. We then ave two sides of a right-angled triangle, and of course all the lements are known.

"*To Investigate the Errors arising out of the Distance of the Lines.*—Of course the usual plan of taking transits can be adopted, and to ascertain if the lines be perpendicular at right angles a special additional ye-piece is provided so that transits can be taken across each iagonal of the square."

This instrument has great advantage over Clark's in case of djustment not true, and has done good work at the University Observatory, Oxford (*Mon. R. A. S.*, vol. xlvii. pp. 5, 12). Professor Pritchard claims too much when he estimates its work as qual in accuracy with that of the heliometer—at least the published esults do not contain such a view. But it is a very valuable nstrument for measuring objects too faint for the limited aperture of most heliometers, and which at the same time are farther apart han the field of view of its micrometer eye-piece.

The accuracy of the duplex micrometer would be very greatly ncreased if Clark's idea above mentioned, of viewing both widely eparated wires in one eye-piece of high power could be reduced to convenient practical form.

Method of Webbing the Eye Micrometer.

The webbing of a micrometer is a process that should be familiar o all practical astronomers. English opticians usually proceed as ollows. A spider (the variety is marked by a cross on the back, nd is found in English gardens about decayed wood) is caught, nd placed on a wire fork. The insect immediately attaches a web o the wire and begins to lower itself by a web to the ground. This web is wound up on the fork till ten or twelve turns, separated by convenient space, have been secured. A brush with varnish is then passed along the prongs; the webs are thus securely fixed to the fork. The parallel prongs of the fork must be sufficiently far apart to allow the web frame of the micrometer to pass between them. The frame to be webbed is placed on a flat dull black surface between the prongs of the fork, the latter being carefully arranged so that one of the webs lies nearly in the furrow ruled in the frame for its reception. As the web-frame is generally thicker than the fork, the web will now be stretched across the former, with a certain amount of tension, and is brought into the furrow with a finely pointed piece of soft wood. If the surface of the frame is well polished, and the furrows sharply cut, without "burr," the web should leap sharply and decidedly into its place. Each end of the web is then secured by a drop of shellac varnish, which should be allowed to harden thoroughly before the frame is touched. The webs can be very readily so handled against a black background, with the aid of a hand lens of 2 or 3 inches focus. In experienced hands this method gives good results, but the following, which is generally followed on the Continent, is preferable.

A web, about 2 inches longer than the width of the frame, is unwound from a cocoon,[1] and small pieces of lead are attached to its extremities by beeswax. One end of the web, with its attached lead, is laid on a piece of cork floating in a tumbler of water; the other end is allowed to hang down in the water, where it becomes thoroughly saturated and untwisted. It is then laid across the fork, and dropped into its furrows in the manner above described, the little lead weights exerting a definite tension. Varnish[2] is immediately applied to secure the webs, and the frame is not touched till it is dry.

The bevel-edge of the web-frame introduced by Repsold (type D) offers great facilities for accurate webbing, and should be employed in all future micrometers.

Illumination of Micrometers.

When micrometer observations are made by night it is necessary to have some mode of rendering the webs visible, either by rays of light at right angles to the axis illuminating the webs, or by rays nearly coincident with the axis of the telescope. In the former case we get bright webs in a dark field, in the latter dark webs on a bright field.

In the older telescopes bright web illumination is produced by small lamps with nozzles that enter the tubes L, L (fig. 9). The illumination is regulated in colour and intensity by wedges of coloured or darkened glass passing through slides in the nozzles. But it is inconvenient to have lamps so near the observer's eye, and it is at least very difficult to obtain a perfectly dark field when the wires are illuminated in this way.

The Clarks, in their micrometer of the great Washington telescope, have made the end of box T (fig. 15) transparent, and light is thrown on the webs from a lamp held by an assistant. Holden has very recently applied a lamp ingeniously hung so as to preserve its verticality and the constant direction of its light in a similar way, adding a plain silvered mirror inside the box and opposite the lamp, so as to illuminate the webs symmetrically. In the Clarks' and Holden's methods it is only the webs at right angles to the screw that are illuminated.

For illumination of the field, in very old telescopes, light was thrown on a small ivory reflector fixed outside the object-glass in the axis of the telescope by an arm fitting on the cell of the lens. This involved the aid of an assistant to direct lamplight on the ivory reflector, or the very frequent change of a lamp support. Afterwards the light from an attached lamp was introduced through a hole in the telescope-tube and thrown upon an elliptical plane (generally dull-gilt) having its centre part cut away sufficiently to avoid interruption of the cone of rays from the object glass. Many ingenious modes of suspending the lamp have been invented for the purpose of securing a constant direction of its light coupled with verticality of the lamp. One of the best of these, due to Cooke, is shown in fig. 19. L is the lamp, P a prism to reflect

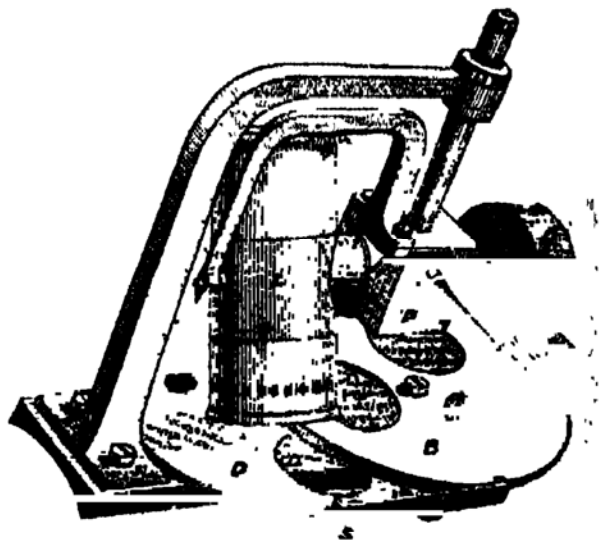


Fig. 19.

[1] It is asserted that webs from cocoons are more elastic, better shaped, and more durable than those obtained during an effort of the insect to escape. The best webs we have seen were from a cocoon obtained in Holland, but we have been unable to ascertain the name of the variety of spider.

[2] Argelander used to apply two drops of varnish at each end of his webs. He first fixed each extremity by a drop of shellac varnish, and after that had dried he applied a drop of copal varnish nearer the centre of the frame; the latter took a long time to harden, but gave ultimately a much stronger attachment.

nto the tube, D a disk to regulate the quantity of light, k with glasses to regulate the colour of the light, S a o clamp the disks, C the counterpose of the lamp, G a preserve the horizontality of the axis CL. But astronomers the genius of Grubb the introduction of a more efficient vement system, viz., the performance of all necessary illu- n of an astronomical telescope by a single lamp, and the ontrol of the illumination of the field or webs, and the n of these as to intensity or colour by simple motions from nd. It is impossible to speak too highly of Grubb's efforts irection; he has broken the ground in this department of nical engineering, and rendered the working of so huge an ent as the Vienna telescope of 27 inches aperture not only nt, but easier for a single observer than that of a very lescope of the older constructions.

the illumination of the field wires and scales of micro- Grubb's original method has recently been surpassed by h is due to the Repsolds. We shall therefore describe the

0 represents the eye-end of a telescope. The reader will the micrometer (figs. 16 and 17) previously described. L naflin lamp fitting by a joint into a copper cover s effectually defends its imney against accident, ects the lamp from wind. ple means by which this made to preserve its ver- n all positions of the is evident from the By this lamp alone the ne or bright field illumi- s given at pleasure, and desired intensity, simply ment of the small pin *p* osition circle and the head micrometer are also illu- as well as the declina- le, by the same lamp. cylindrical box, ending nated cone toward A n, mid-section, in a plane hrough the telescope axis, 1, where all details un- to the explanation of the tion are omitted, and pro- ot parts is sacrificed to s. P is a prism (fig. 21) ates with the lamp and ts light into AB. The the lamp is in the focus eus *H*, so that the rays parallel after passing it. There is a sliding o perfect this adjustment. There is a well-polished flat reflector of speculum metal *rr* (figs. 21), which reflects light double mirror M (fig. 20), whence it is diverted to the two points on the declination circle that are read by micrometer

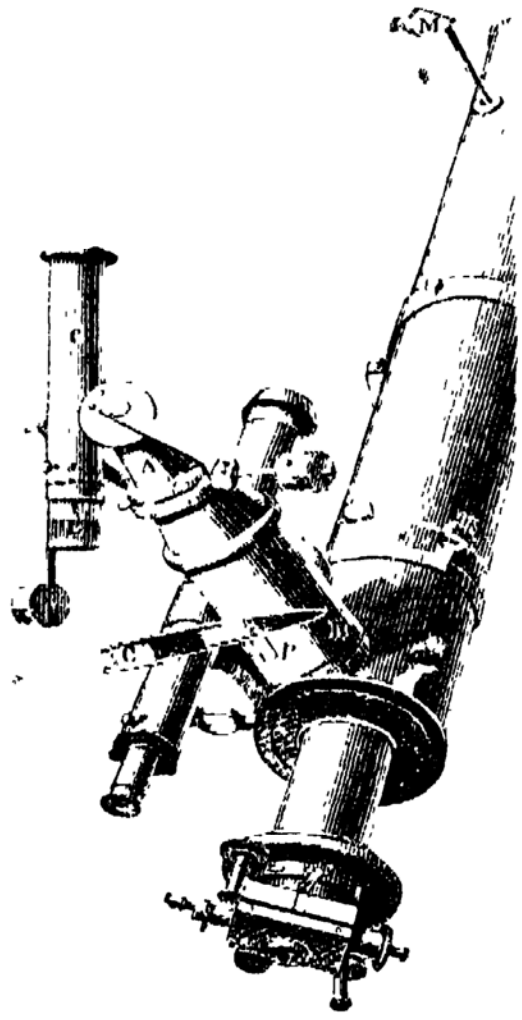


Fig. 20.

ges from -end (the e omitted of clear- ttle handle the dotted represent liaphragm, ngeniously ed, mount- plate of nt glass. a flat ring carrying ns, which d by the *p'*, in a at right to *Pn*. ns work in ots cut in les. Thus

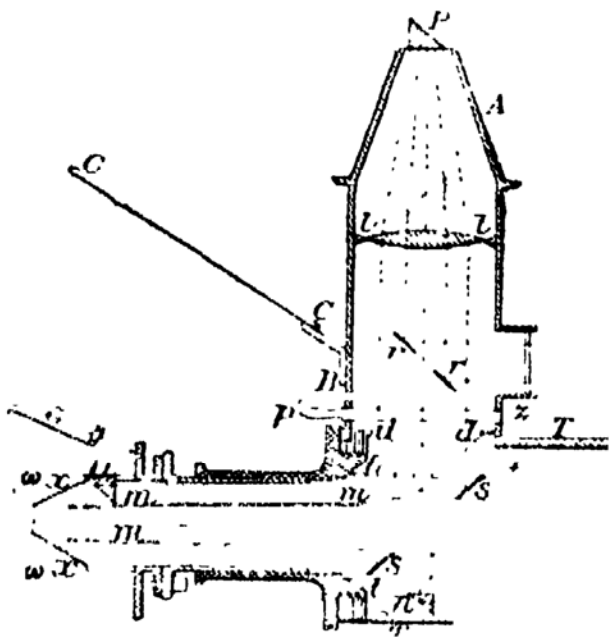


Fig. 21.

of the ring causes the four slides to approach or recede from When the handle *p'* is in the middle of its range, the ether form a disk as large as the hole in the diaphragm *dd*, prevent all light from entering the telescope tube. When ed to one side of its range the slides move outwards leaving opening in the centre so that the light falls on the prism *n*, whence it is diverted to a silvered reflector cemented on the middle of the inner surface of the object-glass, and is then reflected back along the axis of the telescope to illuminate the field at *a*. When *p'* is pushed to the other side of its range the slides again overlap at the centre, excluding light from *n* and allowing it to fall upon the reflector *s* instead. From *s* the light is thrown upon the webs *ω*, *ω* by reflexion from a white papier maché surface lined on the inside of a thin hollow brass truncated cone *xx*. The edge of this cone forms the circle seen within *rr* in fig. 17. All stray light is prevented by the light-guard tube *mm*, which is attached to and moves with the rotating part of the micrometer. The result is to produce a symmetrical illumination of the whole system of webs on a perfectly dark field. It is also obvious that by placing *p'* at any intermediate position between the centre and the extremes of its range any desired modification of bright wire or bright field illumination can be obtained at pleasure.

The light falling on the papier maché hollow cone is intercepted at three points by prisms, one of which *w* is shown in section. These prisms are inserted in the cylinder which carries the foundation plate of the micrometer box and rotate with it. Two of them divert light upon the reflectors *s* seen from different points of view in figs. 16, 17, 20. The third prism after two reflexions (fig. 16, 20) illuminates the micrometer head. The whole arrangement is in the highest degree elegant, and we have found it most simple and convenient in practice. The screen C (figs. 20 and 21) made of thin copper and attached to AB effectually protects the observer's eye from stray light from the lamp.

It has been found essential, in bright field illumination, when the highest accuracy is desired, to have the illuminating rays parallel with the telescope axis.

In the best telescopes of the future some plan like that of Repsold's, above described, will doubtless be adopted. It is probable also that with the introduction of condensers, in connection with the incandescent carbon light in vacuum, electricity will ultimately supersede the oil or paraffin lamp in illuminating astronomical instruments. A small "Swan lamp" can be placed anywhere, is unaffected by wind, and gives off comparatively little heat. These are most valuable qualities for the purpose in question.

The astronomer-royal (Mr Christie) has recently used luminous paint to render the measuring pointer of the Greenwich spectroscope viewable at night. This paint, after exposure during the day to sunlight, shines at night with a dull phosphorescence sufficient to make the micrometer pointer, to which it is applied, faintly visible, and it is stated, with very satisfactory result.

On the use of the five micrometer consult Struve, *Mensura Micrometrica*, St Petersburg, 1837, Brunnow *Practical and Spherical Astronomy*, Chauvenet *Practical and Spherical Astronomy*, Brunnow, *Astronomical Observations and Researches made at Dunsink*, Dublin 1860, 1870, 1879. Bessel *Astr. Beobachtungen*; and the papers of Dembowski in the *Memorie de Venezia*.

Double Image Micrometers.

The discovery of the method of making measures by double images is stated to have been first suggested by Roemer about 1678. But no such suggestion occurs in the *Basis Astronomiae* of Horrebow (Copenhagen, 1735), which contains the only works of Roemer that remain to us. It would appear that to Savary is due the first invention of a micrometer for measurement by double image. His heliometer (described in a paper communicated to the Royal Society in 1743, and printed, along with a letter from Short, in *Phil. Trans.*, 1753, p. 156) was constructed by cutting from a complete lens *abcd* the equal portions *agbe* and *cgfe* (fig. 22). The segments *abk* and *cfd* so formed were then attached to the end of a tube having an internal diameter represented by the dotted circle (fig. 23). The width of each of the portions *agbe* and *cgfe* cut away from the lens was made slightly greater than the focal length of lens = tangent of sun's greatest diameter. Thus at the focus two images of the sun were formed nearly in contact as in fig. 24. The small interval between the adjacent limbs was then measured with a wire micrometer.

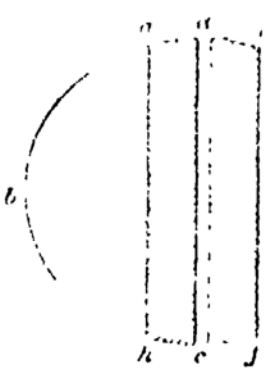


Fig. 22.

Fig. 23.

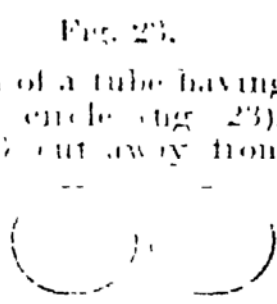


Fig. 24.

Savary also describes another form of heliometer, on the same principle, in which the segments *agbe* and *cgfe* are utilized by cementing their edges *gh* and *ef* together (fig. 25) and covering all except the portion indicated by the unshaded circle. Savary expresses preference for this second plan, and makes the pertinent remark that in both these models "the rays of red light in the two solar images will be next to each other, which will render the sun's disk more easy to be observed than the violet ones. This

e mentions "because the glasses in the two sorts are somewhat
nsmatical, but mostly those of the first model which could
n before bear no great charge" of magnifying power.

A third model proposed by Savary consisted of two complete
enses of equal focal length, mounted in cylinders
de by side, and attached to a strong brass plate be-
ig. 26). Here, in order to fulfil the purposes of the pre-
ious models, the distance of the centre of the lenses
om each other should only slightly exceed the tan-
ent of one diameter to focal length of lens.
avary dwells on the difficulty both of procuring
enses sufficiently equal in focal length and of accurately
djusting and centring them.

In the *Mem. de l'Acad. des Sciences*, 1748, Bouguer des-
ribes an instrument which he calls a héliomètre
alitude in his *Traité d'Optique* (p. 139) he mentions
uch a héliomètre which had been in his possession
rom the year 1729, and of which he gives a representation on
Plate XXVIII. fig. 3 of the same volume. Bouguer's héliomètre was at first similar to that of Savary's
third model, with the important difference that the two object-glasses being
fixed, one of them is movable by a screw
moved by a divided head. No auxiliary
eye-glass or micrometer was required, as in
Savary's héliomètre to measure the interval
between the limbs of two adjacent images
of the sun it became only necessary to turn
the screw with the divided head to change
the distance between the object-glasses till
the two images of the sun are in contact as
in fig. 27. The differences of the readings
of the screw which corresponded to one afford
the means of measuring the variation of
the sun's apparent diameter.

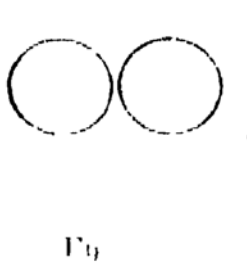


Fig. 25.

Fig. 26.

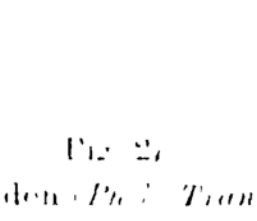


Fig. 27.

On the 4th April 1754 Dollond communicated a paper to the Royal Society of London (*Phil. Trans.*, vol. xlviii. p. 567) in which he shows that a micrometer can be much more easily constructed by dividing a single object-glass through its axis than by the employment of two object-glasses. He points out also that a telescope with an object-glass so divided still produces a single image of any object to which it may be directed, provided that the optical centre of the segments are in coincidence; and provided the segments retain their same relative positions to each other as before the glass was cut; so that if the segments are separated in any direction two images of the object viewed will be produced. So that the most convenient direction of separation for micrometric purposes is to slide these straight edges one along the other as the figure in the margin (fig. 28) represents them: "for thus they may be moved without suffering any false light to come in between them, and by this way of removing them the distance between their centres may be very conveniently measured, viz., by having a vernier's division fixed to the brass work that holds one segment, to slide above a scale on the plate to which the other part of the glass is fitted.

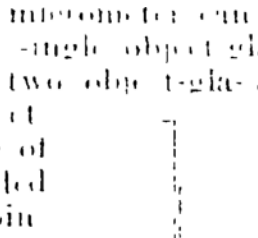


Fig. 28.

Dollond then points out three different types in which a glass so divided and mounted may be used as a micrometer.

"1. It may be fixed at the end of a tube, of a suitable length to its focal distance, as an object-glass, the other end of the tube having an eye-glass such as is usual in astronomical telescopes.

"2. It may be applied to the end of a tube much shorter than its focal distance, by having another convex glass within the tube, to shorten the focal distance of that which is cut in two.

"3. It may be applied to the open end of a reflecting telescope, either of the Newtonian or the Cassegrain construction."

Dollond adds his opinion that the third type is "much the best and most convenient of the three", yet it is the first type that has survived the test of time and experience, and which is in fact the modern héliomètre.

Fig. 29 illustrates Dollond's divided object-glass héliomètre of the third type. A is the end of the reflecting telescope, upon which the adapter B is fitted. B carries a wheel (not seen in the figure) formed of a ring racked at the outer edge, and fixed to the brass plate CC, so that a pinion moved by the handle D may turn it into any position. Two plates F, G, with the attached semi-lenses, move in slides fixed to the plate CC, a simultaneous motion, in contrary directions, being communicated to them by turning the handle E, which drives a concealed pinion that works in the two racks seen in the highest part of the figure. The amount of separation of the semi-lenses is measured by a scale 5 inches long, subdivided to $\frac{1}{10}$th of an inch, and read by a vernier on the plate F to $\frac{1}{100}$th of an inch. In practical use this micrometer has never given satisfactory results (see Mosotti in the *Efemeride* of Milan for 1821). It must be remembered, however, that when Dollond gave preference to this type he had not *invented* the achromatic object-glass; his preference was fully justified under these circumstances. So far as we know no héliometer with a divided achromatic object-glass was ever made by the elder Dollond on the principle of his first type. His son, however, made what he called an "elder" micrometer, which was a great improvement on the elder Dollond's second type.

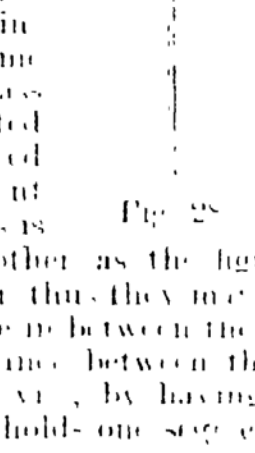


Fig. 29.

In the older construction the brass mountings of the semi-lenses obstructed the light entering the telescope in proportion to their separation, and the images were so coloured as to prevent the use of any but very low powers. In the later construction the movable segments are formed from a negative achromatic lens of much larger aperture than the object-glass of the telescope with which the micrometer is employed, and, for convenience in mounting, the segments *abh* and *cdi* (fig. 22) are removed. In the fine example of this instrument at the Royal Observatory, Cape of Good Hope, the movable lenses consist of segments of the shape *gach* and *cacf* (fig. 22) cut from a complete negative achromatic combination of 8¼ inches aperture and about 41 feet focal length, composed of a double concave flint lens and a double convex crown. This is applied to an excellent achromatic telescope of 3¼ inches aperture and 12 inches focal length. The instrument is represented in fig. 30, the same letters indicate the analogous parts of fig. 29. The frame CC moved by teeth on its outer edge, carries one of the lenses G of the lens, and a similar frame with teeth carries the other half F. A scale 8¼ inches long is fastened like an edge-bar to the frame of the segment G, and each inch is subdivided into twenty parts, which are read off by a vernier to $\frac{1}{1000}$th of an inch, and, by estimation, this can easily be carried to $\frac{1}{5000}$th or $\frac{1}{4000}$th of an inch. The two movable frames are imbedded in a fixed plate HH, screwed to the adapter B having a circular hole in its middle equal to the diameter of the object-glass. The slide of the segment G is moved by turning the milled head to the right of A, and the other segment F by means of a rack and pinion on the opposite side, the latter being turned from the eye-end by a handle not seen in the figure. A screw is provided for clamping the slide of the segment G, as it is intended that only the segment F shall be moved in making the final bisection. There is an index attached to the slide of G, reading on a rough scale engraved on the plate H, which is obviously intended for setting the optical centre of the segment G approximately as far from the optical axis of the telescope on one side as the optical centre of the segment F will be on the other side during the intended measurement. This arrangement not only permits the measurement of angles twice as great as would be possible if one segment were fixed, but is also important in increasing the symmetry of the measures. The vernier is placed at one end of the scale when the optical centres of the segments are in coincidence, and is provided with screws at I, which are intended for adjusting the zero of the scale. The younger Dollond has in this model retrograded, in some respects, from the admirable example of his father, who, as shown in fig. 29, not only gave the lenses automatic opposite motion symmetrically with respect to the axis of the telescope, but seems also to have provided for entire elimination of index error by making it possible to observe all angles on opposite sides of zero—a precaution possible in the later form only when very small angles are measured. Rotation of the micrometer in position angle is provided for as in the earlier form, but the instrument is not furnished with a position circle.

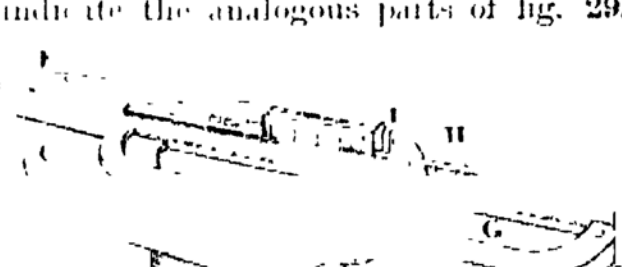


Fig. 30.

With one of these instruments of somewhat smaller dimensions (telescope 2½ inches aperture and 3½ feet focus) Triesnecker made a series of measurements at the observatory of Vienna which has been recently reduced by Dr Schur of Strasburg (*Nova Acta der Ksl. Leop. Carol. Deutschen Akademie der Naturforscher*, xlv. No. 3). The angle between the stars ζ and *g* Ursæ maj. (708″·55) was measured on four nights; the probable error of a measure on one night was ± 0″·44. Jupiter was measured on eleven nights in the months of June and July 1794; from these measures Schur derives the values 35″·39 and 37″·94 for the polar and equatorial diameters respectively, at mean distance, corresponding with a compression 1/14·44. These agree satisfactorily with the corresponding value

35″·21, 37″·60, 1/15·69 afterwards obtained by Bessel (*Konigsberger Beobachtungen*, xix. 102). From a series of measures of the angle between Jupiter's satellites and the planet, made in June and July 1794 and in August and September 1795, Schur finds the mass of Jupiter $= \frac{1}{1018.55 \pm 1.45}$, a result which accords perfectly with the received value of the mass derived from modern researches. The probable errors for the measures of one night are ±0″·547, ±0″·889, ±0″·542, ±1″·096, for Satellites I., II., III., and IV. respectively. It is probable that Tiesnecker deduced the index error from his measures of the diameter of Jupiter, and in 1794, the measures of diameter are made on the same nights with those of the measures of distance of the satellites, and it is possible that measures of diameter may have been made in 1795 but not published.

Considering the accuracy of these measures (an accuracy far surpassing that of any contemporary [illegible] somewhat surprising that the form of micrometer was never systematically used in any sustained or important astronomical researches, although a number of instruments of the kind were made by Dollond. Probably the first example of its employment is in observation of the transit of Mercury (November 4, 1868) by Mr Main, at the Royal Observatory, Cape of Good Hope (*Monthly Notices R. A. S.*, vol. xxix. p. 197–209). The most important part, however, which this type of instrument seems to have played in the history of astronomy arises from the fact that one of them was in the possession of Bessel at Konigsberg during the time when his new observatory there was being built. In 1812 Bessel entered into correspondence with Fraunhofer (then almost exclusively engaged in Germany, were used by verniers only.

[illegible] angle between the components of the double star δ Cygni and observed the great comet of [illegible] of the disc of the sun on May 4, 1818. In the discussion of these observations (*Konigsberger Beobacht.*, Abth. 3, p. xv) he found that the index error of the scale changed systematically in different position angles by quantities which were independent of the direction of gravity, but depended solely on the direction of the micrometer relative to the axis of the object glass. Bessel attributed this to non-homogeneity in the object glass, and determined with great care the necessary corrections. But he was so delighted with the general performance of the instrument, with the sharpness of the images, and the possibilities which a kindred construction offered for the measurement of considerable angles with micrometric accuracy, that he resolved, when he should have the choice of a new telescope for the observatory, to secure some form of heliometer.

Nor is it difficult to imagine the probable course of reasoning which led Bessel to select the model of his new heliometer. Why, he might ask, should he not select the simple form of Dollond's first type? Given the achromatic object-glass, why should not it be divided? This construction would give all the advantage of the younger Dollond's object glass micrometer and more than its sharpness of definition, without liability to the systematic errors may be due to want of homogeneity of the object glasses, for the lenses will not be turned with respect to each other, but, in measurement, will always have the same relation in position angle to the line joining the objects under observation. It is true that the scale will require to be capable of being read with much greater accuracy than $\frac{1}{100}$th of an inch, for that, even in a telescope of 10 feet focus, would correspond with 2″ of arc. But, after all, this is no practical difficulty.—for screws can be used to separate the lenses, and, by these screws, as in a Gascoigne micrometer, the separation of the lenses can be measured, or we can have scales for this purpose, read by microscopes, like the Troughton[1] circles of Pond, or those of the Carey circle, with almost any required accuracy.

Whether Bessel communicated such a course of reasoning to Fraunhofer or whether that great artist arrived independently at like conclusions, we have been unable to ascertain with certainty. The fact remains that before 1820 Fraunhofer had completed one or more of the five heliometers (3 inches aperture and 39 inches focus) which have since become historical instruments. In 1821 the great Konigsberg heliometer was commenced, and it was completed in 1829.

To sum up briefly the history of the heliometer. The first application of the divided object glass and the employment of double images in astronomical measures is due to Savary in 1743. To Bouguer in 1748 is due the true conception of measurement by double image without the auxiliary and of a filar micrometer, viz., by changing the distance between two object glasses of equal focus. To Dollond in 1754 we owe the combination of Savary's idea of the divided object-glass with Bouguer's method of measurement, and the construction of the first really practical heliometers. To Fraunhofer, some time not long previous to 1820, is due, so far as we can ascertain, the construction of the first heliometer with an achromatic divided object-glass, *i.e.*, the first heliometer of modern type.

[1] The circles by Reichenbach, then almost exclusively used in Germany, were

[2] The diameter of Venus was measured with one of these heliometers at the observatory of Breslau by Brandes in 1820 (*Berlin Jahrbuch* 1824, p. 164).

Double-Image Micrometers with Decided Lenses.

Various micrometers have been invented besides the heliometer for measuring by double image. Ramsden's dioptric micrometer consists of a divided lens placed in the conjugate focus of the innermost lens of the erecting eye tube of a terrestrial telescope. The inventor claimed that it would supersede the heliometer, but it never done anything for astronomy. Dollond claims the independent invention and first construction of a similar instrument. Peters (*Practical Astronomy*, vol. ii. p. 182). Of these and kindred instruments only two types have proved of practical value. Amici of Modena (*Mem. Soc. Ital.*, xviii. (1816) pp. 344–359) describes a micrometer in which a negative lens is introduced between the eye piece and the object-glass. This lens, divided and mounted like a heliometer object glass, the separation of the lenses produces the required double image and is measured by a screw. Dawes has very successfully used this micrometer in conjunction with a filar micrometer, and finds that the precision of the measures in this way greatly increased (*Monthly Notices*, vol. xviii. p. 9, and *Mem. R. A. S.*, vol. xxxv. p. 117).

In the improved form[3] of Airy's divided eye-glass micrometer (*Mem. R. A. S.*, [illegible]09), the rays from the object-glass pass successively through lenses as follows:

1st lens	Concave lens	Focal length p
2nd lens	Achromatic convex lens	Arbitrary q
3rd lens	Eye-piece	r

The lens b is divided, [illegible] one of the [illegible] is moved by micrometer screw. The magnifying power is varied by changing the lens a for another in which p has [illegible] value. The magnifying power of the eye piece is that [illegible] of focus r.

In 1850 Airy pointed out that the other optical conditions could be equally satisfied if the divided lens were made concave instead of convex, with the advantage of giving a larger field of view (*Monthly Notices*, vol. x. p. 160).

The last improvement on this instrument is mentioned in the *Report* of the R. A. S. council February 1865. It consists in the introduction by Simms of a fifth lens, but no satisfactory description has [illegible]d. There is only one practical published investigation of Airy's micrometer that is worthy of mention, viz., that of Kaiser, *Annalen der Sternwarte zu Leiden*, iii. 111–174. The reader is referred to that paper for an exhaustive history and discussion of the instrument. It is somewhat surprising that, after Kaiser's investigations, observers should, as in time, as many have done, to discuss their observations with the instrument as at [illegible] screw value were constant for all an

Steinheil (*Journal Savant de Munich*, 28th February 1843) describes a "héliomètre-oculaire" which he made for the great Pulkowa refractor, the result of consultations between himself and the late Struve. It is essentially the same in principle as Amici's micrometer, except that the divided lens is an achromatic positive instead of a negative lens. Struve (*Description de l'Observatoire Central de Pulkowa*, pp. 196, 197) adds a few remarks to Steinheil's description, in which he states that the images have not all desirable precision, a fault perhaps inevitable in all micrometers with divided lenses, and which is probably in this case aggravated by the fact that the rays falling upon the divided lens have considerable convergence. He however, successfully employed the instrument in measuring double stars [illegible] 1″ or 2″, and using a power of 300 diameters, with results that agreed satisfactorily amongst themselves and with those obtained with the filar micrometer. If Struve had employed a properly proportioned dou

[3] For description of the earlier forms see *Cambridge Phil. Trans.*, vol. x. *Greenwich Observations*, 1849.

[4] We understand that a very thorough investigation of Airy's double micrometer used by De Opelard at Mauritius on Lord Lindsay's expedition has been made by him and will soon be published.

[5] Dawes (*Monthly Notices* January 1858, and *Mem. R. A. S.* vol. xxx. p. has suggested and used a valuable improvement for producing round images instead of the elongated images which are otherwise inevitable when the pas through a bevelled lens of which the optical centres are not in coincide [illegible], the introduction of a diaphragm having two circular apertures [illegible] line of collimation of the tel the diameter of each aperture [illegible] the semidiameter of the co rays at the distance of the diaphragm from the focal point of the object gl Practically the difficulty of making these diaphragms for the different powe the exact required equality is insuperable, but, if the observer is content to a certain amount of light, we see no reason why they may not readily be slightly less. Dawes found the best method for the purpose in question was limit the aperture of the object glass by a diaphragm between a double eye aperture, placing the line joining the centres of the circles approximately in position angle under measurement. Dawes successfully employed the double circular aperture also with Amici's micrometer. The present writer has successfully used a similar plan in measuring position angles of a Centauri with the heliometer, viz., by placing circular diaphragms on the two segments of the object glass.

ular diaphragm, fixed symmetrically with the axis of the telescope in front of the divided lens and turning with the micrometer, it is probable that his report on the instrument would have been still more favourable. The particular instrument had been fashioned to correct, having led Struve to some of those corrections of the Dorpat heliometer which ultimately bore such valuable fruit (see below).

Ramsden (*Phil. Trans.*, vol. xcv. p. 129) had suggested the division of the small speculum of a Gregorian telescope and the introduction of double motion by rotation of the semi-circles in the plane perpendicular to the axis. Brewster (*Encyc. Metrol.*, Sheet, vol. xiv. p. 749) proposed to act on a like principle, dividing the plane mirror of a Newtonian telescope. Again, to obtain an ocular heliometer by which a double image is similarly produced by a divided prism of total reflexion placed in parallel rays. But practically both of these methods are failures. In the latter the field is full of false light, and it is not possible to give sufficiently intimate and steady adjustment to the nearer pair of prisms of total reflexion, and a small telescope through which the rays must pass, consequently loses much of its light.

Micrometer depending on Double Refraction.

To the Abbé Rochon (*Journ. de Paris*, Jan., 1801, pp. 169, 198) is due the happy idea of applying the two images formed by double refraction to the construction of a micrometer. He fell upon a most ingenious plan of doubling the amount of double refraction of a prism by using two prisms of rock crystal, so cut out of the solid as to give each the same quantity of double refraction, and yet to double the quantity in the effect produced. The combination so formed is known as Rochon's prism. Such a prism to be placed between the object-glass and eye piece of a telescope. The separation of the images increases as the prism is approached to the object-glass, and diminishes as it is approached towards the eye-piece.

Arago (*Comptes Rendus*, xxiv., 1847, pp. 400, 402) found that a Rochon micrometer, when the prism was approached close to the eye piece for the measurement of very small angles, the smallest imperfections in the crystal or its surfaces were enormously magnified. He therefore selected for any particular measurement such a Rochon prism as when fixed between the eye and the eye piece (*i.e.*, where a sunshade is usually placed) would, combined with the normal eye piece employed, bring the images just to be measured nearly in contact. He then altered the magnifying power by sliding the field lens of the eye-piece (which was fitted with a slipping tube for the purpose) along the eye tube, till the images were brought into contact. By a scale attached to the sliding tube the magnifying power of the eye piece was deduced, and this combined with the angle of the prism employed gave the angle measured. If p'' is the refracting angle of the prism, and n the magnifying power of the eye piece, then $p'' n$ will be the distance observed. Arago made many measures of the diameters of the planets with such a micrometer.

Dollond (*Phil. Trans.*, 1821, pp. 101, 103) describes a double-image micrometer of his own invention in which a sphere of rock crystal is substituted for the eye lens of an ordinary eye-piece. In this instrument (figs. 31, 32) a is the sphere, placed in half axle, on

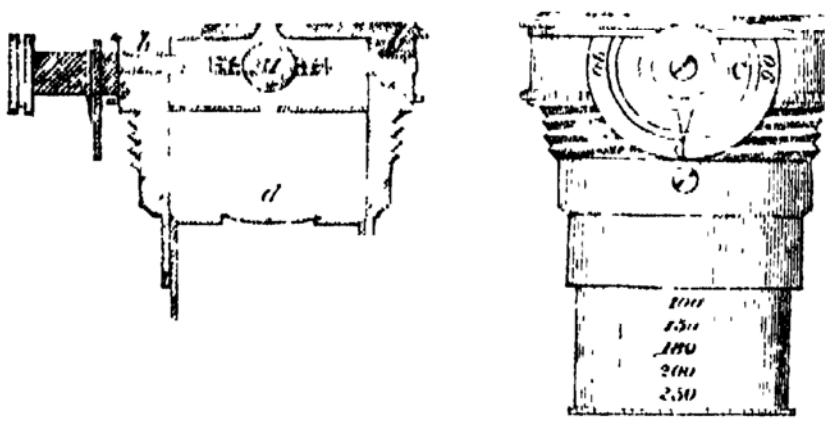


Fig. 32.

axis bb, so that when its principal axis is parallel to the axis of the telescope it gives only one image of the object. In a direction perpendicular to that axis it must be so placed that when it is moved by rotation of the axis bb the separation of the images shall be parallel to that motion. The angle of rotation is measured on a graduated circle C. The angle between the objects measured = $z \sin 2\theta$, where z is a constant to be determined for each magnifying power employed,[1] and θ the angle through which the sphere has been turned from a position of coincidence of its principal axis with that of the telescope. The maximum separation is consequently at 45° from zero. The readings can be made on both sides of zero for eliminating index error. There are considerable difficulties of construction, but these have been successfully overcome by Dollond, and in the hands of Dawes (*Mem. R. A. S.*, xxxv. p. 111 *sq.*) such instruments have done valuable service. They are liable to the objection that their employment is limited to the measurement of very small angles, viz., 15″ or 14″ when the magnifying power is 100, and varying inversely as the power. Yet the beautiful images which these micrometers give permit the measurement of very difficult objects as a check on measures with the parallel-wire micrometer.

The Modern Heliometer.

The Konigsberg heliometer is represented in fig. 33. No part of the equatoreal mounting is shown in the figure, as it resembles in every respect the usual Fraunhofer mounting. An adapter h is fixed on a telescope tube, made of wood, in Fraunhofer's usual fashion. To this adapter is attached a flat circular flange h. The slides carrying the segments of the divided object-glass are mounted on a plate, which is fitted and ground to rotate smoothly on the flange h. Rotation is communicated by a pinion, turned by the handle c (concealed in the figure, which works in teeth cut on the edge of the flange h. The counterpoise e balances the head about its axis of rotation. The slides are moved by the screws a and b, the divided heads of which serve to measure the separation of the segments. These screws are turned from the eye-end by bevelled wheels and pinions, the latter connected with the handles a', b'. The reading micrometers e, f also serve to measure, independently, the separation of the segments, by scales attached to the slides; such measurements can be employed as a check on those made by the screws. The measurement of position angles is provided for by a graduated circle attached to the head. There is also a position circle, attached at m to the eye-end, provided with a slide to move the eye-piece radially from the axis of the telescope, and with a micrometer to measure the distance of an object from that axis. The ring which carries the supports of the handles a', b', c is capable of a certain amount of rotation on the tube. The weight of the handles and their supports is balanced by the counterpoise z. This ring is necessary in order to allow the rods to follow the micrometer heads when the position angle is changed. Complete rotation of the head is obviously impossible because of the interference of the declination axis with the rods, and therefore, in some angles, objects cannot be measured in two positions of the circle. The object glass has an aperture of 6½ inches, and 102 inches focal length.

Fig. 33.

Königsberg heliometer.

There are three methods in which this heliometer can be used.

First Method. One of the segments is fixed in the axis of the telescope, and the eye piece is also placed in the axis. Measures are made with the moving segment displaced alternately on opposite sides of the fixed segment.

Second Method. – One segment is fixed, and the measures are made as in the first method, excepting that the eye-piece is placed symmetrically with respect to the images under measurement. For this purpose the position angle of the eye-piece micrometer is set to that of the head, and the eye-piece is displaced from the axis of the tube (in the direction of the movable segment) by an amount equal to half the angle under measurement.

Third Method. – The eye-piece is fixed in the axis, and the segments are symmetrically displaced from the axis each by an amount equal to half the angle measured.

Of these methods Bessel generally employed the first because of its simplicity, notwithstanding that it involved a resetting of the right ascension and declination of the axis of the tube with each reversal of the segments. The chief objections to the method are that, as one star is in the axis of the telescope and the other displaced from it, the images are not both in focus of the eye-piece,[2] and the rays from the two stars do not make the same angle with the optical axis of each segment. Thus the two images under measurement are not defined with equal sharpness and symmetry. The second method is free from the objection of non-coincidence in focus of the images, but is more troublesome in practice from the necessity for frequent readjustment of the position of the eye-piece. The third method is the most symmetrical of all, both in observation and reduction; but it was not employed by Bessel, on the ground that it involved the determination of the errors of two screws instead of one. On the other hand it is not necessary to reset the telescope after each reversal of the segments.[3]

[1] Dollond provides for changing the power by sliding the lens d nearer to or further from a.

[2] The distances of the optical centres of the segments from the eye-piece are in this method as 1 : cosine of the angle under measurement. In Bessel's heliometer this would amount to a difference of $\frac{1}{1000}$th of an inch when an angle of 1° is measured. For two degrees the difference would amount to nearly $\frac{1}{10}$th of an inch. Bessel confined his measures to distances considerably less than 1°.

[3] In criticizing Bessel's choice of methods, and considering the loss of time involved in each, it must be remembered that Fraunhofer provided no means of

When Bessel ordered the Konigsberg heliometer, he was anxious to have the segments made to move in cylindrical slides, of which the radius should be equal to the focal length of the object-glass. Fraunhofer, however, did not execute this wish, on the ground that the mechanical difficulties were too great.

Wichmann states (*Konigsb. Beobacht.*, xxv. p. 4) that Bessel had indicated, by notes in his handbook, the following points which should be kept in mind in the construction of future heliometers: (1) The segments should move in cylindrical slides;[1] (2) the screw should be protected from dust;[2] (3) the zero of the position circle should not be so liable to change;[3] (4) the distance of the optical centres of the segments should not change in different position angles or otherwise;[4] (5) the points of the micrometer screws should rest on ivory plates;[5] (6) there should be an apparatus for enlarging the screen.[6]

The elder Struve, in describing the Pulkowa heliometer,[7] made by Merz in 1839 on the model of Bessel's heliometer, submits the following suggestions for its improvement:[8] (1) to give automatically to the two segments simultaneous equal and opposite movement;[9] and (2) to make the tube of brass instead of wood, to attach the heliometer head firmly to this tube, to place the eye-piece permanently in the axis of the telescope, and to fix a strong cradle on the end of the declination axis, in which the tube, with the attached head and eye-piece, could rotate on its axis.

Both suggestions are important. The first is originally the idea of Dollond (fig. 29), its advantages were overlooked by his son (description of fig. 30), and it seems to have been quite forgotten till resuggested by Struve. But the method is not available if the separation is to be measured by screws, it is found, in that case, that the direction of the final motion of turning of the screw must always be such as to produce motion of the segment against gravity, otherwise the "loss of time" is apt to be variable. Thus the simple connexion of the two screws by cog-wheels to give them automatic opposite motion is not an available method unless the separation of the segments is independently measured by scales.

Struve's second suggestion has been adopted in nearly all succeeding heliometers. It permits complete rotation of the tube and measurement of all angles in reversed positions of the circle; the handles that move the slide can be brought down to the eye-end, inside the tube, and consequently made to rotate with it; and the position circle may be placed at the end of the cradle next the eye-end where it is convenient of access. Struve also points out that by attaching a fine scale to the focussing slide of the eye piece, and knowing the coefficient of expansion of the brass tube, the means would be provided for determining the absolute change of the focal length of the object-glass at any time by the simple process of focussing on a double star. This, with a knowledge of the temperature of the screw or scale and its coefficient of expansion, would enable the change of screw value to be determined at any instant. Or, if we suppose the temperature of the instrument to be the same in all its parts, the changed scale value becomes simply a function of the reading of the focal scale.

It is probable that the Bonn heliometer was in course of construction before these suggestions of Struve were published or discussed, since its construction resembles that of the Konigsberg and Pulkowa instruments. Its dimensions are similar to those of the former instrument. Bessel, having been consulted by the celebrated statesman Sir Robert Peel, on behalf of the Radcliffe trustees, as to what instrument, added to the Radcliffe Observatory, would probably most promote the advancement of astronomy, strongly advised the selection of a heliometer. The order for the instrument was given to the Repsolds in 1840, but "various circumstances, for which the makers are not responsible, contributed to delay the completion of the instrument, which was not delivered before the winter of 1848."[10] The building to receive it was commenced in March 1849 and completed in the end of the same year. This splendid instrument has a superb object-glass of 7·1 inches aperture and 126 inches focal length. The makers availed themselves of Bessel's suggestion to make the segments move in cylindrical slides, and of Struve's to have the head attached to a brass tube; the eye-piece is set permanently in the axis, and the whole rotates in a cradle attached to the declination axis. They provided a splendid, rigidly mounted, equatorial stand, fitted with every luxury in the way of slow motion, and scales for measuring the displacement of the segments were read by powerful microscopes from the eye-end.[11] It is somewhat curious that, though Struve's second suggestion was adopted, his first was overlooked by the makers. But it is still more curious that it was not afterwards carried out, for the communication of automatic symmetrical motion to both segments only involves a simple alteration previously described. But, as it came from the hands of the makers in 1849, the Oxford heliometer was incomparably the most powerful and perfect instrument in the world for the highest order of micrometric research. It so remained, unrivalled in every respect, till 1873; it remains still, optically, the most powerful heliometer in the world, and, with a few alterations, it might almost rival the most recent instruments in practical convenience and accuracy. These alterations, all of which could be made without great difficulty, are the following:

(*a*) Beyond the automatic symmetrical motion above described the instrument should be fitted with means for adjusting the screen from the eye-end (see footnote[9] in last column).

(*b*) The arrangement of the scales should be changed. At present both scales are read separately by separate micrometers, each relative to a separate fiducial line. What the observer requires is the difference of the readings of the two scales, and this can obviously be most quickly and accurately obtained if the edges of the two scales are brought together, and both are read, relatively to each other, by the same micrometer.

(*c*) The unsatisfactory motion in position angle should be replaced by the action of a pinion (attached to the cradle) in the teeth of a wheel (attached to the tube).[12]

(*d*) The position circle should be read by telescopes or microscopes attached to the cradle, and accessible from the eye-end.

(*e*) It would add greatly to the rapidity of work and the ease of the observer if a small declination circle were attached to the cross-head, capable of being read from the eye-end.

As the transit of Venus of 1874 approached, preparations were set on foot by the German Government in good time; a commission of the most celebrated astronomers was appointed, and it was resolved that the heliometer should be the instrument chiefly relied on. The four long-neglected small heliometers made by Fraunhofer were brought into requisition. Fundamental alterations were made upon them – their wooden tubes were replaced by tubes of metal, means of measuring the focal point were provided, symmetrical motion was given to the slides; scales on each slide were provided instead of screws for measuring the separation of the segments, and both scales were read by the same micrometer microscope; a metallic thermometer was added to determine the temperature of the scales. These small instruments have since done admirable work in the hands of Schur, Hartwig, Kustner, and Elkin.

The Russian Government ordered three new heliometers (each 4 inches aperture and 5 feet focal length) from the Repsolds, and the design for their construction was superintended by Struve, Auwers

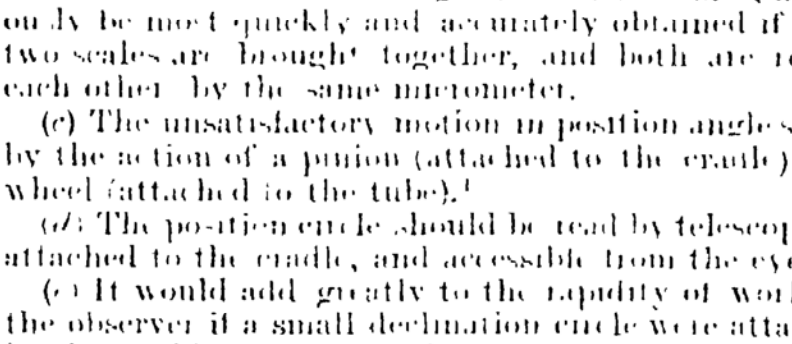


Fig. 31.

and Winnecke, the last named making the necessary experiments at Carlsruhe. Fig. 31 represents the type of instrument which

[1] This most important improvement would permit any two stars under measurement each to be viewed in the optical axis of each segment. The optical centres of the segments would also remain at the same distance from the eye-piece at all angles of separation. Thus, in measuring the largest as well as the smallest angles, the images of both stars would be equally symmetrical and equally well in focus. Modern heliometers made with cylindrical slides measure angles over two degrees, the images remaining as sharp and perfect as when the smallest angles are measured.

[2] Bessel found in course of time, that the original corrections for the errors of his screw were no longer applicable. He considered that the changes were due to wear, which would be much lessened if the screws were protected from dust.

[3] The tube, being of wood, was probably liable to warp and twist in a very uncertain way.

[4] We have been unable to find any published drawing showing how the segments are fitted in their cells.

[5] We have been unable to ascertain the reasons which led Bessel to choose *ivory* planes for the end-bearings of his screws. He actually introduced them in the Konigsberg heliometer in 1840 and they were renewed in 1848 and 1850.

[6] A screen of wire gauze, placed in front of the segment through which the fainter star is viewed, was employed by Bessel to equalize the brilliancy of the images under observation. An arrangement, afterwards described, has been fitted in modern heliometers for placing the screen in front of either segment by a handle at the eye-end.

[7] This heliometer resembles Bessel's, except that its foot is a solid block of granite instead of the ill-conceived wooden structure that supported his instrument. The object-glass is of 7·4 inches aperture and 123 inches focus.

[8] *Description de l'Observatoire central de Pulkowa*, p. 208.

[9] Steinheil applied such motion to a double-image micrometer made for Struve. This instrument suggested to Struve the above-mentioned idea of employing a similar motion for the heliometer.

[10] Manuel Johnson, M.A., Radcliffe observer, *Astronomical Observations made at the Radcliffe Observatory, Oxford, in the year* 1850, Introduction p. iii.

[11] The illumination of these scales is interesting as being the first application of electricity to the illumination of astronomical instruments. Thin platinum wire was rendered incandescent by a voltaic current. A small Swan light and condenser would probably now be found more satisfactory.

[12] This has been recently carried out by Stone, the present Radcliffe observer, on Gill's suggestion.

reading the screws or even the heads from the eye-end. Bessel's practice was to unclamp in declination, lower and read off the head, and then restore the telescope to its former declination reading, the clockwork meanwhile following the stars in right ascension. The setting of both lenses symmetrically would, under such circumstances, be very tedious.

lted from their bloun The brass tube, strengthened at the
ering point by strong fatty turned collars rotates in the cast
on cradle q attached to the declination axis r is the eye piece
xed in that axis, b micrometer for reading both scales,

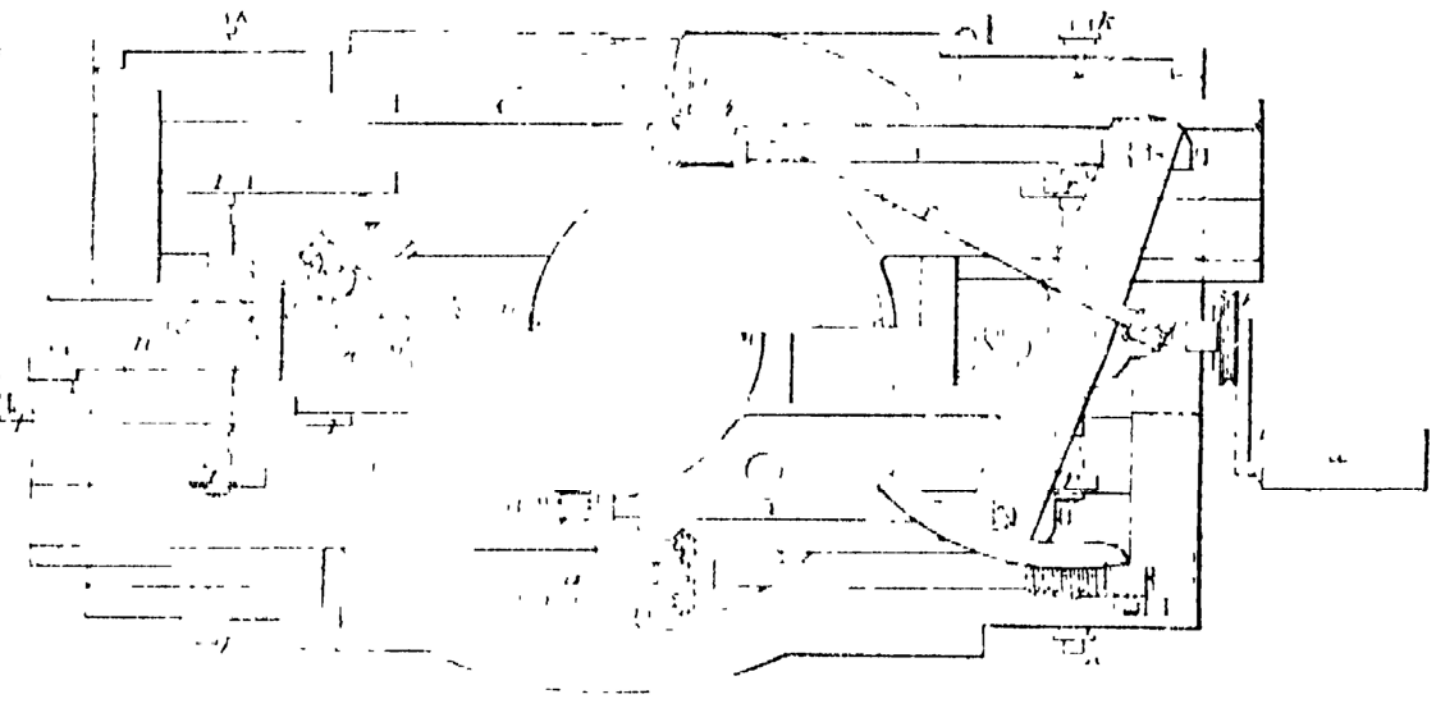


Fig. 35.

a are telescopes for reading the position circle p, c the handle
quick motion in position angle f the slow motion in position
ngle g the handle for changing the separation of the segments
acting on the bevel wheel n fig 35)
ected by a rod with h fig 35), for the
urpose of interposing at pleasure the
ream π in the axis of the reading micro-
eter, this enable the observer to view
he graduations on the face of the metallic
e micrometer xx composed of a rod of brass
nd a rod of steel x a milled head
onnected with the wheel x' fig 35, and
holds the means of placing the screen s
g 34), counterpoised by w over either
alf of the object glass f clamps the
lescope in declination, u clamps it in
ght ascension and the handles uu and
provide slow motion in declination and
ght ascension respectively

The details of the internal mechanism
the "head" will be almost evident
om fig 35 without description The
rew, turned by the wheel at a', acts in
toothed arc, whence, as shown in the
gure equal and opposite motion is com-
unicated to the slides by the pointed
ds z, z The slides are kept firmly
own to their bearings by the rollers
z, z, z attached to axes which are in
e middle, very strong springs Side
ake is prevented by the screws and
ts k, k, k, k The scales are at p, p;
ey are hardened only at the middle, and
e kept down by the brass pieces k, k.

A similar heliometer was made by the
epsold to the order of Lord Lindsay
or his Marsden expedition in 1874. It
ffered only from the three Russian in-
truments in having a mounting by the
ooke in which the declination circle
ads from the eye-end[3] This instru-
ent was afterwards most generously
nt by Lord Lindsay to Gill for his ex-
edition to Ascension in 1877

These four Repsold heliometers proved
o be excellent instruments, easy and
onvenient in use and yielding results
f very high accuracy in the average dis-
nces. Their slow motion in position circle, however, was not all
hat could be desired When small movements were communi-
ated to the handle e (fig 34) by the tangent screw f, acting on
small toothed wheel clamped to the rod connected with the driv
ng pinion, there was apt to be a torsion of the rod rather than an
mmediate action. Thus the slow motion would take place by
erks instead of with the necessary smoothness and certainty.
When the heliometer part of Lord Lindsay's heliometer was ac-

[3] For a detailed description of this instrument see *Dunecht Publications*, vol. II. *Mem. Royal Astronomical Society*, vol. XLVI. pp. 1-172

quired by Gill in 1879, he changed the manner of imparting t
motion in question A square toothed racked wheel was applied
the tube at e (fig 34). This wheel is acted on by a tangent scr
whose bearings are attached to the cradle, the screw is turned
means of a handle supported by bearin
attached to the cradle, and coming with
convenient reach of the observer's ha
The tube turns smoothly in the racked whe
or can be clamped to it at the will of t
observer This alteration and the new equ
torial mounting have been admirably ma
by Grubb; the result is completely succe
ful. The instrument so altered has be
in constant use at the Cape Observato
since March 1881 in determining the par
lax of the more interesting southern stars

Still more recently the Repsolds have co
pleted a new heliometer for Yale Colleg
New Haven, United States The object gl
s of 6 inches aperture and 98 inches fo
length. The mounting, the tube, objective
cell, slides, &c., are all of steel[4] The
strument is shown in fig 36 The circ
for position angle and declination are re
by micrometer microscopes illuminated
the lamp L, the scales are illuminated
the lamp l T is part of the tube prop
and turns with the head. The tube V, on
contrary, is attached to the cradle, and merely forms a support
the finder Q, the handles at f and p, and the moving ring P T
latter gives quick motion in position angle; the handles a
clamp and give slow motion in position angle, those at f cla

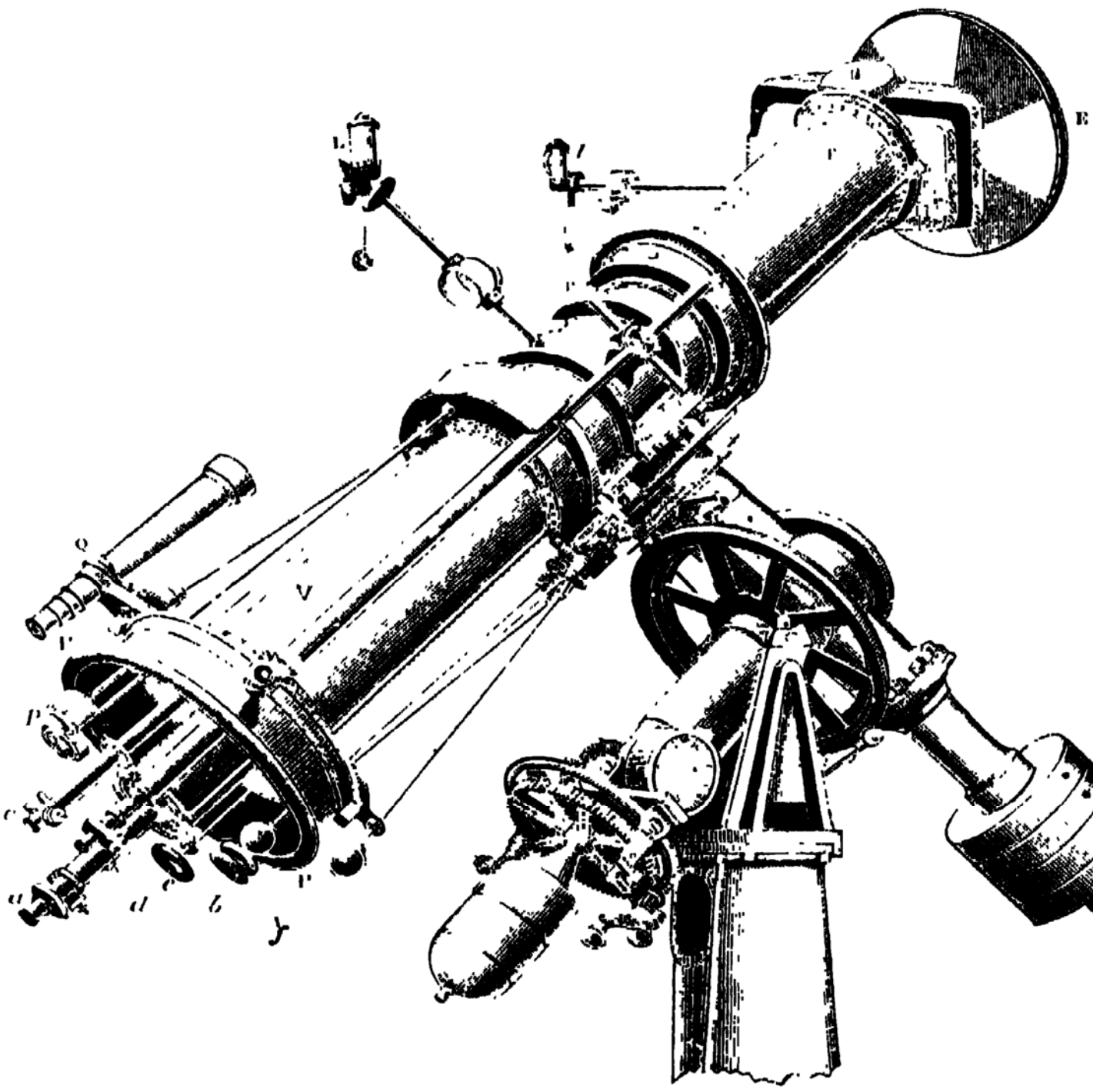


Fig. 36.

and give slow motion in right ascension and declination. a
the eye piece, b the handle for moving the segments, c the mic
meter microscope for reading the scales and scale micrometer
the micrometer readers of the position and declination circles
the handle for rotating the large wheel E which carries
screens The hour circle is also read by microscopes, and
instrument can be used in both positions (tube preceding a

[4] The primary object was to have the object glass mounted in steel cells, wh
more nearly correspond in expansion with glass It became then desirabl
make the head of steel for sake of uniformity of material, and the advantage
steel in lightness and rigidity for the tube then became evident.

following) for the elimination of the effect of flexure on the position angles.

There is very little left to criticize in this instrument. It embraces the results of all knowledge and experience on the subject to the present time. In one point, however, modern heliometers have a disadvantage compared with the older forms. A great advance in accuracy was, no doubt, made when the screw was abandoned as a means both of moving and measuring the displacement of the slides.[1] But it is obviously much quicker to read and record the indication of one screw head than to bisect two or four scale-divisions and enter the corresponding readings. Auwers, in his researches on the parallax of 61 Cygni,' was able, with the Konigsberg heliometer, to make forty pointings in about an hour; it is quick work to make sixteen pointings (reading two divisions on each scale at each pointing) with the modern heliometer in the same time, when attention is paid to the desirable reversal of the segments and of the position circle and the resettings in right ascension and declination. Now time during opportunities of good definition (or otherwise)[2] is too precious to be sacrificed, it can be saved even by ten-fold labour afterwards. Carrington[3] has suggested the possible use of photography to record the readings of astronomical circles, and since his day "Swan lights" and "sensitive dry plates" seems to have brought his suggestion within the range of practice. A special microscope, fitted with an aplanatic photographic objective and a well contrived carrier, might be made automatically to expose a different part of a narrow dry plate, by mere pressure or turning of a button after each bisection. Each plate might easily record the sixteen bisections which constitute a complete measure of two pairs of stars (as in a parallax determination). As it is only necessary to photograph two divisions of each scale, the photographic enlargement of these divisions need only be limited by the sensitiveness of the plates and the power of the illumination to produce a picture in a conveniently short space of time. The plates employed at night could be conveniently developed the following day and measured with a special apparatus at any convenient time and with almost any desired accuracy. Were such a system reduced to practice it would at least double, perhaps treble, an observer's possible output of work.

Gill has introduced a powerful auxiliary to the accuracy of heliometer measures in the shape of a reversing prism placed in front of the eye-piece, between the latter and the observer's eye. If measures are made by placing the image of a star in the centre of the disk of a planet, the observer may have a tendency to do so systematically in error from some acquired habit or from natural astigmatism of the eye. But by rotating the prism 90° the image is presented entirely reversed to the eye, so that in the mean of measures made in two such positions personal error is eliminated. Similarly the prism may be used for the study and elimination of personal errors depending on the angle made by a double star with the vertical. The best plan of mounting such a prism has been found to be the following. l', l^2 (fig. 37) are the eye lens and field lens respectively of a Merz positive eye-piece. In this construction the lenses are much closer together and the diaphragm for the eye is much farther from the lenses than in Ramsden's eye-piece. The prism is fitted accurately into brass slides (care has to be taken in the construction to place the prism so that an object in the centre of the field will so remain when the eye piece is rotated in its adapter). There is a collar, clamped by the screw at S, which is so adjusted that the eye-piece is in focus when pushed home, in its adapter, to this collar. The prism and eye piece are then rotated together in the adapter.

Fig. 37.

On the theory of the heliometer and its use consult Bessel, *Astronomische Untersuchungen*, vol. i.; Hansen *Ausführliche Methode mit dem Dembowski'schen Heliometer anzustellen*, Gotha 1824; Chauvenet, *Spherical and Practical Astronomy*, vol. ii. pp. 403-436, Philadelphia and London, 1876; Seeliger *Theorie des Heliometers*, Leipsic, 1877; Lindsay and Gill, *Dunecht Publications*, vol. ii. Dunecht (for private circulation), 1877; Gill, *Memoirs of the Royal Astronomical Society*, vol. xlvi. pp. 1-172.

Micrometers which Involve the Employment of the Diurnal Motion

Advantage is often taken of the diurnal motion to measure the relative positions of stars. The varieties of reticles and scales that have been employed are far too numerous even for mention in detail. The following are the means and method by which most work has been done, and they are typical of all the others. In the focus of his meridian telescope Lacaille had a brass diaphragm in which was cut a hole, having parallel, sharp, straight edges of the shape shown in fig. 38. The longer diagonal of the rhomboid so formed was at right angles, and the shorter parallel, to the diurnal motion. The method of observation consisted in noting the instant of ingress and egress of each star which presented itself. The mean of the times thus noted for each star gave the time of its transit over the imaginary line ab, whence the difference between the instant of ingress and that of egress (converted into arc by the known approximate declination) gave the length of the chord traversed by the star parallel to the imaginary line cd. Hence (the camera constant of the rhomboid being known) the difference of the star's declination from the line cd became known. The observer was of course careful to note whether the star passed to north or south of cd. Thus every star that crossed the field was observed, all their right ascensions were referred to the clock time of passing cd, and all their declinations to that of cd; hence their mutual differences of right ascension and declination were known. In this way, in the short space of ten months, Lacaille observed nearly ten thousand stars at the Cape of Good Hope in the years 1751-52.

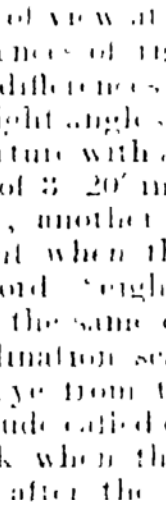


Fig. 38.

Fraunhofer's ring micrometer consists of a ring of steel, very truly turned, mounted in a hole cut in a circular disk of glass. The ring is placed in the focus of a telescope, and viewed by a positive eye piece. The observer notes the instants when the two objects enter and emerge from each side of the ring. The only data required for computing the difference of right ascension and declination of the two objects are the times above mentioned, the diameter of the ring, and the approximate declination of one of the objects. The latter is always known. The methods of determining the former and of reducing the observations are to be found in every work on practical astronomy. The ring micrometer has been largely used in observing comets.

Argelander, in making his famous survey of the northern heavens, employed a reticle of wires, the straight edge of which (true by diurnal motion) crosses the centre of the field of view at right angles to the diurnal motion of the stars. Differences of right ascension were directly observed at this edge, while differences of declination were noted by straight lines drawn at right angles to the edge at each 10′ of arc. A [illegible] 3 inches aperture with a magnifying power of 10 diameters commanded a field of 3° 20′ in declination. One observer was placed at the telescope, another at the clock. The telescope observer marked the instant when the star touched the glass edge, by calling sharply the word "eight" or "nine," &c., which also indicated the magnitude, the same observer also noted and recorded the reading of the declination scale (where the wires crossed it), without removing his eye from the telescope. The clock observer wrote down the magnitude called out by the telescope observer, and the instant by the clock when the word was given. The two records were then compared after the observations of the night were over. In this way Schönfeld and Krueger (Argelander's assistants) observed and catalogued about three hundred thousand stars. The probable error of an observation is about ±0·07 sec. in right ascension and ±0″·4 in declination.

Bond[7] employed a very similar arrangement, differing only from Argelander's in having the scale cut on a sheet of transparent mica $\frac{1}{1000}$th of an inch in thickness. Very oblique illumination was employed, and the divisions and figures were seen bright upon a dark background. The range of declination was limited to 10′, the scale was divided to 10″, the right ascensions were observed by chronographic registration, and the great refractor of the Cambridge U.S. Observatory (with an aperture of 15 inches and power of 140) was employed. The probable errors in right ascension and declination were found to be ±0·06 sec. in right ascension and ±0″·6 in declination—results of marvellous accuracy considering the amount of work accomplished in a short time and the faintness (eleven to twelve magnitudes) of the stars observed.

We were on the point of criticizing Bond's programme as somewhat too ambitious for realization without cooperation (it would take about twenty-six thousand hours of observing to carry out the northern hemisphere alone) when we received from Peters of Clinton, U. S., the first twenty maps of a series which will include the whole of the sky between declination +90° and −30°. If we consider that all the stars in these maps of the eleventh magnitude or brighter have been observed by a method similar to Bond's, that the enormous additional labour of frequent reversion has been undertaken, and all stars visible with a power of 80 on a 15 inches aperture (about fourteenth magnitude) have been filled

[1] Screws, as Auwers's discussion of Bessel's observations of Parallax in 61 Cygni," *Abhandlungen der Konigl. Akad. der Wissenschaften zu Berlin* 1868) has shown, are apt to wear and change their error. For besides, unable to apply force and friction to a delicate standard of measure.

[2] *Astron. Nachrichten*, No. 1416.

[3] For example, in determining the diurnal parallax of a planet the most favourable conditions are limited on the one hand by the uncertainties of refraction at large zenith distances, and on the other by the small parallax factors of small zenith distances. It would probably be best to secure all the observations between 50° and 60° ZD, and this would only be possible with special facilities for reading the scales.

[4] ***Monthly Notices R. A. S.*, vol. xxx. p. 46.**

[5] Lacaille *Coelum Australe Stelliferum* Paris 1763, and *Catalogue of 9766 Stars, from the Observations of Lacaille*, London, 1847.

[6] *Atlas des Nord'lichen Gestirnten Himmels*, Bonn 1863, Introduction.

[7] ***Annals of the Astronomical Observatory Harvard College*, vol. i. part ii.**

by alignment, *and that all this results from the unaided labour of a single observer*, we shall find that our ideas of *the possible* have to be modified, when such a man undertakes a work with persistent unity of purpose for more than twenty years (1876–98).

There is another more modern mode of registering differences of declination that has been in use at the Berlin Observatory since 1879, and is described by Dr Knorre in the *Astronomische Nachrichten* for July 1881. The instrument is called the micrograph. It has a well-grooved micrometer screw, the same screw carries a tracing-point or pencil. The observer having bisected a star by the wire, keeps it so by means of an india-rubber ball connected with the micrometer screw, and moves a box made on the principle of the vacuum breaker of the aneroid barometer. The expansion of the box causes a sheet of paper in contact with two pricker-points, on the micrometer order before mentioned, the other point to move. The action of the vacuum box also automatically shifts the paper forward by a small quantity at each observation. Three successive observations are recorded in regular order. For measuring the observed differences of declination it is the easiest way to measure with a glass scale divided for the purpose corresponding to the distance of each record of the moving pricker from the fixed pricker. It is found, with the declinometer at the Berlin equatorial, that the observed declinations have a very probable error of 1″·0. It is obvious that by using a barograph in connection with this instrument both right ascensions and declinations could be recorded with great accuracy and rapidity.

Heliometric Micrometers.

Clausen (*Astr. Nach.*, No. 111) proposed a form of micrometer consisting of a divided plate of parallel glass placed within the cone of rays from the object-glass at right angles to the telescope axis. One half of this plane remains fixed, the other half is movable. When the inclination of the movable half with respect to the axis of the telescope is changed by rotation about an axis at right angles to the plane of division, two images are produced. The amount of separation is very small, and depends on the thickness of the glass, the index of refraction, and the focal length of the telescope. Secchi (*Comptes Rendus*, xli., 1855, p. 906) gives an account of some experiments with a similar micrometer, and Porro (*Comptes Rendus*, xlv. p. 1058) claims the original invention and construction of such a micrometer in 1845. Clausen, however, has undoubted priority. Helmholtz in his "Ophthalmometer" has employed Clausen's principle, but arranges the plates so that both move symmetrically in opposite directions with respect to the telescope axis. Should Clausen's micrometer be employed as an astronomical instrument it would be well to adopt the improvement of Helmholtz.

Burton and Grubb (*Monthly Notices*, vol. xli. p. 596), after calling attention to Lamont's paper *Jahrbuch d. k. S. b. Munchen*, p. 187, and Lattrow's paper *Proc. of Vienna Acad. of Sciences*, vol. xx. p. 265, on a like subject, proceed to describe a most ingenious form of "Ghost Micrometer," in which the *image* of a fine line or lines ruled on (or rather cut through) a silver film deposited on glass is formed at the common focus of an object-glass and eye-piece of a telescope. A faint light being thrown on the outside of the silvered plate, there appear bright lines in the field of view. We have not had an opportunity of testing this, nor Grubb's more recent models; but should it be found possible to produce such images satisfactorily without diffraction and with an apparatus convenient in general form, such micrometers will probably supersede the ordinary micrometer. Their absolute freedom from diffraction, the perfect control of the illumination and thickness of the lines, and the facility with which it will be possible to construct scales for any required purpose, will be important features of the new method.

For the use of micrometers in connexion with the microscope, see p. 277 of the present volume. (D. GI.)

MICRONESIA. The term "Micronesia" embraces that region of the Pacific north of the great Melanesian islands, where, either perhaps from a greater or more rapid subsidence, or from the decreasing activity northwards of the coral builders, the islands become, generally speaking, smaller and lower, and finally cease. Accordingly, excepting the Marianas or Ladrone, which are of volcanic origin, and a few isolated instances of elevation in the Carolines, the Micronesian islands, though many of the groups cover a vast area, are almost without exception very small low coral (atoll) formations. Besides the LADRONE and CAROLINE ISLANDS (*q.v.*) Micronesia includes the Marshall and Gilbert groups, and some geographers include the Anson group, a number of small widely-scattered islets to the west of Hawaii, the M group farther west, and the Bonin Islands north Ladrones.[1]

North-easterly winds prevail during the winter over the Marshalls, Ladrones, and Carolines, e the extreme west, while between May and Septem influence of the monsoon causes unsettled weath the west, with heavy gales. In the Gilberts the s trade-wind brings fine weather at this season.

The ethnological features of Micronesia are mu definite than the geographical, for its populatio one great branch of the fair Polynesian race, distin from the other by well-marked differences in app language, and institutions. Its ethnological relat not thoroughly understood. The proximity of Ja the Philippine on the west and of the Papuan an Polynesian islands on the south and south-east s what in fact we find, a combination of elements in degrees of fusion. In some places the oblique M eye is noticed, and (along with certain Indo customs) there is often a scantiness of beard and "Malay" look, which increases westwards, and s imply relations with the archipelago subsequent departure thence of the pure Polynesians. In the the traces of Polynesian (Samoan) influences are and are confirmed by tradition. Among the Carol the Marshalls darker and more savage communi found, suggesting a Melanesian element, which is traceable in the Ebon (Marshall) and other langua

Each of the four groups, from long isolation, ha oped peculiarities of its own. The most advanc the "Chamorros" of the Ladrones, owing to the natural resources of the islands, and perhaps more contact with influences from the west; but as a people they no longer exist, having been nearly ex ated by the Spaniards in the 17th century. advancement come the Carolines. The general t well-proportioned rather slightly built figure, wit and regular features; head high and well-prope but forehead rather retreating, and narrow at the t cheek bones and chin slightly prominent; colour so darker than the Polynesians, the Marshalls being and more vigorous than the Carolines, while the type is still darker and coarser. The upper class surpasses the common people in physique and intel

There is a peculiar division of society into clans, the membership of which constitutes the clo Persons of the same sept must not intermarry, an two islands or communities meet in war the men one sept, however widely separated by distance or time, will not injure or fight with each other. community is usually composed (but there are loca ences) of —(1) an upper class of chiefs, from among the head (*tamol* or *iros*) is chosen; (2) a lower noble class; and (3) common people, mostly rights of property. These last are only allowed o Assemblies of the chiefs everywhere limit the authority. In the Marshalls the sovereign has control over many of the atolls, and in the Gilb above distinctions have nearly disappeared; the h has lapsed, and, especially in the southern islands, t of largest substance is the most powerful, and so establishes a local supremacy. Here and there are as in Tonga, of a spiritual sovereign, the desc probably of a conquered dynasty. Succession is the female side, which assures to women a certain

[1] These islands, which contain a mixed immigrant popula claimed, and have been recently surveyed, by Japan. But annexed to England by Captain Beechey in 1827. (See Von *Denkwürdigkeiten einer Reise nach . . . . Mikronesien*, &c.

eads besides to some curious results (see paper by y in *Das Ausland*, 1880, No. 27). The upper class ie keepers of traditions, boat-builders, leaders of tions; tattooing is generally done by them, the t increasing with a man's rank; the custom here as definite religious associations. Both sexes are ed. The people are singularly amiable and well ed, but will repay ill usage with treachery. The n (although chastity is not expected before marriage) newhat more moral than the Polynesians, and are d with respect, as are the aged. The natives are and hospitable to strangers (except on the poorer and islands), bright and intelligent, active traders, expert ators and fishermen. They have a hand-loom from beautiful fabrics of banana, hibiscus, and other fibres roduced. The Marshall Islanders are the boldest ost skilful navigators in the Pacific. Their voyages any months' duration, in great canoes sailing with ger to windward, well-provisioned, and depending on kies for fresh water, help to show how the Pacific olonized. They have a sort of chart, *medo*, of small tied together, representing the positions of islands e directions of the winds and currents. A two-edged n, of which the blade is of sharks' teeth, and a sive armour of braided sennit, are also peculiar to the s; a large adze, made of the *Tridacna gigas*, was rly used in the Carolines, probably by the old r race.

languages of Micronesia, though grammatically alike, differ in their vocabularies. They have the chief characteristics Polynesian, with Malay affinities, and peculiarities such as the suffixes and inseparable pronouns and, as in Tagal, of the infix ote changes in the verb; in the west groups there is a tend- closed syllables and double consonants, and a use of the pala- *j*, *sh*, the dental *th*, and *s* (the last perhaps only in foreign , which is alien to the Polynesian. These letters are g in the Gilbert language, which differs considerably from others, and has much greater affinities with the Polynesian. religious myths are generally identifiable with the Polynesian, belief in the gods proper is overshadowed by a general tion of ancestors, who are supposed from time to time to certain blocks of stone, set up near the family dwelling, and nded by circles of smaller ones. These stones are anointed il, and worshipped with prayer and offerings, and are also used rposes of divination, in which, and in various omens, there is ral belief. In the Marshalls, in place of these stones, certain trees are similarly enclosed. The spirits also sometimes t certain birds or fishes, which are then *tabu*, as food, to the ; but they will help to catch them for others. All this recalls the *karwars* or ancestral images of New Guinea. es are very rare, though these blocks of coral are sometimes nded by a roofless enclosure opening to the west. The bodies dead, and sometimes even of the sick, are despatched to sea ards, with certain rites; those of the chiefs, however, are , for the order has something essentially divine about it, odies therefore are sacred, and their spirits naturally assume sition above described. Such a belief greatly strengthens the authority, for the spirits of his ancestors are necessarily more ful than any other spirits. Thus too it comes that the chiefs, l belonging to them, are tabu as regards the common people. are various other subjects and occasions of tabu, but the tion has not the oppressive and all-pervading character it has in Polynesia. Its action is often economical or able, *e.g.*, the ripening cocoa-nuts are tabu as long as the bread- asts, thus securing the former for future use; or it is put on death, and the nuts thus saved are given to the family—ness to them, and a mark of respect for the dead.

flora of the Gilbert and Marshall groups is of the usual c character, with close Indo-Malay affinities. It is much than that of the Carolines,[1] with its Moluccan and Philip- lements, and this again is surpassed by that of the Ladrones. e Gilberts the scattered woods of cocoa-palm and *Pandanus* ittle undergrowth, while the south Marshalls, being within the constant precipitation, have a dense growth of (mostly) low and shrubs, with here and there a tropical luxuriance and y unusual on atolls. The *Pandanus* grows wild profusely, and xceptional importance, being the chief staple of food, so that the cocoa-nut, which, however, flourishes chiefly in the G used mainly to produce oil for exportation. The bread-fr chiefly in the south Marshalls. The taro (*Arum co* and others) is cultivated laboriously, deep trenches bei the solid rock for its irrigation, but this and other plants o tion, and indeed the vegetation generally, fall off in nu quality northwards. Various vegetables are grown on ported for the purpose. Marine plants are rare. Wilkes Makin Island, Gilbert group, a "fruit resembling the goo called "teiparu," from which a preserve is made. This s like the tipari or Cape gooseberry of India (*Physalis pe* And their *karaka*, a drink made from the sap of the flowe the cocoa-palm (unfermented before the arrival of European the attack of southern Asia.

The fauna, like the flora, becomes poorer eastwards, bi much more numerous on the high islands than on the ato the few are chiefly aquatic. On Bonabe (Puynipet) out o nine species eleven are sea birds, and of the remaining eight are peculiar to the island. From the Pelews fifty-six s recorded (twelve peculiar), and from the neighbouring M group (Ulithi) twenty (six peculiar). Yet curiously no recorded common to these two groups and peculiar to th common fowl is found everywhere, wild or tame, and in so is kept for its feathers only. The rat and a *Pteropus* are indigenous land mammals. The Indian crocodile is fou east as the Pelews. There are five or six lizards, in *Gecko* and *Ablepharus*. Insects are numerous, but of f Scorpions and centipedes are common, but are said to be

The houses in the Gilberts and Marshalls (much less than in the Carolines) consist merely of a thatched roof r posts or on blocks of coral about 3 feet high, with a flo level, which is reached from an opening in the centre. the principal people sleep, and it serves as a storeh accessible to rats, which infest all the island.

The Marshall archipelago consists of two nearly parall of atolls, from 100 to 300 miles apart, the west known as east as Ratak. They lie between 4° 30′ and 12° N., and 165° 15′ and 172° 15′ E., and run about N.N.W. a They were discovered in 1529 by Saavedra, who, observing tattooing of the inhabitants (the first allusion to the p the Pacific), called them Los Pintados. Among modern Wallis first visited them in 1767; Captains Marshall bert reached them in 1788, and Kotzebue (1816) explo more thoroughly. Each group contains fifteen or sixte which range from 2 to 50 miles in circumference. An a feature is reported on some of them, viz., that the gr portion of land, or at all events of oil, is not found as us windward side of the lagoon, for the prevailing north sweeps, it is said, the materials of which the soil of such composed across to the lee side. Jaluit Island is the e emporium of the whole region. There is a curious tra Ebon Island of the Darwinian fact that the atoll once f barrier reef of an island now sunk beneath the lagoon. T tion of Ratak is about 6000, of Ralik 4000; there is little u between the two groups.

The Gilbert archipelago, discovered by Byron in geographically a south continuation of the Marshalls, th separating them being 50 leagues wide. It lies betwe S. and 3° 20′ N., and between 172° 30′ and 177° 15′ E., tains sixteen atolls, not including two hilly islands, Ba Nawodo, which lie 5 to 6° to the west. Several have good a inside the lagoon, with entrances on the lee side. On so or west reef is wanting, owing to the abrading force of storms. During these large trees are washed ashore, t containing pieces of fine basalt, of which implements There is a far larger proportion of land to submerged lagoon than in the Marshalls, the land sometimes risi above the sea, whereas in the Marshalls the average le reef rock is less than a foot above the surface; but, th supply of fresh water is exceptionally great, in fact enou luxury of a bath, the soil (especially in the south) is very productive. Yet the population, about 50,000, is exc dense. The usual scattered houses are replaced by com of roofs which, shaded by cocoa-palm, and each with its below, line the shore. Their numbers are unchecked eit constant practice of abortion or by fighting, to which much addicted, their weapons being more formidable t of their neighbours. This exceptional vigour may be decidedly hybrid character of the race. Hawaiian mi under American superintendence, have laboured here su

See also Findlay's *Sailing Directions for the North Pacific*; Ko *Pacific Pilot and Nautical Magazine*, vols. xxxi. and xxxv. Other are Gerland in *Waitz's Anthropologie der Naturvölker* vol. v.; M *Inseln des Stillen Oceans*; Hale's *Ethnography and Philology of W Exploring Expedition*; Kotzebue and Chamisso, *Entdeckung reise in Proc. Zool. Soc.*, 1872 and 1877.

[1] About 180 species have been observed on Kusaie, one-fourth of plants being ferns.

MICROPHONE. See TELEPHONE.

MICROSCOPE

E microscope is an optical instrument for the examination of minute objects or parts of objects, enlarge the visual pictures formed upon the retina observer by the rays proceeding from them.

roscopes are distinguished as *simple* or *compound*. former, the rays which enter the eye of the observer from an object brought near to it after refraction h either a single lens or a combination of lenses as a single lens, its action as a "magnifier" depend its enabling the eye to form a distinct image of the at a much shorter distance than would otherwise be . The latter consists of at least two lenses, so placed ly to the object, to the eye, and to one another that ged image of the object, formed by the lens placed to it (the "object-glass"), is looked at through the nt the eye (the "eye-glass"), which acts as a roscope in "magnifying" it, so that the com roscope may be described as a simple microscope look at an enlarged image of the object, instead he object itself.

ory of the Simple Microscope.—Any solid or liquid rent medium of lenticular form having either one and one flat surface or two convex surfaces whose nt coincident, may serve as a "magnifier," what is ial being that it shall have the power of so refracting rays which pass through it as to cause widely ing rays to become either parallel or but slightly ent. Thus if a minute object be placed on a slip of and a single drop of water be carefully placed upon drop will act as a magnifier in virtue of the con of its upper surface, so that when the eye is at sufficiently near it (the glass being of course held ntally, so as not to distort the spherical curvature of op) the object will be seen much enlarged. And if ll hole be made in a thin plate of metal, and a drop of water be inserted in it, this drop, having onvex surfaces, will serve as a still more powerful fier. There is reason to believe that the magnifying wer of transparent media with convex surfaces was arly known. A convex lens of rock crystal was by Layard among the ruins of the palace of Nimrud. is pretty certain that, after the invention of glass, spheres blown of that material and filled with were commonly used as magnifiers (comp. vol. xiv.). The perfection of gem-cutting shown in ancient especially in those of very minute size, could not been attained without the use of such aids to the power, and there can be little doubt that the rs who could execute these wonderful works could hape and polish the magnifiers best suited for their r other." i. e. Though it is impossible to say when x lenses of glass were first made by grinding, it is certain that they were first generally used to assist ry vision as "spectacles," the use of which can be back nearly six centuries; and not only were cle-makers the first to produce glass magnifiers (or e microscopes), but by them also the telescope and the ound microscope were first invented. There seems ason to believe, however, that lenses of very high fying power (or short focus) were produced until and for them had been created by the introduction e compound microscope, in which such lenses are ed as "object-glasses"; and the difficulty of working of high curvature with the requisite accuracy led in st instance to the employment of globules made by the ends of threads of spun glass. It was in this way that Robert Hooke shaped the minutest of the with which he made many of the numerous disc recorded in his *Micrographia*; and the same metho employed by the Italian microscopist Father Di Tor seems to have been Leeuwenhoek that first succee grinding and polishing lenses of such short foc perfect figure as to render the simple microscope a instrument for most purposes than any compound scope then constructed,—its inferiority in magnifying being more than counterbalanced by the superior cl of the retinal picture. And, in despair of any such fication in the compound form as should remove the defects which seemed inherent in its plan of constr scientific opticians and microscopic observers alik their chief attention for a considerable period improvement of the simple microscope. In order t nature of these improvements may be understoo principle of its action must be first explained.

The normal human eye has a considerable power adjustment, by which its focal length is so varied forms equally distinct pictures of objects brought ordinary reading distance (say 10 inches) and of whose distance is many times that length,—the size visual picture of any object diminishing, however the increase in the distance to which it is removed, amount of detail distinguishable in it following th proportion. Thus a man who looks across the stre placard posted on the opposite wall may very distinc its general form and the arrangement of its heading, a be able to read what is set forth in its largest type, unable to separate the lines, still more to read the of what is set forth below. But by crossing the so as to bring his eye nearer the picture he finds able to read the smaller type as easily as he befo the larger,—the visual picture on his retina havin magnified, say 10 times in linear dimension, reduction of the distance of his eye from 40 fee Similarly, if he holds a page of excessively minute arm's length (say 10 inches) from his eye, he may be to read it, not because his eye does not form a retinal picture of the page at that distance, but the details of that picture are too minute for distinguish them. But if he brings the page fr inches to 10 inches distance, he may be able to without difficulty,—the retinal picture being enlarg times linear (or sixteen times superficial) by this a mation. Now the rays that enter the eye from eac of a remote object diverge so little as to be vi parallel; but the divergence increases with the appr tion of the object to the eye, and at 10 inches th of their divergence is as wide as permits the ordin to bring them to a focus on the retina. When the is approximated more closely, an automatic contrac the pupil takes place, so that the most diverging each pencil are cut off, and a distinct picture formed (though not without a feeling of strain) wh object is (say) from 5 to 8 inches distant,—givi greater minuteness of visual detail in conformity w increase of size. A further magnifying power obtained without the interposition of any lens, by at an object, at 2 or 3 inches distance, through a in a card; for by thus cutting off the more di rays of each pencil, so as to admit only those wh be made to converge to a focus on the retina distance, a distinct and detailed picture may be ob though at the expense of a great loss of light. Mo

MICROSCOPE

...n an ordinary eye does not form a distinct picture
... object at less than from 10 to 6 inches distance, a
...pic" or "short-sighted" eye (whose greater refractive
... enables it to bring rays of wider divergence to a
...on the retina) may form an equally distinct picture
... object at from 5 to 3 inches distance; and, as the
...dimensions of that picture will be double that of the
...ing, the object will be "magnified" in that propor-
...nd its details more clearly seen.

... effect of the interposition of a convex lens between
...e and an object nearly approximated to it primarily
...s in its reduction in the divergence of the rays of
...encils which issue from its several points, so that
...nter the eye at the moderate divergence which they
... have if the object were at the ordinary nearest limit
...inct vision. And, since the shorter the focus of the
...e more closely may the object be approximated to
...e, the retinal picture is enlarged, causing the object
...pear magnified in the same proportion. Not only,
...er, are the component rays of each pencil brought
...divergence into convergence, but the course of the
... themselves is changed, so that they enter the eye
... an angle corresponding to that under which they
... have arrived from a larger object situated at a
...r distance; and thus, as the picture formed upon the
... by the small object *ab*, fig. 1, corresponds in all

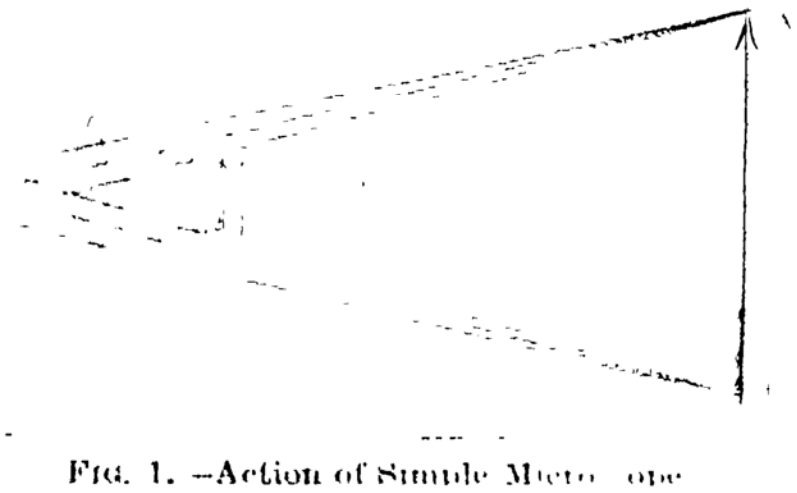


FIG. 1.—Action of Simple Microscope.

...ts with that which would have been made by the
...object AB of several times its linear dimension
...d at the nearest ordinary limit of distinct vision, the
... is seen (by the formation of a "virtual image") on
...nified scale.

...is obvious that the "magnifying power" of any
...x lens so used is measured by the ratio between the
...sions of the retinal picture formed with its assistance
...ose of the picture formed by the unaided eye. Thus,
...he use of a convex lens having 1 inch focal length
...n form a distinct retinal image of an object at only
...ch distance, this image will have ten times the
... dimensions of that formed by the same object at a
...ce of 10 inches, but will be only eight times as large
...e picture formed when the object can be seen by
...ry vision at 8 inches distance, and only four times
...ge as the picture of the same object formed by a
...c eye at a distance of 4 inches. It is usual to
...te the magnifying power of single lenses (or of com-
...ons that are used as such) by the number of times that
...ocal length is contained in 10 inches,—that of 1 inch
... being thus taken as ten times, that of $\frac{1}{10}$ inch as
...ndred times, and so on. But the rule is obviously
...ary, as the actual magnifying power varies in each
...dual with the nearest limit of distinct vision. Thus
...e myopic who can see an object clearly at 4 inches
...ce, the magnifying powers of a 1 inch and $\frac{1}{10}$ inch
...ill be only 4 and 40 respectively. The amplifying
... of every single convex lens, however, is impaired (1)
...at inability to bring to the same focus the rays which fall upon the central and the marginal parts of its ... which is called "spherical aberration," and (2) ... dispersion of the rays of different wave lengths, in ... of their different refrangibilities, which produces co... fringes around the points and lines of the visual p... and is therefore called "chromatic aberration" (see ... These aberrations increase with the "angle of ape... given to the lens, that is, with the proportion betwe... diameter of its actual "opening" and the focal dist... the object, and thus, when a single lens of very ... focus is used in order to gain a high magnifying ... such a reduction of its aperture by a perforated diap... or "stop" becomes necessary (in order, by exc... the peripheral rays, to obtain tolerable "defin... with freedom from false colour) that the amo... light admitted to the eye is so small as only to all... most transparent objects to be thus viewed, and ... only very imperfectly. In order to remedy this ... back, it was proposed by Sir D. Brewster to use ... of glass, in the construction of simple microscopes ... transparent minerals as have high refractive wi... dispersive power, in which case the same optical ... could be obtained with lenses of much lower cur... and the aperture might be proportionately enlarged. ... combination of qualities is found in the diamond, ... index of refraction bears such a proportion to that ... that a diamond lens having a radius of curvature of 8 ... give the same magnifying power as a glass lens whose ... of curvature is 3, while the "longitudinal aberr... (or distance between the foci of central and of m... rays) would be in a diamond lens only one ninth ... of a glass lens having the same power and aperture; ... ting aside, however, the costliness of the material a... difficulty of working it, a source of imperfection aris... a frequent want of homogeneousness in the diamond ... which has proved sufficient to make a lens worked ... give a double or even a triple image. Similar at... made by Mr Pritchard with sapphire proved more succ... and, as a sapphire lens having a radius of curvatu... has the same focus and gives the same magnifying ... as a crown glass lens having a radius of 3, it was fo... bear a much larger aperture without serious impa... by either spherical or chromatic aberration. ... sapphire, however, possesses the property of double ... tion, the duplication of the markings of the object ... retinal image constitutes a very serious drawback ... utility of lenses constructed of this mineral, for, ... the double refraction may be reduced almost to n... by turning the convex side of the lens towards the ... yet, as this is the worst position in regard to sp... aberration, more is lost than is gained. Forti... however, for biological investigators working with ... microscopes, the introduction of the Wollaston ... superseded the necessity of any further attempts at ... costly jewels to account ... high-power magnifiers.

Wollaston Doublet.—This consists of a combina... two plano-convex lenses, whose focal lengths (as dire... Dr Wollaston) should be as 3 to 1, with their pla... turned towards the object, the smaller lens being ... lowest, and the upper lens at a distance of one and ... times its focal length above it. This constructio... ever, has been subsequently improved—(1) by the i... tion of a perforated diaphragm between the ... uses; ... a more effective adjustment of the distance betw... two lenses, which seems to be most satisfactory w... equals the difference of their respective focal ... allowance being made for their thickness; and (3) ... division of the power of the lower lens (when a ... focus than $\frac{1}{10}$ inch is required) into two, so as t... a "triplet." When combinations of this kind a...

eted, spherical aberration is almost wholly got rid chromatic dispersion is so slight that the angle of e may be considerably enlarged without much of distinctness. Such "doublets" and "triplets," been brought into use in England while the com- microscope still retained its original imperfections, very serviceable to such as were at that time ting minute biological investigations: for example, mirable researches of Dr Sharpey on ciliary action nals (1830-35) and Mr Henry Slack's beautiful ons of the elementary tissues of plants, as well as ellent observations on vegetable cyclosis (1831), ade by their means. No one, however, would now lla.ton "doublet" or "triplets" of high power in a compound achromatic microscope; and for the microscopes of low power that are useful either for g or for picking out minute specimens (such as other constructions are preferable, as giving a ield and more light. As a hand magnifier the ngton lens, which is a sphere of glass with a oove ground out of its equatorial portion, has lvantages.[1] By making this groove sufficiently oth spherical and chromatic aberrations can be almost insensible, and, as the rays falling on any he spherical surface can only pass to the eye either or near the centre, the action of every part of that the same, so that the image of the object will be ht, the eye (when properly focussed) whether its parts r to the axis of the sphere or more remote from it, is be itself turned to one side or the other. Again, athematically shown by Sir John Herschel in 1821 the combination of a meniscus with a double con- the four surfaces of these lenses having certain onate curvatures spherical aberration could be extinguished for rays parallel to the axis, the tion being thus an "aplanatic" doublet, while combination, which he termed a "periscope," gives a remarkable range of oblique vision with vers, and almost entirely extinguishes chromatic on, although at the expense of residual spherical on. These combinations have been mounted both -magnifiers and as single microscopes, for both rposes they are much superior to single lenses of magnifying power. But such combinations have atly improved by the introduction of concave of s, so as to render them achromatic as well as e, and nothing, according to the writer's experi- n now be used with greater advantage for all the s answered either by the simple microscope or d magnifier than Browning's "platyscopic" lenses "achromatic doublets" of Steinheil of Munich the combinations gives a large flat field, with t light, admirable definition, and freedom from ion.

pared above "doublets" of very short focus were used in order to be magnifying power, it was requisite to mount n that would enable the focal adjustment to be d would permit the use of a special illuminating apparatus at one side. But now that comparatively low powers employed the coarse rack and pinion movement is quite for their focal adjustment and nothing more is required

difficult to understand how the name of Coddington came to ned to the grooved lens, seeing that he neither was nor to be the inventor of it. Dr Wollaston's first "doublet" of a pair of plano-convex lenses with their plane surfaces to each other, and a stop diaphragm with central aperture placed them. Sir D. Brewster has shown that this construction is most ous when the two lenses are hemispheres, and the central between their two plane surfaces is filled up by a transparent ving the same refractive index as glass. And from this the is obvious to the grooved sphere, which had been made for rewster long before the high commendation it received from ngton brought it into general repute.

for the illumination of the object than a concave mirror beneath the stage when it is transparent, and a condensing lens above when it is opaque. The various patterns of simple microscope now made by different makers vary in their construction, chiefly in regard to portability, the size of their stages, and the mode in which "rests" or supports to the hands are provided. These, in Continental instruments, are very commonly attached to the stage; but, unless the stage itself and the pillar to which it is fixed are extremely massive, the resting of the hands on the supports is apt to depress the stage in a degree that affects the focal adjustment; and where portability is not an object it seems better that the hand-supports should be independent of the stage. For a laboratory microscope, the pattern represented in fig. 2 has been found very convenient,—the framework being of mahogany or other hard wood, the stage

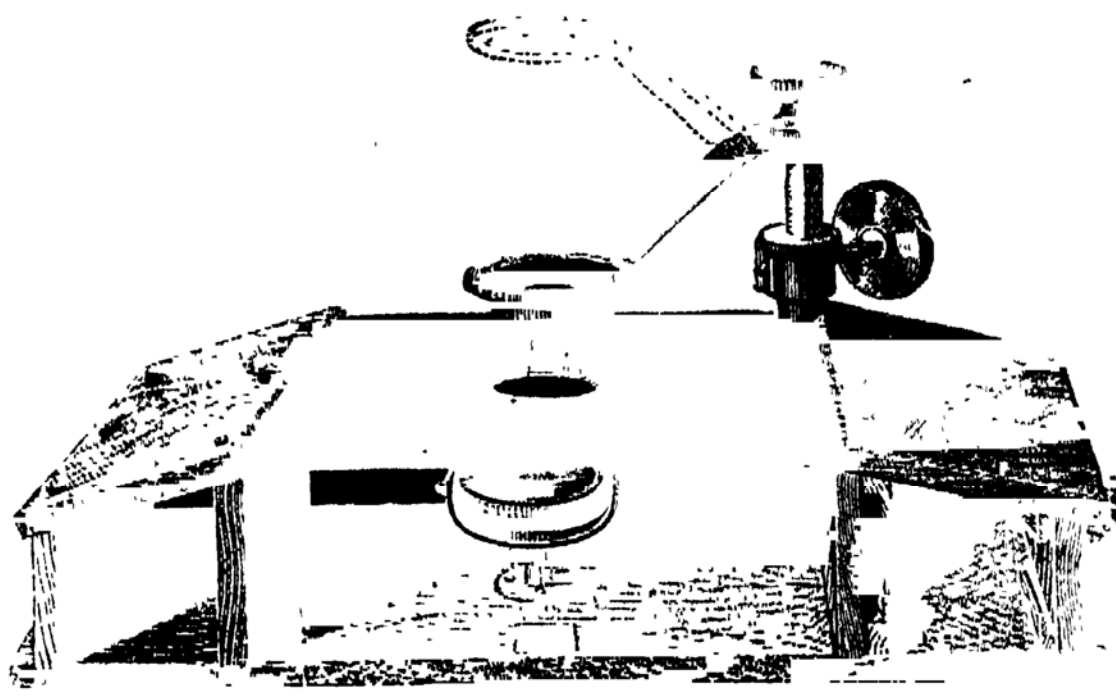


Fig. 2.—Laboratory Dissecting Microscope.

being large enough to admit a dissection or carry a water-trough of considerable size, and the bent arm that carries the "powers" being made capable of reversion, so as to permit the use of lenses of very long as well as of very short focus. As it is desirable that the stage should not be acted on chemically by sea-water, acids, or other reagents, it may be made either of a square of plate-glass or of a plate of ebonite with an aperture in the middle; and either of these may be made to slide in grooves in the side supports, so that one may be substituted for the other. The arm may be easily made (if desired) to carry the body of a compound microscope, so as to apply it to the examination of objects dissected or otherwise prepared under the simple microscope, without transferring them to another instrument. A portable form of simple microscope is shown in fig. 30.

Compound Microscope.—The placing of two convex lenses in such relative positions that one should magnify an enlarged image of a small near object formed by the other naturally soon followed the invention of the telescope, and seems to have first occurred to Hans Zansz or his son Zacharias Zansz, spectacle makers at Middelburg in Holland, about 1590. One of their compound microscopes, which they presented to Prince Maurice, was in the year 1617 in the possession of Cornelius Drebell of Alkmaar, who then resided in London as mathematician to king James I. In order to make clear the successive stages by which the rude and imperfect microscope of that period has, after remaining for two centuries unimproved in any essential particular, been developed within the last half-century into one of the most important instruments of scientific research that the combination of theoretical acumen and manipulative skill has ever produced, it is necessary to explain the principle of its construction, and to show wherein lay the imperfection of its earlier form.

In its simplest construction, as already stated, the compound microscope consists of only two lenses,—the "object-glass" OD, fig. 3, which receives the light-rays direct from the object AB placed near it, and forms an enlarged but reversed image A′B′ at a greater distance on the other side, and the "eye glass" LM, which receives the rays that diverge from the several points of this image as if they proceeded from the points of an actual object occupying the position and enlarged to the dimensions A′B′, and brings these to the eye at E, so altering their course as to

simple microscope in magnifying that image to the
r. It was early found useful, however, to interpose
lens FF, fig. 4 (the "field-glass"), between the
glass and the image formed by it, for the purpose
ng such a slight convergence to the pencil of rays as
duce the dimensions of the image, and thus allow
r part of it to come within the range of the eye

Diagram of Simplest
of Compound Micro-

FIG. 4. Diagram of Complete
Compound Microscope.

so that more of the object can be seen at once.
t was soon perceived that the eye-glass and the
ass might be advantageously combined into an
piece," in which a perforated diaphragm might be
d at the focal plane of the image (*i.e.*, in the focus of
e-glass), so as, by cutting off the peripheral portion
field of view, to limit it to what can be seen with
le distinctness.

s obvious that the magnifying power of such an
ment would depend (1) on the proportion between
ze of the image formed at BB and that of the
object, and (2) upon the magnifying power of the
ss. And further the proportion which the size of
age bears to that of the object depends upon two
,—(1) the focal length of the object glass, and
e distance between the object-glass and the plan
ccupied by the image it forms. If we dimmish
cal length of the object-glass, the object must be
t nearer to it, so that, while the distance of the
on the other side remains unchanged, that distance
to bear a larger proportion to the distance of the
and the size of the image is augmented in a cor-
ding ratio. On the other hand, the object glass
ning unchanged, the distance at which it forms the
of the object can be increased by a lengthening of the
f the microscope; and, as this involves a shortening
of the distance between the object-glass and the obje
proportion which the former bears to the latter is augm
and the image is correspondingly enlarged. Th
increase in the magnifying power of the compound
scope may be gained in three modes, which may b
either separately or in double or triple combination,
(1) shortening the focus of the object-glass, (2) lengt
the tube of the microscope, and (3) increasing the ma
ng power of the eye glass by shortening its focus.
t may be remarked, also lengthens the distance
mage from the object glass, by bringing the foca
BB nearer the eye glass. The second of these m
was not unfrequently used in the older microscopes,
were sometimes made to draw out like telescopes, s
increase the amplifying power of their object glasses.
whilst very inconvenient to the observer, such a len
ing of the one distance involved such a shortening
other as greatly impaired the distinctness of the im
increasing the aberrations of the object glass, so th
method came to be generally abandoned for one of the
two

When lenses of from 1 to 4 inches focus were u
object glasses, and their apertures were restricted by
to the central part of each, tolerably distinct image
given of the larger structural arrangements of such obj
sections of wood or the more transparent wings of ins
which images would bear a further moderate enlarg
by the eye glass without any serious deterioration ei
want of definition or the introduction of colour f
But when lenses of less than 1 inch focus were em
in order to obtain a higher magnifying power, the
obliquity of the rays so greatly increased their aber
that defective definition and the introduction o
colours went far to nullify any advantage obtainabl
the higher amplification, while the limitation
aperture required to keep these aberrations withi
moderate limits occasioned such a loss of light a
seriously to detract from the value of the picture.
other hand, the use of deeper eye pieces to enlarg
images formed by the object glasses not only brou
more strongly all the defects of those images, but intr
a new set of errors of their own, so that very litt
gained by that mode of amplification. Hence many
best of the older microscopists (notably LEEUWE
q.v.) made some of their most valuable discoveries
use of the simple microscope; and the amount of ex
work thus done surprises every one who studies the
of microscopic inquiry. This was still more the
already stated, when the use of single lenses of ver
focus was superseded by the introduction of the Wo
doublet. And the substitution of these doublets
single lenses of object glasses, while the single lens
eye glass was replaced by a Herschel's aplanatic d
and the field glass was a convex lens whose two curv
the proportion of 1:6 (the form of least spherical
tion), constituted the greatest improvement of wh
instrument seemed capable in pre-achromatic times.

It has been only within the last sixty years (18
that the microscope has undergone the important i
ment which had been worked out by Dollond
refracting telescope more than sixty years previ
namely, the correction of the chromatic aberration
objectives by the combination of concave lenses

[1] This combination was made in the first microscope of w
writer became possessed, about the year 1830, and he well
the great superiority to any compound microscope of the old
tion which was proved by its power of separating the lin
Menelaus scale, and of bringing into view the detail of the str
animalcules, with a clearness that only an achromatized ob
could surpass.

with convex lenses of crown, while their spherical
tion is corrected by the combination (as in Herschel's
tic doublet) of convex and concave surfaces of
nt curvatures. The minute size and high curvature
lenses required as microscopic objectives were long
ered as altogether precluding the possibility of success
production of such combinations, more especially
condition, they would have to meet differ altogether
those under which telescopic object-glasses are
yed. For the rays from distant objects fall upon the
with virtual parallelism and the higher the power
ed the longer is the focus given to them, and the
r is the deflexion of the rays. In the microscope, on
ner hand, the object is so closely approximated to the
ve that the rays which proceed to it from the latter
always a very considerable divergence; and the
on to which they are subjected increases with that
ion of the focal length of the objective which is
cessary condition of the increase of its magnifying
And thus, although the telescopic "triplet"
l out by Dollond (consisting of a double concave of
ass, interposed between two double convex lenses of
can be so constructed as to be not only completely
ic (or free from spherical aberration) but almost
tely achromatic (or free from chromatic aberration),
nstruction is only suitable for microscopic objectives
foci and small angular aperture, the rays falling
ich have but a very moderate divergence. At
, as will presently appear, some of the early attempts
achromatization of the microscope were made in
rection, it was soon abandoned for other plans of
ction, which were found to be alike theoretica
retically superior.

eems to have been by Professor Amici, in
, about 1812, that the first attempts were made at
romatization of microscopic objectives, but, these
ts not proving successful, he turned his attention to
oduction of a reflecting micro-scope, which was a
improvement upon the non achromatized compound
opes then in use. In the year 1820, however, the
was taken up by Selligues and Chevalier of Paris,
dopted the plan of superposing three or four com
e, each consisting of a double convex of crown
d to a plano concave of flint. The back combina
at nearest to the eye) was of somewhat lower po ver
ose placed in front of it, but these last w of
e focus, and no attempt was made by these opticians
the construction of the several pairs thus united
to make them correct each other's aberrations
although a considerable magnifying power could
obtained, with an almost complete extinction of
the aberration, the aperture of these objectives
not be greatly widened without the impairment of
definition of the image by a "coma" proceeding
uncorrected spherical aberration.

Ignorance, it would appear, of what was being done
Paris opticians, and at the instigation of Dr Goring
ntific amateur, Mr Tulley, well known in London
able constructor of telescopic objectives, began,
he year 1824, to work object glasses for the micro
on the telescope plan. After many trials[1] he
ed, in 1825, in producing a triplet of $\frac{3}{10}$ inch focus,
ng a pencil of 18°, which was so well corrected as
form very satisfactorily with an eye-piece giving a
ying power of 120 diameters. He afterwards made
r triplet of shorter focus, which, when placed in
front of the previous one, increased the angle of th
mitted pencil to 38°, and bore an eye-piece gi
magnifying power of 300 diameters. These tripl
said by Mr Ross to have never been exceeded by any
combinations for accurate correction throughout the

Having come into possession, at the end of 1
an objective of Chevalier's construction, Mr J. J.
carefully examined its properties, and compared the
those of Tulley's triplets; and this comparison hav
him to institute further experiments he obtained
which were at first so conflicting that they mus
proved utterly bewildering to a less acute mind,[2] bu
finally led him to the enunciation of the principle on
all the best microscopic objectives are now const
For he discovered that the performance of such
posite objectives greatly depends upon the relative p
of their component combinations,- the effect of t
plano concave upon the spherical aberration produ
the double convex of crown varying remarkably ac
to the distance of the luminous point from the from
objective. If the radiant is at a considerable dista
rays proceeding from it have their spherical error
corrected; but, as the source of light is brought ne
the glass, the flint lens produces greater propor
effect, and the under-correction diminishes, until at
a point is reached where it disappears entirely, th
being all brought to one point at the conjugate f
the lens. This then, is one aplanatic focus. If, h
the luminous point is brought still nearer to the gl
influence of the flint continues for a time to increa
he opposite condition of over correction shows itself
on still further approximation of the radiant, th
comes to operate with less effect, the excess of co
diminishes and at a point still nearer to the glass va
and a second aplanatic focus appears. From thi
onwards under correction takes the place of over-cor
and increases till the object touches the surface
glas As every such doublet, therefore, has two ap
foci for all points between which it is over-corrected
for all points beyond it is under-corrected, the opt
enabled to combine two or more doublets with
security against spherical error. This will be
avoided if the rays be received by the front glass f
shorter aplanatic focus, and transmitted through th
glass in the direction of its longer aplanatic pene
the approximation of the two doublets over-correcti
be reduced, while their separation will produce an
rection; and thus, by merely varying the distance b
two such combinations, the correction of the sp
error may be either increased or diminished accordi
definite rule. Slight defects in one glass may t
remedied by simply altering its position in relation
other, an alteration which may be made with ver
disturbance of the colour-correction. This imp
principle was developed and illustrated by Mr List
memoir read to the Royal Society on January 21,
On some Properties in Achromatic Object-glasses, app
to the Improvement of the Microscope; and it was by
ing on the lines there laid down that the three
opticians Ross,[3] Powell, and James Smith soo

[1] due to Mr Joseph J. Lister to mention that Tulley's final
with this low power seems to have been attained by working
gestion given him by that gentleman. See *Monthly Micro-*
Journal, vol. III. (1870), p. 134.

[2] Thus he found that, while each of Chevalier's doublet
lens, when used singly, presented a "blur" or "coma" o
this coma, instead of being exaggerated by the combination o
these doublets, was much diminished. On the other han
two of Tulley's triplets, each of which performed admi
itself, were used together, the images of all objects not in th
presented a strong blur inwards with an under-correction of co

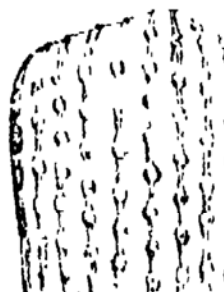
[3] In 1837 Mr Lister gave Mr Ross a projection for an obj
$\frac{1}{4}$ inch focus, in which a triple front was combined with two d
The great superiority of this lens, admirably executed by Mr Ros
him to adopt its plan as the standard one for high powers; and
in general use,—the back lens also being sometimes made as

microscopic objectives that surpassed any then con-
ted on the Continent, while the subsequent adoption
e same principles by French and German opticians,
o by Professor Amici of Florence, soon raised their
tives to a corresponding level.

has proved more advantageous in practice to
the several components of an achromatic objective
ct each others' aberrations than to attempt to render
perfect in itself; and the mode in which this is
nplished will vary with the focus and angular aperture
to each combination. Thus, while a single "telescopic
t" answers very well for the lowest power usually
(4 inches focus), and the same plan may be used
gh at the sacrifice of angular aperture for objectives
inches, 2 inches, and even 1 inch focus, the best per
ance of these powers requires the combination of two
lets. And, while this last system also serves for
tives of $\frac{3}{4}$ inch and $\frac{1}{2}$ inch of low angle, a third com
nt is required for giving to these objectives the
ure that renders them most serviceable, as well as for
gher powers. Instead of combining three achromatic
lets, however, many makers prefer placing in front a
convex of crown, and adding a third lens of crown to
oublet at the back, still using a doublet in the middle,
whole combination thus consisting of six lenses, four
rown and two of flint. Further, Mr Wenham has
n that the whole colour-correction may be effected in
iddle by interposing a double concave of dense flint
een two double-convex lenses of crown, the back lens,
ll as the front, being then a plano-convex of crown,
ng five lenses in all. This plan of construction, though
le to objectives of moderate angular aperture, and
ntageous in regard to comparative simplicity and
my of construction, does not seem so well adapted for
tives to which the largest attainable aperture is to be
, these being usually constructed with a triplet in
, a doublet in the middle, and a triplet at the back, so
consist of eight separate lenses. And the first class
ructors of achromatic objectives in the United States
ly place in front of these, in their highest powers, a
plano-convex of crown, by the addition of which a
er working distance can be obtained. But, as every
addition increases the liability to error from imper-
ons in the centring and grinding of the lenses (as
as loss of light by the partial reflexion of oblique
from their surfaces), it is obvious that the most exact
manship, involving a proportionate costliness, is
red to bring out the full effect of such complex com
tion. And where angular aperture is regarded as the
ty of primary importance it will be usually found
rable to have recourse to objectives constructed on
r the "water" or the "oil" immersion system, to be
ntly described.

e great increase thus attained in the perfection
e corrections of microscopic objectives for both
cical and chromatic aberration of course rendered
ssible to make a corresponding increase in their
lar aperture. The minute scales of the wings of
erflies and other insects were naturally among the
ts much examined; and it was soon perceived that
in lines and other markings became clearly discernible
ese scales with objectives of what was then considered
angle which were utterly undistinguishable with
achromatized microscopes (however high their magnifying
power), and very imperfectly shown under achromatic
tives of small angle. Hence these scales came to be
as "test-objects," for judging of the "definition" and
olving power" of microscopic objectives, the former
erty consisting in the clearness, sharpness, and freedom
false colour of the microscopic images of boundary
lines, and depending on the accuracy with which th
rations are corrected, while the latter term designat
power of separating very closely approximated m
which is now known to be a
"function" of aperture. The
insect scales formerly most valued
for these purposes were those of
the *Morpho menelaus* (fig. 5) and
the similarly lined scales of the
Polyommatus argus (azure blue),
the "battledoor" scales of the
same butterfly (fig. 6), the ribbed
scales of the *Lepisma saccharina*
(sugar louse), and the minute and
peculiarly marked scales of the
Lepidocyrtus curvicollis (fig. 7),
commonly known as the *Podura*.
The writer recollects the time
when the satisfactory "resolution" of the first three of these
tests was considered a sufficient
proof of the go even
high power objective, and when
the *Podura*-markings, if visible at all, could only
distinguished as stria. The further opening
aperture, however enabled these stri
to be resolved into rows of "exclamation marks," and, while there is still
some uncertainty as to the precise
structure of which these markings are
the optical expression, practical opticians are generally agreed that the
Podura scale is very useful as a test
for definition, with even the highest
objectives, though it only
test for a very moderate degree of re
solving power. For the latter purpose
it has been completely superseded by
the closely approximated markings of
the silicified envelop of the
diatoms (which, however, show them
selves in very different aspects according to the conditions under which they are vie
8, 11), and also by lines artificially ruled on gla
Nobert's "test plate," the number
of lines in the nineteen bands of
which is stated by M. Nobert
to range from 1000 to 10,000
to a Paris line, while Dr Royston
Pigott gives the number in an
English inch as 11,529 to the inch
in the first band and 112,590
in the nineteenth. This last
dimension (as will afterwards
appear) approaches the minimum
distance at which such markings
are theoretically separable by any
magnifying power of the microscope.

The enlargement of the angle
of aperture of microscopic objectives and the greater completeness of their corrections, which
were obtained in the first instance by the adoption of Mr
Lister's principles, and were demonstrated by the resolution of
the test-objects then in use, soon rendered sen
imperfection in their performance under certain
stances, which had previously passed unnoticed;



tant discovery was made by Mr Andrew Ross that
y decided difference exists in the precision of the
according as the object is viewed with or without
ring of thin glass, as also according as this cover is
r thick.[1] As this difference increases in proportion
widening of the aperture, it would obviously be a

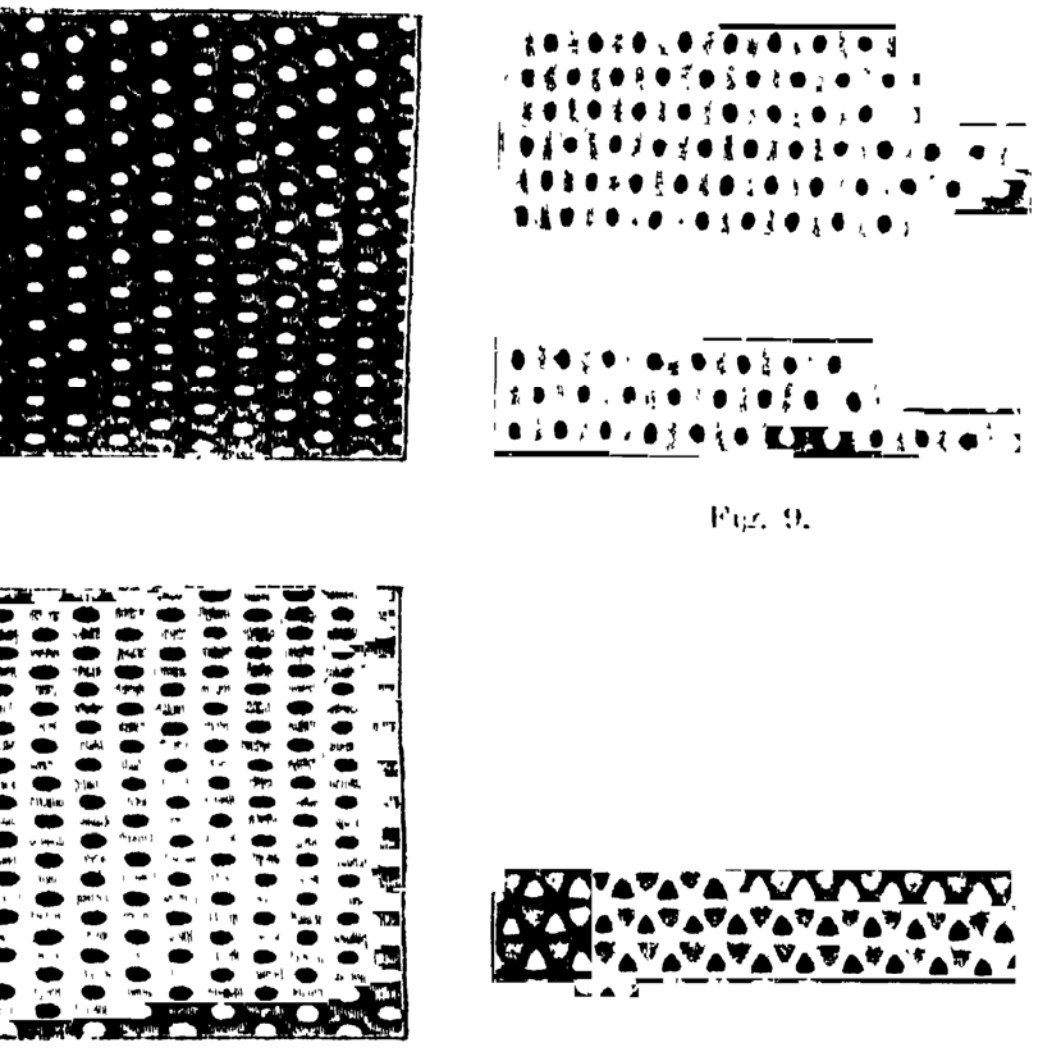


Fig. 9.

Fig. 10

of silicone, V ve of *Pleurosigma angulatum* from a Photo-
taken by Central Illumination. Magnified 2000 diameters.

ot great error and embarrassment if a means could
found for its rectification. Its optical source, how
having been found by Mr Ross to lie in the
ive aberration' which is produced in the rays
ing from the object to the front glass of the objec
the interposition of the plane glass cover, and
increases with its thickness, his practical ability
him at the same time to indicate the remedy,
consists in under correcting the front lens and over
ng the two pos
ombinations, and
ing the distance
n the former and
tter capable of
ent by means of
collar, as shown
12. For when
t pair is approxi-
most nearly to the
and its distance
he object is in-
its excess of
aberration is
strongly exerted
he other two pairs
is in the con
conditions, and
eutralizes the negative aberration produced by the
sition of the covering glass. This correction is not
for objectives of low or medium power and small
aperture; but it should always be provided when
gle exceeds 50°, unless (as is now generally done

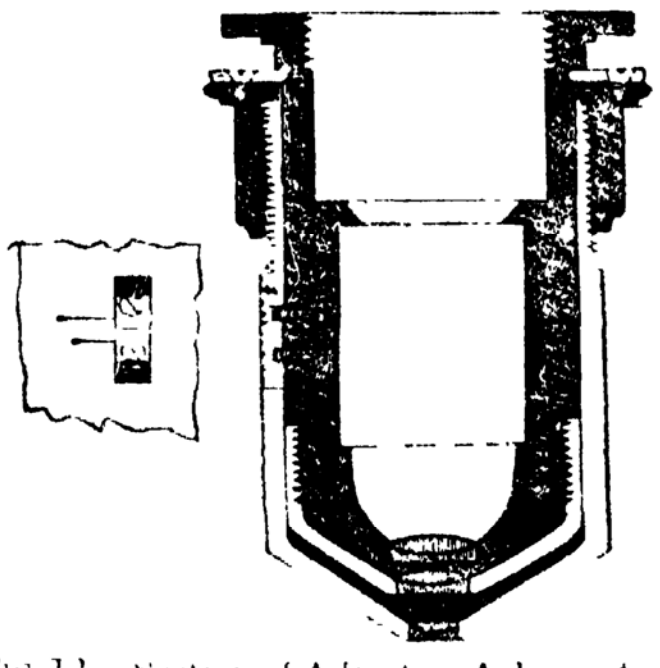


Fig. 11. Section of Adjusting Achromatic Object Glass. A, uncovered, B, covered.

in the case of objectives constructed for studen
the maker adjusts them originally, not for un
objects, but for objects covered with glass of a st
thickness, say 0·005 or 0·004 inch. A departur
that standard to the extent of one or two thousan
an inch in either direction, though extremely in
to the performance of objectives whose aperture is
more, scarcely makes itself perceptible in those of
100°. And the same may be said in regard
immersion objectives next to be described, whi
peculiarly suitable to the purposes of minute histo
research.

Immersion System. It was long since pointed
Professor Amici that the introduction of a drop o
between the front surface of the objective and eit
object itself or its covering glass would diminish t
of light resulting from the passage of the rays fr
object or its covering-glass into air, and from air i
front glass of the objective. It was obvious to him
over, that when the rays enter the object-glass from
instead of from air, both its refractive and its dis
action will be so greatly changed as to need an imp
constructive modification to meet the new condition.
modification seems never to have been successfully
by Amici himself; but his idea was taken up by t
eminent Paris opticians, MM. Hartnack and Nache
showed that the application of what is now known
"immersion system" to objectives of short focus an
angular aperture is attended, not merely with the
tages expected by Professor Amici, but with others o
he did not reckon. As the loss of light by the refle
a portion of the incident rays increases with the ob
of their incidence, and as the proportional loss is far
when the oblique rays pass into glass from wate
when they enter it from air, the advantage of i
ing the angular aperture is more fully expe
with "immersion" than with "dry" objectives,
Professor Amici anticipated. But, further, the
sion system allows of a greater working distance b
the objective and the object than can be attained
dry or air objective having the same angular ap
and this increase affords not only a greater freed
manipulation, but also a greater range of "penetr
or "focal depth." Further, the observer is rende
much less dependent upon the exactness of his
correction that it is found that water-immersion obj
of high power and considerable angular aperture, ext
well adapted for the ordinary purposes of scientific
tigation, can be constructed without it,—a small dep
from the standard thickness of covering-glass to whic
objectives are adjusted by the maker having scarce
effect upon the distinctness of the image. It is n
practice of several makers to supply two fronts to obj
of $\frac{1}{10}$ or $\frac{1}{12}$ inch focus, one of them fitting the object
use "dry" (that is, in air), whilst the substitution
other converts it into a water-immersion objective.
in the objectives constructed on Mr Wenham's syst
change in the front glass is needed, all that is necess
making them work as immersion-lenses being a yet
approximation of the front lens to the second combi
which can be made by the screw-collar.

Within the last few years, however, the imm
system has undergone a still further and most imp
development, by the adoption of a method ori
suggested by Mr Wenham (though never carried
him), and independently suggested by Mr Stephen
Professor Abbe of Jena, under whose direction it w
worked out by Zeiss (the very able optician of Jena
has been followed by Powell and Lealand of Lon
well as by several other constructors of achromatic

oth in England and elsewhere, with complete
This method consists in the replacement of the
reviously interposed between the covering-glass and
nt glass of the objective by a liquid having the same
ve and dispersive powers as crown-glass, so that the
uing at any angle from the upper plane surface of
ering-glass shall enter the plane front of the objec-
thout any deflexion from their straight course, and
any sensible loss by reflexion,- even the most
rays that proceed from the object keeping their
n unchanged until they meet the back or convex
of the front lens of the objective. It is obvious
the advantages derivable from the system of water
ion will be still more thoroughly attained by this
of "homogeneous" immersion, provided that a fluid
obtained which meets its requirements. After a
urse of experiments, Professor Abbe found that oil
r wood so nearly corresponds with crown glass, alike
active and in dispersive power, as to serve the
extremely well, except when it is desired to take
advantage of the most divergent or marginal rays,
ennel being then preferable. There are, however,
objections to the use of these essential oils in the
y work of research; and it seems not unlikely that
ion of some one or more saline substances will be
more suitable. In addition to the benefit conferred
water immersion system, and more completely
d with the homogeneous, it may be specially pointed
at, as no correction for the thickness of the covering-
s here required, the microscopist can feel assured
has such a view of his object as only the most per-
rrection of an air-objective can afford. This is a
of no small importance, for while, in looking at a
object, the practised microscopist can so adjust his
ective to the thickness of its covering-glass as to
ut its best performance, he cannot be sure, in regard
unknown object, what appearances it ought to pre-
nd may be led by imperfect cover-correction to an
ous conception of its structure.

s been recently argued that, as the slightest variation in the
ve index of either the immersion fluid or the covering glass,
ge of eye pieces, or the least alteration in the length of the
in a word, any circumstances differing in the slightest degree
hose under which the objective was corrected -must affect
formance of homogeneous-immersion objectives of the highest
hey should still be made adjustable. The truth of this
tion can, no doubt, be proved, not only theoretically, but
ally, -the introduction of the adjustment enabling an experi-
manipulator to attain the highest degree of perfection in the
ion of many mounted objects, which cannot be so well shown
bjectives in fixed settings. But it may well be questioned
r it is likely to do the same service in the hands of an ordi
orking histologist, and whether the scientific investigator will
d it preferable, when using these objectives, to accept what their
has fixed as their point of best performance. The principal
of error in his employment of them lies in the thickness of the
section of the object; for the rays proceeding from its deeper
having to pass through a medium intervening between that
nd the cover-glass, whose refractive and dispersive indices
from those of the glass and immersion-fluid, cannot be
t to so accurate a focus as those proceeding from the plane
iately beneath the cover-glass. The remedy for this, how
seems to lie rather in making the preparation as thin as
le than in the introduction of what is likely, in any but the
kilful and experienced hands, to prove a new source of error
one who has examined muscular fibre, for example, under a
jective of very high power and large aperture, well knows
great an alteration is produced in its aspect by the slightest
in either the focal adjustment or the cover-correction
t is impossible to say with certainty what are the appear
which give the most correct optical expression of its structure.
eing a matter of judgment on the part of each observer, it
obvious that the nearest approach to a correct view will be
ly given by the focal adjustment of the best homogeneous
sion-objectives, in fixed settings, to the plane of the prepara-
mmediately beneath the cover-glass (see *Jour. Roy. Micros.* 1882, pp. 407, 854, 906).

In every particular in which the water-imm
system is superior to the dry, it is itself surpasse
the oil or other homogeneous system, the ant
tions of those by whom it was suggested being thus
realized. But the advantages already spoken of as
able from the use of the "immersion system" are altog
surpassed by that which the theoretical studies of Pro
Abbe have led him to assign to it, and of which h
practically demonstrated its possession. For he has s
(as will be explained below) that the interposition of
water or oil so greatly increases the real "apertu
the objective that immersion-objectives may be constr
having a far greater virtual aperture than even the
retical maximum (180°) of the angular aperture
air-objective.

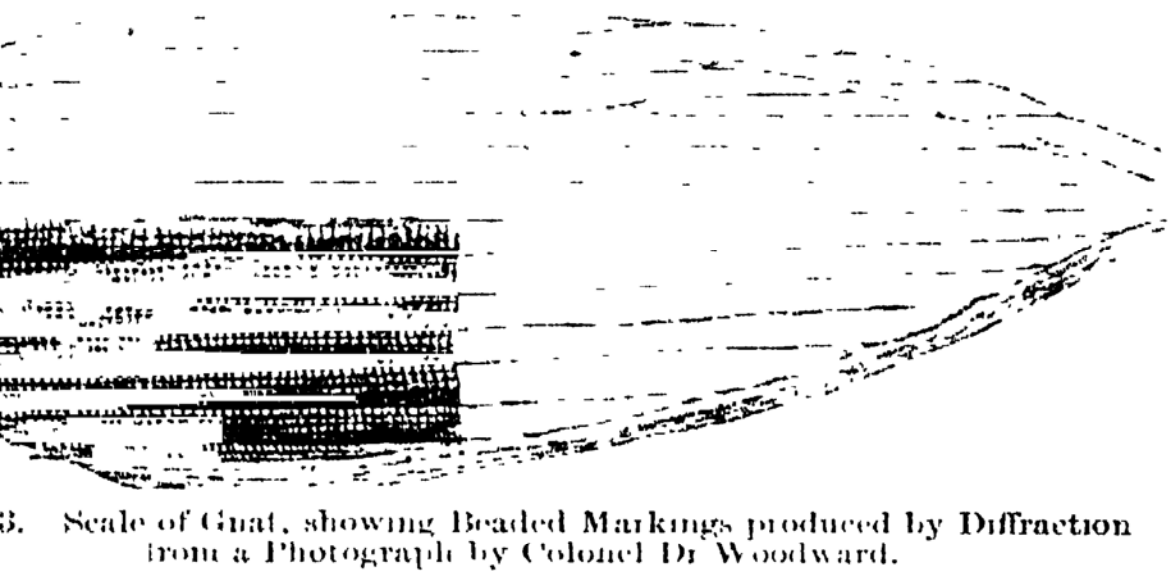
The same eminent physicist, working on the
supplied by the mathematical investigations of Pro
Helmholtz and himself on the undulatory theory of
has further established an entirely new doctrine in
to the production of highly magnified representatio
closely approximated markings. All that has hi
been said of the formation of images by the comp
microscope relates to such as are produced, in accor
with the laws of refraction, by the alteration in dir
which the light rays undergo in their passage throu
lenses interposed between the object and the eye.
dioptric images, when formed by lenses free from sp
and chromatic aberration, are geometrically correct pi
truly representing the appearances which the objects
selves would present were they enlarged to the sam
and viewed under similar illumination. And we
justified, therefore, in drawing from such micr
images the same conclusions in regard to the objec
picture as we should draw from the direct vision of
objects having the same dimensions. The principal so
error in such interpretations arises out of the "interfe
to which the rays of light are subjected along the e
the minute objects through which they pass, or alo
such lines or margins in their inner part as are suffi
opaque to throw a definite shadow. For every
shadow must be bordered, more or less obviously, b
ference or diffraction spectra; and thus the ima
strongly-lined objects with very transparent interv
spaces may be so troubled or confused by these "diffr
spectra" as to render it very doubtful what interpr
is to be put upon their appearances.

A good example of this kind is afforded by the scale
gnat or mosquito, which are composed of a very delicate
membrane, strengthened by longitudinal ribs on both side
of the opposite sides uniting at the broad end of the scal
they generally terminate as bristle-shaped appendages bey
intermediate membrane. These are crossed by fine marking
are probably ridge like corrugations of the membrane, com
both sides of the scale. Between each pair of longitudina
there may be seen, under certain adjustments of focus and
nation, three uniform parallel rows of beads, which ha
supposed to represent a true structure in the membrane.
Woodward (colonel in the United States army), however, it
shown that this beaded appearance is merely the result of the
ferences" produced by the longitudinal and transverse lin
scale. For the longitudinal diffraction-lines are clearly se
in the microscopic image and in photographs (fig. 13), to ex
empty space beyond the contour of the scales, almost as f
ends of the bristles in which the parallel ribs termina
they vary in number with the varying obliquity of illumin
that in the same scale two, three, four, or even five rows
can be seen, and photographed at pleasure, in every in
space.[1]

Every microscopist who has worked much wi
powers is well aware of the difficulty of disting
between real and spectral markings, a difficulty wh
only be overcome by training and experience. It

[1] *Monthly Micros. Jour.*, vol. xv. (1876), p. 253.

er, to have been now fully ascertained by Pro- Abbe that it is only through such diffraction-spectra he microscope can make us acquainted with the est structural features of objects, since, according calculations of Professor Helmholtz and himself on the constants of the undulatory theory), no nt of magnifying power can separate dioptrically two apertures, or markings of any kind, not more than of an inch apart. The visual differentiation or lution" of lines or other markings whose distance lies



3. Scale of Gnat, showing Beaded Markings produced by Diffraction from a Photograph by Colonel Dr Woodward.

that limit is entirely the result of "interference," jective receiving and transmitting, not only dioptric out the inflected rays whose course has been altered r passage through the object by the peculiar disposi- f its particles, and combining these rays into a series raction-spectra, the number and relative position of bear a relation to the structural arrangement on their production depends. If the objective be per- corrected, and all the diffraction-spectra he within l, these will be recombined by the eye-piece so as to secondary or "diffraction" image, lying in the same with the dioptric image, and coinciding with it, while up its outlines by supplying intermediate details. here the markings (of whatever nature) are so closely imated as to produce a wide dispersion of the inter- spectra, only a part of them may fall within the of the objective and the recombination of these by ye-piece may produce a diffraction-image diffe or less completely (perhaps even totally) from the ucture; while, if they should he entirely outside ld of the objective, no secondary or diffraction image produced. And thus, while the general form of n object as a diatom-valve may be correctly given in tric image, its surface may appear quite unmarked an objective of small aperture, however great its fying power, though covered with regularly disposed ngs when seen through an objective of wider aperture erhaps only half the magnifying power.

s obvious, however, that, while the dioptric image sents the actual object, the diffraction-image thus l by the reunion of a portion of the interference s only an optical expression of the result of their l recombination, which may represent something ly different from the real structure. For it has been l experimentally, by placing finely-ruled gratings in osition of object, and by limiting the apertures of ives by diaphragms with variously disposed perfora that the same arrangement of lines shall be presented e eye by differently lined surfaces, and different gements by similarly lined surfaces, according to the ers and relative positions of the reunited spectra. it is clear that there must be an essential difference aracter and trustworthiness between the images ically formed of the general outlines and larger of microscopic objects and those representations of iner details which are given by the recombination of their diffraction-spectra,[1] and that the confidence placed in the latter class of representations will be in proportion to the completeness of the recombina the separated interference-spectra, which, again, proportional (accurate correction of the aberrations assumed) to the aperture of the objective.[2]

The combined advance of scientific theory a practical skill in the application of it have now b up the compound achromatic microscope to an optic fection that renders it capable of actually doing everything of which, in the present state of theory, it can be regarded as capable. The res of Nobert's nineteenth band, having 112,59 to an inch, which was long regarded as the microscopists, is now found so easy as to leav room for doubt that, if a new test were obt having the *minimum visibile* of 118,000 lines inch, an oil-immersion objective would be fo resolve it. But the experience of the past m evident that, as no limit can be set to the a of optical theory, results yet more remarkable still expected to arise, every such advance being to account by the practical skill which experie now enabled the best constructors of achrom jectives to attain.[3]

The progressive improvements thus effected in the cons of microscopic objectives have been accompanied by other i ments, alike in the optical and in the mechanical arrangen which the best performance of these objectives can be secu it will be desirable now to describe in succession the most a forms of the eye piece, the objective, and the illuminating a respectively, and then those of the instrument as a whole ng out the special adaptiveness of each to the requiren different classes of scientific investigators.

Eye-Pieces.

It very early became obvious to those who were en the achromatization of microscopic objectives that th performance was obtained when the image given by th further enlarged by the eye-piece known as the Huyge having been devised by Huygens for his telescopes. It of two plano-convex lenses (EE and FF, fig. 4), with th sides towards the eye; these are placed at a distance equa the sum of their focal lengths,—or, to speak with more p at half the sum of the focal length of the eye-glass, and of tance from the field-glass at which an image of the obj would be formed by it. A "stop" or diaphragm BB placed between the two lenses, in the visual focus of the e which is, of course, the position wherein the image of th will be formed by the rays brought into convergence passage through the field-glass. Huygens devised this ment merely to diminish the spherical aberration; but it w quently shown by Boscovich that the chromatic dispersion in great part corrected by it. Since the introduction of ach object-glasses for compound microscopes, it has been furthe that nearly all error may be avoided by a slight over-corr that the blue and red rays may be caused to e eye in a parallel direction (though not actually coincide thus to produce a colourless image. Thus let N, M, N (fig. 1 sent the two extreme rays of three pencils, which with field-glass would form a blue image convex to the eye-glas and a red one at RR; then, by the intervention of the fie a blue image concave to the eye-glass is formed at B'B', a

[1] Thus it is still a moot point whether the microscopic ances seen in the siliceous valves of diatoms (figs. 8–11) optical representations of elevations, depressions, or perfora of internal molecular arrangements not involving any ineq surface.

[2] This doctrine was first fully developed by Professor Abb *Archiv für Microsk. Anatomie*, vol. ix. (1874), and is more pounded in his subsequent contributions to *Jour. Roy. Mic* See also the papers of Mr Stephenson and Mr Crisp in that and in the preceding *Monthly Microscopical Journal*.

[3] Any good workman can now make by the dozen such sma ⅓ inch objectives as Mr A. Ross produced with much pains an fifty years ago. It was not until 1844 that, with the ho emulation of surpassing what Professor Amici had then accon he produced a $\frac{1}{10}$ inch of 135°, which, by taking advantage very heavy flint-glass he had, he afterwards increased to 170°

R'R'. As the focus of the eye-glass is shorter for blue ray
red rays by just the difference in the place of these images
ys, after refraction by it, enter the eye in a parallel direction
duce a picture free from false colour. If the object-glas
en rendered perfectly
atic, the blue rays,
passing through the
ass, would have been
to a focus at *b*, and
at *r*; so that an error
be produced, which
have been increased in-
f being corrected by the
ss. Another advantage
well-constructed Huy-
eye-piece is that the
produced by the meet-
the rays after passing
the field-glass is by it
d concave towards the
ss instead of convex,
every part of it may
ocus at the same time,
e field of view thereby
d flat.[1]

or more Huygenian eye-
of different magnify-
vers, known as A, B, C,
usually supplied with
ound microscope. The utility of the higher powers wi
depend upon the excellence of the objectives; for, when a
natic combination of small aperture which is sufficiently we
ed to perform very tolerably with a "low" or "shallow
ce is used with an eye-piece of higher magnifying power (con
spoken of as a "deeper" one), the image may lose more i
ness and in definition than is gained by its amplification, whi
age given by an objective of large angular aperture and ver
correction shall sustain so little loss of light or of definitio
eep eye-piecing" that the increase of magnifying power sha
ost clear gain. Hence the modes in which different objective
same power, whose performance with shallow eye pieces
the same, are respectively affected by deep eye pieces allor
test of their respective merits, since any defect in the corre
sure to be brought out by the higher amplification of th
while a deficiency of aperture is manifested by the want
The working microscopist will generally find the A ey
ost suitable, B being occasionally employed when a greate
is required to separate details, whilst C and others still deep
ful for the purpose of testing the goodness of objectives,
cial investigations requiring the highest amplification wit
ves of the finest quality. But he can commit no great
han habitually to use deep eye-pieces for the purposes
fic research, especially when (as in the study of livin
) long-continued and unintermitted observation is necessar
e visual strain thus occasioned is exactly like that resultin
he habitual use of magnifying spectacles in reading, requi
e book to be held within 2 or 3 inches of the eye. Ar
perience shows that this feeling of strain cannot be di
ed, without the most injurious consequences to vision.

viewing large flat objects, such as transverse sections of woo
Echinus spines, under low magnifying powers, the eye-pie
as Kellner's may be employed with advantage. In th
uction the field-glass, which is a double convex lens,
in the focus of the eye-glass, without the interposition of
agm; and the eye-glass is an achromatic combination of
concave of flint with a double-convex of crown, which
y under-corrected, so as to neutralize the over-correctio
to the objectives for use with Huygenian eye pieces.
ll-illuminated field of as much as 14 inches in diamet
nus be obtained with very little loss of light; but, on t
nand, there is a certain impairment of defining power, whi
s the Kellner eye-piece unsuitable for objects presenti
e structural details; and it is an additional objection th
allest speck or smear upon the surface of the field-glass
so unpleasantly obvious that the most careful cleansing
urface is required every time that this eye-piece is use
it is better fitted for the occasional display of objects of t
ter already specified than for the ordinary wants of t
ng microscopist.

d eye-pieces, consisting of cylinders of glass with convex en
metimes used in place of the Huygenian, when high magn
power is required for testing the performance of objectiv
ower surface, which has the lesser convexity, serves as a

FIG. 14.—Section of Huygenian Eye Piece, adapted to Over-Corrected Microscopic Objectives.

[1] The reader may be referred to Mr Varley's investigation of the properties of the Huygenian eye-piece in the fifty-first volume of the *Transactions of the Society of Arts*; and to the article "Microscope," by Mr Ross, in the *Penny Cyclopædia*, reprinted, with additions, in the *English Cyclopædia*.

field-glass, while the image formed by this is magnified
highly convex upper surface to which the eye is applie
advantage derivable from this construction lying in the abol
the plane surfaces of the two lenses of the ordinary eye-piec

A "positive" or Ramsden's eye-piece—in which the fiel
whose convex side is turned upwards, is placed so much ne
eye-glass that the image formed by the objective lies below
of above it—was formerly used for the purpose of microme
divided glass being fitted in the exact plane occupied by the
so that its scale and that image are both magnified together
lenses interposed between them and the eye. The same en
ever, may be so readily attained with the Huygenian e
that no essential advantage is gained by the use of that of R
the field of which is distinct only in its centre.

Objectives.

It has been seen that one of the principal points in t
struction of microscopic objectives to which the attention
makers has been constantly directed has been the enla
of their "aperture,"—this term being understood to me
their absolute opening as expressed by linear measure, b
capacity for receiving and bringing to a remote conjugate f
rays diverging from the several points of a near object. T
ture of an objective has been usually estimated by its "
aperture,"—that is, by the degree of divergence of the most
rays proceeding from the axial point of the object to the m
the objective (fig. 15) which take part in the formation
image. It is pointed out, however, by Professor Abbe that, in the case of single lenses used as objectives, their apertures are really proportional, not to their respective angles of aperture, but to the ratio between the actual diameter or clear opening of each to its focal distance, a ratio which is simply expressed by the sine of its semiangle. And in the case of combinations of lenses it can be demonstrated mathematically that their respective apertures are determinable—other conditions being the same—by the ratio of the diameters of their back lenses, so far as these are really utilized, to their respective focal lengths, this ratio being expressed, as before, by the sine of the semiangle of aperture ($\sin u$). The difference between these two modes of comparison readily made obvious by reference to the theoretical max 180°, which is attained by opening out the boundaries of t *abe* (fig. 15) until they come into the same straight line, th the semiangle (90°) then becoming unity. For, while an having an angle of 60° would count by comparison of a having only one-third of the theoretical maximum, its real would be half that maximum since the sine of its s (30°) = ½. And, as the sines of angles beyond 60° incre slowly, an objective of 120° angle will have as much as 87 of the theoretical maximum of aperture, although its angl two-thirds, or 66·6 per cent., of 180°. It hence becomes that little is really gained in real aperture by the openin the angle of microscopic objectives to its greatest practica (which may be taken as 170°), while such extension—unattended with any loss either of definition or of colour-c—necessarily involves a great reduction alike in the work tance and in the focal depth or penetration of the comb as will be presently explained.

FIG. 15. Section of Ac Object Glass, comp three pairs of (th crown) lenses. *abe* is of aperture.

Numerical Aperture.—It has now been demonstrated by Abbe that, independently of the advantages already spe derivable from the application of the immersion system to of short focus and wide aperture, the real aperture of a sion objective is considerably greater than that of a d objective of the same angle, the comparative apertures tives working through different media being in the ratio of two factors, viz., the sines of their respective se of aperture and the refractive indices of the "immersion It is the product of these ($n \sin u$) that gives what is to Professor Abbe the "numerical aperture," which serves, as the only true standard of comparison, not only betwe air and water or oil immersion lenses, but also between n lenses adapted to work respectively with water, oil or a interposed fluid. That the angle of aperture expresse same number of degrees must correspond with very differe ing apertures in dry, water immersion, and oil or hom immersion objectives becomes evident when we consi

[2] These eye-pieces are much in vogue in the United States, where the of extremely short focal—even to ⅛ inch.

when divergent pencils of rays pass from one medium other of higher refractive index. For such divergent proceeding from air into water or oil, will be closed or compressed; so that the rays which, when an object ited in air, spread out over the whole hemisphere then omparatively narrow pencils, and can thus be utilized mmersion objective of smaller aperture than is required in bjective to admit the most diverging rays of air-pencils. vs, therefore, that a given angle in a water or oil immersion e represents a much larger aperture than does the same n an air objective; and thus it comes to pass that by out the angle of immersion objectives they may be made ve and utilize rays of much greater divergence than can enter dry objectives of even maximum aperture.

following table, abridged from that given by Professor Abbe y 0·02 of numerical aperture from 0·50 up to the maximum brings this contrast into clear view:—

Numerical Aperture Table.

Angle of Aperture (= 2u)			Illuminating Power (a^2)	Theoretical Resolving Power, in Lines to an Inch (λ = 0·5269 μ = line F).	Penetrating Power $\left(\frac{1}{a}\right)$
Dry Objectives (n 1)	Water Immersion Objectives (n 1·33).	Homogeneous-Immersion Objectives (n 1·52).			
° ′	° ′	° ′			
	...	180 0	2·310	146,528	·658
	...	138 12	2·016	136,888	·704
...	180 0	122 6	1·770	128,212	·752
..	142 39	111 59	1·588	121,464	·794
...	125 3	101 50	1·392	113,752	·847
...	111 44	94 56	1·254	107,968	·893
..	105 42	88 26	1·124	102,184	·943
180 0	97 31	82 17	1·000	96,100	1·000
140 6	89 56	76 24	·884	90,616	1·064
118 58	80 34	68 54	·740	82,904	1·164
106 16	73 58	63 31	·640	77,120	1·250
98 56	69 42	60 0	·578	73,264	1·316
88 51	63 31	54 50	·490	67,480	1·429
76 58	55 34	48 9	·384	59,768	1·613
68 6	49 18	43 14	·314	53,981	1·786
60 0	44 10	38 24	·250	48,200	2·000

taking as a standard of comparison a dry objective of ximum theoretical angle of 180°, whose numerical aperthe sine of 90°, or 1·00, we find this standard equalled ter immersion objective whose angle of aperture is no more °, and by an oil or homogeneous immersion objective 82°, the numerical apertures of these, obtained by multi the sines of their respective semiangles by the refractive f water or of oil, being 1·00 in each case. Each, the re- l have as great a power of receiving and utilizing divergent ny dry objective can even theoretically possess.

as the actual angle of either a water or an oil immersion e can be opened out to the same extent as that of an air ob ective, it follows that the aperture of the former can be ted far beyond even the theoretical maximum of the latter. he numerical aperture of a water-immersion lens of the m angle of 180° is 1·33, or one-third greater than that ir-lens of the same angle; and this aperture would be y an oil-immersion objective of only 122°. Again, the l aperture of an oil immersion objective having the theo maximum angle of 180° would be 1·52, or more than one ater than that of an air-lens of the same angle. And the al apertures corresponding to angles of 170°, which have tually attained in both cases, fall very little short of the ons just given.

gain, an oil immersion objective whose angle of aperture is has as high a numerical aperture (0·76) as a water- on objective of 69½°, or as a dry objective of 99°; and a dry e of 140° has no greater a numerical aperture (0·94) than immersion of 90° or an oil immersion of 76½°.

important doctrine may be best made practically intelligible omparison of the relative diameters of the back lenses of th those of water and oil immersion objectives of the ower, from an "air angle" of 60° to an "oil angle" of these diameters expressing, in each case, the opening between treme pencil forming rays at their issue from the posterior of the combination, to meet in its conjugate focus for the ion of the image, the relation of which opening in each case focal length of the combination is the real measure of its e (fig. 16). Thus the dry objective of 60° angle (5 in fig. 16) air angle represented by $\sin u = \frac{1}{2} = 0{\cdot}50$ numerical aperture. y objective of 97° (4) has its air angle represented by $\sin u =$ 5 numerical aperture. And the dry objective having the tical) angle of 180° (3) has its air-angle represented by $\sin u$ numerical aperture, this corresponding to 96° water- and 82° oil-angle. But the water-immersion lens having coretical) angle of 180° (2) has its water-angle represented $nu = 1{\cdot}33$ numerical aperture. And the oil-immersion lens having the (theoretical) angle of 180° (1) has its oi represented by $n \sin u = 1{\cdot}52$ "numerical aperture."[1] theoretical apertures for water and oil immersion lenses havin found as nearly attainable in practice as the theoretical max for dry objectives, such lenses can utilize rays from mounted in balsam or other dense media, which are entirely lost for the image (since they do not exist physically) when the same object is in air or is observed through a film of air. And this loss cannot be compensated by an increase of illumination; because the rays which are lost are different rays physically from those obtained by any illumination, however intense, through an aeriform medium.

It is by increasing the number of diffraction-spectra that the additional rays thus received by objectives of great numerical aperture impart to them an increased resolving power for lined and dotted objects,—the truth of the image formed by the recombination of these spectra being (as already shown) essentially dependent on the number of them that the objective may be capable of receiving.

But whilst the resolving power of microscopic objectives increases in the ratio of their respective numerical apertures, and whilst their illuminating power (dependent upon the quantity of light that passes through them) increases with the square of the numerical aperture, the case is reversed with another most important quality,—that of penetration or focal depth; for this diminishes as the numerical aperture increases, until nothing but what is precisely in the focal plane can be even discerned with objectives possessed of the highest resolving power. Thus, the penetrating power of an objective of 60° air-angle being expressed as 2·000, an extension of that angle to 76½° reduces it to 1·613, an extension to 89° reduces it to 1·429, and an extension to 99° reduces it to 1·316; further extension to 118½° reduces it to while an objective whose air angle is 140° has a penetrating of only 1·064. So, again, the oil immersion objective which numerical aperture of 1·00 corresponding to the theoretic angle of 180° has a penetrating power of 1·000; this is b down to ·752 when its angle is so increased as to make its nu aperture 1·33, equalling the theoretical maximum of a immersion objective, and is ·658 at the theoretical maximum of an oil-objective.

Fig. 16.—Relati meters of Back of Air, Wate Oil Immersion tives.

Hence it is clear that, as some of the qualities to be sou microscopic objectives are absolutely incompatible, a prefer to be accorded to objectives of greatest resolving power bu little penetration, or to those of moderate resolving pow great penetration, according to the uses to which they are applied; and some general principles will now be laid do regard to this matter, based alike on science and experience.

In the first place, a marked distinction is to be drawn b those objectives of low or moderate power which are to be v dioptrically and those of high power which are to be work fractively. The objects on which the former are to be for th part used are either minute transparent bodies having solid which the observer should be able to take in as wholes (as case of *Polycystina*, the larger diatoms, *Infusoria*, &c.); or parent sections, dissections, or injections, whose parts different planes, the general relations of which he desires to while reserving their details for more special scrutiny; or objects, whose structure can only be apprehended fro examination of their surfaces, when the inequalities of tho faces are seen in their relations to each other. In all thes it is desirable that microscopic vision should resemble or vision as much as possible. If the eye were so constructed enable us to discern only those parts of an object that l cisely in the plane to which we focus it, our visual concept the forms and relations of these parts, and consequently object as a whole, would in general be very inadequate, an erroneous. It is because, while focussing our eye successiv the several planes of the object, we can see the relation of what is nearer and more remote that we can readily acc visual conception of its shape as a whole, and that unmist perception of solid form which is given by the combination two dissimilar perspectives of near objects in binocular

[1] The dotted circles in the interior of 1 and 2, of the same diameter as the excess in the diameters of the back lenses of the water and oil ob over that of the dry at their respective theoretical limits.

could not possibly be formed if our vision were strictly
o the exact plane for which our eyes are focussed.
it is obvious that, in the case of objectives of low and
amplification, focal depth or penetration is a quality
want of which no other excellence can compensate,—
ning-out of their apertures being only advantageous in
s it does not seriously interfere with their penetrating
It is, no doubt, quite possible to construct a 1 inch
with an aperture so large that, when the requisite ampli-
has been gained by deep eye-piecing, it shall resolve
d "tests" ordinarily used for a $\frac{1}{4}$, or to construct an
of $\frac{4}{10}$ inch focus which shall in like manner do the
work of a $\frac{1}{8}$. But, as such objectives are thereby spoiled
r own proper work, the loss to the microscopist is but
ompensated by his ability to resolve with them, under such
-pieces as cannot be habitually used without serious risk to
sight, the lined and dotted tests which can be much better
nder objectives of shorter focus and wider aperture, with eye-
low amplification. For, whilst deep eye-pieces cannot be
ly employed for continuous observation, without putting
upon the eyes resembling that which results from the
use of a magnifying glass, even the very highest objectives
used continuously for long periods in combination with
eye pieces, with scarcely any fatigue, and therefore (it is
) without sensible injury.[1]

timating the goodness of a microscopic objective, five
qualities have to be separately considered:—(1) its work-
nce, or the actual interval between its front lens and the
which it is focussed; (2) its penetrating power, or focal
3) the flatness of its field; (4) its definition, or power of
distinct image of all well-marked features of an object,
cially of their boundary lines; and (5) its resolving power,
h it separates closely approximated lines, dots, or strie.

e "working distance" of an objective has no fixed relation
cal length,—the latter being estimated by its equality in
ith a single lens of given radius of curvature (such as
$\frac{1}{2}$ inch, $\frac{1}{10}$ inch, &c.), while the former varies with
le in which the combination is constructed and with the
given to it. For low and moderate powers, ranging up to
focus, good working distance is especially important,
ecause it is closely related to penetrating power, and also
it facilitates the use of side-illumination for opaque objects.
such objectives of high power as are to be used, not for the
n of lined or dotted tests, but for the observation of living
ing objects of extreme minuteness, good working distance
s important, on account of its relation to focal depth. In
of those objectives, on the other hand, in which resolving
made the first consideration, it is only needful that the
distance shall be such as to permit the interposition of a
ss cover; and this, although necessarily diminished with
ning of the aperture, can be always obtained by the adoption
mmersion system.

e "penetrating power" or "focal depth" of an objective
defined as consisting in the vertical range through which
s of an object not precisely in the focal plane may be seen
fficient distinctness to enable their relations with what lies
n that plane to be clearly traced out,—just as would be done
nary vision if the object were itself enlarged to the dimen
its microscopic image. The close relation between this
and the preceding becomes obvious when it is considered
longer the working distance of an objective the less will
inctness of the image it forms be affected by any given
n (say the $\frac{1}{1000}$ of an inch) in its focal adjustment. Con-
y, of two objectives having the same magnifying power but
working distances, that one will have the most focal depth
orking distance is the greater. On the other hand, as the
ing power of an objective is reduced in direct accordance
increase of its numerical aperture, it must be sacrificed
r the highest resolving power is to be attained. Hence,
dly remarked, this attribute will be very differently valued
rent observers, according to the work on which they are
vely engaged. For the general purposes of biological
, not only with low or moderate (for the reasons already
but also with high powers, a considerable amount of
pth is essential. It is impossible, for example, to follow
orily the movements of an *Amœba*, or to study the
is" in the cell of a *Vallisneria*, or to trace the distribution
rve-thread, with an objective in which focal depth is so
ly sacrificed to aperture that nothing can be discerned
at is precisely in the focal plane, since, instead of passing
nally from one focal plane to another, as the observer can
an objective of good penetration, he can only get a succes-
"dissolving views," with an interval of "chaos" between
each pair. When, on the other hand, it is desired to scrutini
the greatest precision such minute details as are presented
and the same focal plane (as, for example, those of the t
possible film of tissue spread out between a glass slide and it
ing glass), the microscopist will prefer an objective in whic
depth is subordinated to aperture, for the sake of the re
power which he can thus command. And it will often hap
biological research that it is advantageous thus to bring ob
of the latter class to bear upon objects which could not ha
detected in the first instance save by objectives of much
resolving power but greater focal depth.

3. The "flatness of the field" afforded by the objecti
condition of great importance to the advantageous use of th
scope, since the extent of the area clearly seen at one time
cally depends upon it. Many objectives are so constructe
even when the object is perfectly flat, the foci of the cent
peripheral parts of the field are so different that, when the
ment is made for one, the other is more or less indistinct.
when the central part of the area is in focus, no more info
is gained respecting the peripheral than if the latter had be
gether stopped out. With a really good objective, not only
the image be distinct over the whole field at once, but the n
portion should be as free from colour as the central. As in
tion in this respect is often masked by the contraction
aperture of the diaphragm in the eye piece, the relative m
two objectives, as regards flatness of field, should always be
under an eye piece giving a large aperture.

4. The "defining power" of an objective, which depend
the completeness of its corrections for spherical and for ch
aberration, and upon the accurate centring of its component
is an attribute essential to its satisfactory performance, whate
be its other qualities, its importance in scientific researc
such that no superiority in resolving power can compensate
want of it, and, though it is possible to obtain perfect correc
spherical aberration up to the highest practicable limit of an
the difficulty of securing it increases rapidly with the augme
of aperture, the want of it being made perceptible, especial
deep eye-pieces are put on, by the blurring of clearly-mark
or edges, and by general "fog." Perfect colour correction
other hand, is not possible for dry lenses of the widest a
account of the irrationality of the secondary spectrum, b
may be neutralized by the use of the immersion system. As
stated, what has to be aimed at in the construction of mic
objectives is not absolute colour correction, but a slight d
over-correction, which, by compensating the chromatic di
of the Huygenian eye piece, shall produce an image free fr
colour. As this can be secured far more easily in the cons
of objectives of moderate than in those of very wide apert
cost of the former is proportionally small, an additional
for the preference to be given to them on other grounds, t
to all save very special kinds of microscopic work.

5. "Resolving power," being that by which very min
closely approximated markings whether lines, strie, o
apertures—can be separately discerned, is a function which
primary importance in objectives whose amplifying power s
fits them for the study of objects of this class. It appears f
mathematical researches of Professor Abbe that the m
resolving power (with a theoretical angle of 180°) would be
of separating 146,528 lines to the inch; but he considers th
of visual resolution depending on the power of the eye to
$\frac{1}{113,000}$ of an inch; and this limit seems to have been
reached. To make such a separation distinctly percept
amplification of at least 3000 linear would be requisite; a
can only be obtained either by the use of an objective of ve
power (such as $\frac{1}{12}$ inch focus) in combination with a low or
eye-piece or by putting a very deep eye-piece upon an obje
lower power (such as a 1 inch), the former method, for the
already given, being decidedly preferable. For the resolutio
closely approximated markings objectives of $\frac{1}{25}$, $\frac{1}{50}$, $\frac{1}{75}$
inch answer very well; and the resolving power whi
require may be obtained without any excessive widenin
aperture. For e loss of resolving power consequent u
contraction the angle of a water-immersion objective to
only one-tenth of the theoretical maximum 128,212; while
tion to 105° only lowers the number of separable lines to
to the inch,—thus diminishing the resolving power by litt
than one-fifth, while the working distance and focal depth
combination are greatly increased, and perfect definition
certainly attainable. The $\frac{1}{8}$ inch is (according to the
experience, which is confirmed by the theoretical deduc
Professor Abbe) the lowest objective in which resolving
should be made the primary qualification,—the $\frac{1}{8}$, $\frac{1}{6}$, $\frac{1}{4}$,
inch being specially suited to kinds of biological work i
this is far less important than focal depth and dioptric p
This view is strengthened by the very important considerat
the resolving power given by wide aperture cannot be
except by a method of illumination that causes light to pass

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[1] for work of this kind, the shallower eye-pieces and longer tubes of microscopes are to be preferred to the deeper eye-pieces and shorter tubes dinary Continental model, the shallowest eye-pieces of the latter being qual in power to the ordinary B eye-pieces of the former.

ct at an obliquity corresponding to that at which the most t rays enter the objective. Now, although in the case of whose markings are only superficial such obliquity may not nctive of false appearances (though even this is scarcely con-), it must have that effect when the object is thick enough an internal structure; and the experience of all biological s who have carried out the most delicate and difficult ations is in accord, not only as to the advantage of direct ation, but as to the deceptiveness of the appearances given ue, and the consequent danger of error in any inferences om the latter. Thus, for example, the admirable researches sburger, Fleming, Klein, and others upon the changes which ace in cell nuclei during their subdivision can only be l and verified (as the writer can personally testify) by ation of these objects under axial illumination, with objec- an angle so moderate as to possess focal depth enough to he wonderful differentiation of component parts brought out ing processes through their whole thickness.

nost perfect objectives for the ordinary purposes of scientific , therefore, will be obviously those which combine exact n and flatness of field with the widest aperture that can be ithout an inconvenient reduction of working distance and he degree of focal depth suitable to the work on which they ectively to be employed. These last attributes are especially n the study of living and moving objects; and, in the case , dry objectives are decidedly preferable to immersion, e shifting of the slide which is requisite to enable the move the object to be followed is very apt to produce disarrange- the interposed drop. And, owing to the solvent power which ntial oils employed for homogeneous immersion have for nary cements and varnishes, such care is necessary in the objectives constructed to work with them as can only be hen the observer desires to make a very minute and critical ation of a securely-mounted object.

ollowing table expresses the magnifying powers of objectives ted on the English scale of inches and parts of an inch, with nch body and the A and B eye-pieces usually supplied by makers, and also specifies the angle of aperture which, in the judgment, is most suitable for each. He has the satisfac finding that his opinions on this latter point, which are long experience in the microscopic study of a wider range al and vegetable objects than has fallen within the purview of his contemporaries, are in accordance with the conclu awn by Professor Abbe from his profound investigations into ory of microscopic vision,[1] which have been carried into l accomplishment in the excellent productions of Mr Zeiss.

	Angular Aperture	Magnifying Power. A Eye-piece	Magnifying Power. B Eye-piece	Focal Length.	Angular Aperture.	Magnifying Power. A Eye-piece	Magnifying Power. B Eye-piece
	°				°		
	9	12	18	½ inch.	50 80	200	300
	12	18	27	⅓ ,,	95	250	375
	15	25	37	¼ ,,	110	300	450
	20	36	54	⅕ ,,	140	400	600
	30	50	75	1/10 ,,	150	500	750
	40	75	112	1/12 ,,	160	600	900
	45	100	150	1/16 ,,	170	800	1200
	70	125	187				

ordinary biological work, the ⅔, 1/10, and 1/12 objectives, with of from 100° to 120°, will be found to answer extremely constructed on the water-immersion system.

of these powers should be tested upon objects most suited mine its capacity for the particular kind of work on which it employed, and, in such testing, the application of deeper eye- than can be habitually employed with advantage will often bring out marked differences between two objectives which work almost equally well under those ordinarily used,- in definition or colour correction, and want of light, which otherwise have escaped notice, being thus made apparent. gle object is of such general utility for these purposes as a ell marked *Podura*-scale; for the eye which has been trained se of a particular specimen of it will soon learn to recognize means the qualities of any objective between 1 inch and ⅛ cus; and it may be safely asserted that the objective which early and sharply exhibits its characteristic markings is the the ordinary work of the histologist.

he special attribute of resolving power, on the other hand, an entirely different order are required; and these are fur- as already stated, either by the more "difficult" diatoms, the highest numbers of Nobert's ruled test plate. The valve at present most in use as a test for resolving s the *Amphipleura pellucida*, the lines on which were long d to be more closely approximated than those of Nobert's nineteenth band, being affirmed by Mr Sollitt to range fro to 130 in 1/10000 of an inch. But the admirable photograp this valve obtained by Colonel Dr Woodward have confirme conclusion long previously expressed by the writer, that thi mate was far too high, being based on the "spurious line produced by diffraction, and show that the striæ on the valves do not exceed 91, while those on the smallest are neve numerous than 100, in 1/10000 of an inch. The same adm manipulator has also obtained excellent photographs of anothe difficult test-diatom, *Surirella gemma*, from which it a that its transverse striæ count longitudinally at the rate of to the inch, whilst the beaded appearances into which thes be resolved count transversely at the rate of 84,000 to the Thus it appears that the complete resolution of these "vexa diatoms does not require by any means the maximum of ap but is probably dependent at least as much on the perfection corrections and the effectiveness of the illumination.

It must be understood that there is no intention in these re to undervalue the efforts which have been perseveringly ma the ablest constructors of microscopic objectives in the direc enlargement of aperture. For these efforts, besides increasi resolving power of the instrument, have done the great ser producing a vast improvement in the quality of those object moderate aperture which are most valuable to the scientific gist; and the microscopist who wishes his *armamentum* to b plete will provide himself with objectives of those different qu as well as different powers, which shall best suit his par requirements.[2]

Illuminating Apparatus.

Every improvement in the optical performance of the com achromatic microscope has called forth a corresponding im ment in the illumination of the objects viewed by it, since came to be apparent that without such improvement the f vantage of the increased defining and resolving powers objectives could not be obtained. For the illumination of parent objects examined by light transmitted through them low powers of moderate angle a converging pencil of rays re upon their under surface by a concave mirror is generally suffic a "condenser" being only needed when the imperfect transp of the object requires the transmission of more light throu And the microscopist engaged in ordinary biological studie works on very transparent objects with objectives of ½ or focus, or 1/5 inch immersion, will find that the small c mirror of short focus with which the Continental models a nished (see fig. 28) will generally prove sufficient for his needs mirror is usually hung at such a distance beneath the stag parallel rays falling on it are brought to a focus in the obje lies on a slip of glass resting on the stage; and thus, wh nstrument is used by day, the light of a bright cloud (which erable to any other) gives a well-illuminated field, even wi powers last-mentioned. But when lamplight is used its div rays are not brought to a focus in the object by a mirror fixed as just stated; and the distance of the mirror beneat stage should be made capable of increase (which is easily d attaching it to a lengthening bar), so as to obtain the re focal convergence. Still the best effects of objectives of le ⅓ inch focus cannot be secured without the aid of an achr condenser, interposed between the mirror and the object, s bring a larger body of rays to a more exact convergence.

When objectives of still higher power are employed, the e ment of such a condenser becomes indispensable; and wh highest powers are being used by lamplight, it is desirable pense with the mirror altogether, and to place the flame exa the optic axis of the microscope. The condenser should achromatic combination, corrected for the ordinary thick the glass slip on which the object lies, and capable of b adjusted as to focus the illuminating pencil in the object.

As it is often found desirable that an object should be illum by central rays alone, or that the quantity of light trans through it should be reduced (for bringing into view delicate of structure which are invisible when the object is floode light), every microscope should be provided with some m cutting off the outer rays of the illuminating cone. The phragm plate" ordinarily used for this purpose is a disk o metal, pivoted to the under side of the stage, and perforated graduated series of apertures of different diameters, any one o can be brought, by the rotation of the disk, exactly into th axis of the microscope. But the required effect can be muc advantageously obtained by the "iris-diaphragm," in w number of converging plates of metal are made so to sli each other by the motion of a lever or screw that th ture is either enlarged or diminished, while always remainin tically circular as well as central; and in this manner a con

[1] See paper on "The Relation of Aperture and Power in the Microscope," in *Trans. Micros. Soc.*, 1882, pp. 300, 460.

[2] See the remarks of Mr Dallinger,—whose experience in the applicati highest powers to the study of the minutest living objects is probably gre that of any living observer,—in *Journ. Roy. Micros. Soc.*, December 1882

the object is obtained, with a gradational modification of the
Another method, commonly adopted in German microscopes,
ace a draw-tube in the optic axis between the stage and the
and to drop into the top of this tube one of a set of "stops"
ted with apertures of different sizes; this allows a gra-
l effect to be obtained by raising or lowering the tube, so as
the stop nearer to or more remote from the object; but it
nearly so convenient as the iris-diaphragm; and the effect of
p is not nearly so good when it is removed to some dis-
eneath the object as when it is very near to the under sur-
the glass object-slide. When an achromatic condenser is
ther a diaphragm-plate or an iris-diaphragm should be placed
ts back lens, so as to cut off any required proportion of the
ays that form its illuminating cone.

an arrangement, while suiting all the ordinary requirements
microscopist who uses the highest powers of his instrument
purposes of biological investigation (as, for example, in the
f *Bacteria* or of the reproduction of the *Monadina*), does not
bring into effective use the special resolving power pos-
by objectives of large aperture. It has long been known
r the discernment of very closely approximated markings
illumination is advantageous,—an objective which exhibits
diatom-valve as *Pleurosigma angulatum* with a smooth un
surface when illuminated by the central rays of the achro-
condenser making its characteristic markings (figs. 8-11)
tly visible when the central rays of the condenser are kept
a stop, and the object is illuminated by its convergent mar
ays only. And it has also been practically known for some
hat the resolution of lined or dotted tests can be often
by mirror illumination alone, if the mirror be so mounted
able to reflect rays through the object at such obliquity to
ic axis of the microscope as to reach the margin of a wide-
objective. But it has only been since Professor Abbe's
hes have given the true theory of "resolution" that the
advantage of oblique illumination has been fully compre-
, and that the best means have been devised for using it
ely. Two different systems have now come into use, each
h has its special advantages.

consists in the attachment of the illuminating apparatus
and achromatic condenser) to a "swinging tail-piece" (see
, which, moving radially upon a pivot whose axis intersects
ic axis at right angles in the plane of the object, can trans-
illuminating pencil through it at any degree of obliquity
he construction of the stage allows. The direction of this
being of course limited to one azimuth, it is requisite, in order
g out its full resolving effect, that the object should be made
te, by making the stage that carries it revolve round the
xis, so that the oblique pencil may impinge upon the lines or
markings of the object in every direction successively. It
en be found that the appearances presented by the same
often vary considerably,—one set of lines being shown when
ect lies in one azimuth, and another when its azimuth has
hanged by rotation through 60°, 90°, or some other angle.
s contrivances have also been devised for throwing very
illuminating pencils on the object by means of prisms
beneath the stage.

nination of at least equal obliquity to that afforded by the
ng tail-piece may now, however, be obtained by the use of
sers specially constructed to give a divergence of 170° to the
hich they transmit when used immersionally, by bringing
lat tops into approximation to the under side of the glass
n which the object is mounted, with the interposition
m of water or (preferably) of glycerin. By using a central
marginal rays alone may be allowed to pass; and these will
nsmitted through the object in every azimuth at the same
But diaphragms with apertures limiting the transmitted rays
part of the periphery may be so fixed in a tube beneath
ndenser as to be easily made to rotate, thus sending its
e pencils through the object in every azimuth in succession.
here this rotation of the diaphragm brings out two sets of
t a certain angular interval a diaphragm with two marginal
gs at a corresponding angular distance will enable both to
at once. Numerous arrangements of this kind have been
by those who devote their special attention to the reso-
of difficult diatom-tests; but they are of little or no use to
who use the microscope for biological research.

the illumination of the surfaces of opaque objects which must
by reflected light the means employed will vary with the
ength of the objective employed. For large bright objects
under a low magnifying power good ordinary daylight is
nt; but if the surface of the object is dull, reflecting but
light, the aid of a bull's-eye or large bi-convex lens must be
ysed in order to give it sufficient brilliance. This aid will
be required by lamplight; and by a proper adjustment of
lative distances of the lamp and the object the rays from the
may be made either to spread themselves over a wide area or
[illegible] a small spot. The former is the method suitable

to large objects viewed under a low magnifying power; th
to the illumination of small objects which are to be examine
objectives of (say) 1 inch or ½ inch focus. Another metho
may be conveniently had recourse to when the microscope
vided with a swinging tail-piece is to turn this on its piv
the concave mirror is brought above the stage, so that ray
it gathers either from natural or artificial sources may be
downwards upon the surface of the object.

The illumination of an opaque object to be seen with
power than the ⅔ or ½ inch objectives was formerly provi
by a concave speculum (termed a Lieberkuhn after its invento
a perforation in the centre for the passage of the rays to th
tive to which it is fitted,—the curvature of the speculum
adapted to the focus of the objective which carries it tha
the latter is duly adjusted, the rays reflected upwards around the object from the mirror to the speculum shall converge strongly on the ob ject. The various disadvantages of this mode of illumination, however, have caused it to be now generally superseded by other arrangements. For powers between 1½ inch and ⅛ inch, and even for a ¼ or ⅙ inch of small angle and good working distance, nothing is so convenient as the parabolic speculum or side illuminator (F, fig. 17) invented by the late Richard Beck. This is attached to a spring clip that slides on the tubes of low power objec tives, so that its distance from object and the direction of its re flected pencil are readily adjusted; and for use with higher powers it may be either mounted on a separ ate arm attached to some part of the stand of the micros may be hung in the manner shown in fig. 17 from an "a A interposed between the objective and the body. By the collar B and making use of the joints C, C, the leng rod D, and the ball and socket E, any position may be give speculum F that may best suit the objective with which it

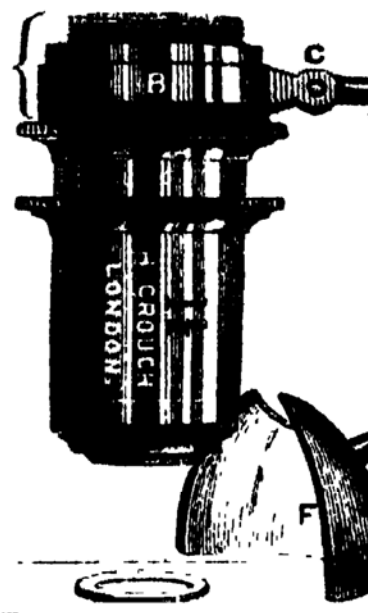
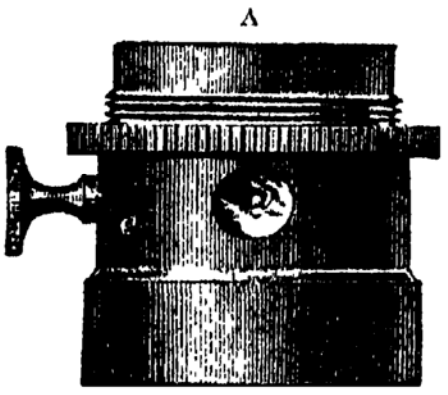


FIG. 17.—Beck's Parabo Illuminator, with Adapter.

When, however, it is desired to illuminate objects to be se objectives of high power and very short working distan illumination of any kind becomes difficult, though not al impossible;[1] and various modes have been devised for the i tion of the object by means of light sent down upon it, the objective, from above. This is done in the vertical illu of Messrs Beck (fig. 18) the original idea of which



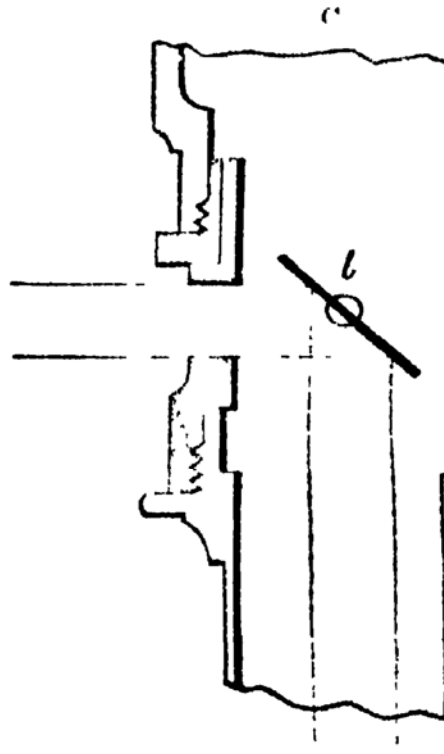


FIG. 18.—Beck's Vertical Illuminator.

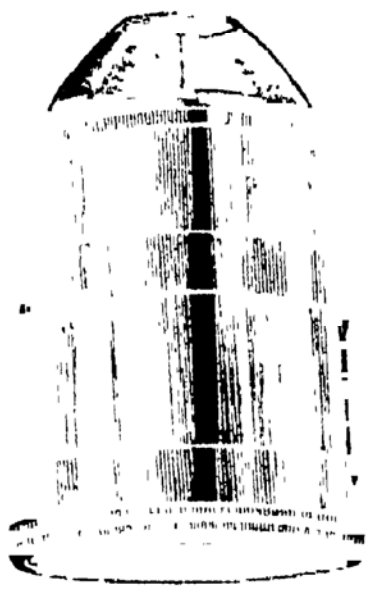
given by the American Professor H. L. Smith—by a thin glass B, *b*, attached to a milled head by which its position may be adjusted, and introduced by a slot A, *c* interior of an adapter that is interposed between the objec and the nose *c* of the body. The light which enters at th aperture A, *a*, falling upon the oblique surface of the dis reflected downwards, and is concentrated by the lense objective upon the object beneath. The lateral apertur provided with a diaphragm, with openings of different diminishing the false light to which this method is liable; o with a small aperture may be placed between the lamp

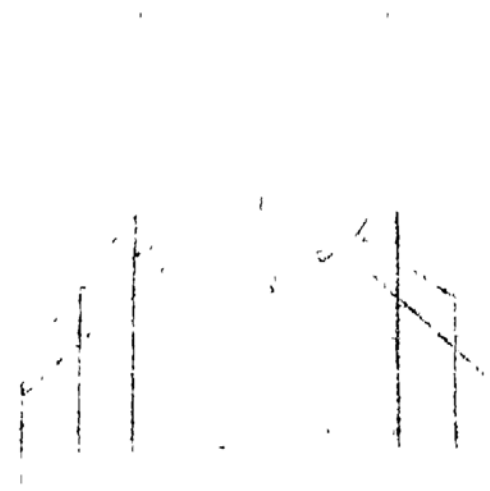
[1] See a method devised by Mr James Smith, in *Jour. Roy. Micros. So* N. S., 1880, p. 398.

tor, at any distance that is found to produce the best effects. this illuminator, the lamp should be placed at a distance 8 inches from the aperture; and, when the proper adjustave been made, the image of the flame should be seen upon ct. The illumination of the entire field, or the direction of t more or less to either side of it, can easily be managed by rposition of a small condensing lens placed at about the dis- its own focus from the lamp. The objects viewed by this illumination with dry-front objectives are best uncovered, they are covered with thin glass, so large a proportion of t sent down upon them is reflected from the cover (especially jectives of large angle of aperture are employed) that very seen of the objects beneath, unless their reflective power is gh. With immersion objectives, however, covered objects used. Another method of vertical illumination long since by Mr Tolles has recently been brought into notice by r W A Rogers of Boston (U. S.). It consists in the inon of a small rectangular prism at a short distance behind t combination of the objective, so that parallel rays entervertical surface pass on between its parallel horizontal surntil they meet the inclined surface, by which they are downwards. In passing through the front combination of ective, they are deflected towards its axis; but, as their convergence is less than the angle of divergence of the rays ng from the object, the reflected rays will not meet in the nt of the lens, but will be so distributed as to illuminate ent area. By altering the extent to which the prism is n, or by lifting or depressing its outer end by means of a ead screw, the field of illumination can be regulated. The of this prism with immersion-objectives is stated by Mr be peculiarly satisfactory.

Ground Illumination.—There are certain classes of objects hough sufficiently transparent to be seen with light transhrough them, are best viewed when illuminated by rays of quity as not to pass directly into the objective, such a on of these rays being retained by the object as to render it nous, when, all direct light being cut off, the general field tly dark. This method is particularly effective in the case delicate mineral structures as the siliceous tests of *Poly* nd the "frustules" of *Diatomaceæ*. And it is one ad- of this kind of illumination that it brings out with able effect the solid forms of objects suited to it, even ey are viewed monocularly. Two modes of providing this tion are in use, each of which has its special advantages. sists in placing a central stop either upon or immediately a condenser of wide aperture, which shall cut off all rays se that, after passing through the object (as in fig. 20), at an angle greater than that of the objective used; so nle the ground is darkened, the object is seen brightly out upon it. But if the divergence of the rays is but (say 60°), and the angle of the objective is large (say most divergent rays of the condenser will enter the marrtion of the objective, and, the field not being darkened, k-ground effect will not be produced. This method great convenience of allowing black-ground illumination bstituted for the ordinary illumination under different without any other change in the apparatus than the turning hragm plate fitted with stops of different sizes suitable to ral apertures of the objectives; and the modern achrondensers of wide aperture can be thus used with objectives ngle.

cellent black ground illumination is also given by the paraminator (fig. 19), originally worked out as a silvered n by Mr Wenham, but now made as a paraboloid of glass ects to its focus the rays which fall upon its internal surface. minate section of this instrument, showing the course of through it, is given in fig. 20, the shaded portion repre- the paraboloid. The parallel rays r, r', r'', entering its lower perpendicularly, pass on until they meet its parabolic on which they fall at such an angle as to be totally reflected nd are all directed towards its focus F. The top of the oid being ground out into a spherical curve of which F is re, the rays in emerging from it undergo no refraction, since ls perpendicularly upon the part of the surface through t passes. A stop placed at S prevents any of the rays l upwards by the mirror from passing to the object, which, laced at F, is illuminated by the rays reflected into it from s of the paraboloid. Those rays which pass through it again at various angles; and if the least of these, GFH, be than the angle of aperture of the object glass, none of them r it. The stop is attached to a stem of wire, which passes ly through the paraboloid and terminates in a knob beneath, n in fig. 19; and by means of this it may be pushed , so as to cut off the less divergent rays in their passage the object, thus giving a black-ground illumination with s of an angle of aperture much wider than GFH. In using boloid for delicate objects, the rays which are made to enter it should be parallel; consequently the plane mirror should be employed; and when, instead of the parallel rays of dayli are obliged to use the diverging rays of a lamp, these sh rendered as parallel as possible, previously to their reflexio the mirror, by the interposition of the "bull's-eye" so adjusted as to produce this effect. There are many cases, however,





FIGS. 19, 20.—Wenham's Parabolic Illuminator.

in which the stronger light of the concave mirror is pre When it is desired that the light should fall on the object f side only, the circular opening at the bottom of the wide tu carries the paraboloid may be fitted with a diaphragm ad cover all but a certain portion of it; and, by giving rot this diaphragm, rays of great obliquity may be made to fa the object from every azimuth in succession.

In order to adapt this paraboloid to objectives of very wi of aperture, a special modification of it, originally devised Wenham, has been latterly reintroduced under the design "immersion paraboloid," with most excellent effect. This in making the top of the paraboloid flat instead of concave interposing a film of glycerin between its surface and th surface of the glass slide carrying the object. Only rays extreme obliquity are allowed to pass into the slide as w totally reflected from its under surface if they fell upon it air; and, as these illuminate the object without passing objective, it can be thus examined under even the highest

Binocular Microscopes.

Stereoscopic Binoculars.—The admirable invention of the scope by Professor Wheatstone has led to a general a tion of the value of the conjoint use of both eyes, in conve the mind a conception of the solid forms of objects such use of either eye singly does not generate with the like cert effectiveness (see STEREOSCOPE). This conception is the of the mental combination of the dissimilar perspective pro which our right and left retinæ receive of any object that ciently near the eyes for the formation of two images that sibly dissimilar. Now it is obvious that a similar differen exist between the two perspective projections of any object that are formed by the right and left halves of a microsc jective and that this difference must increase with the aperture of the objective. And the fact of this difference easily made apparent experimentally, by adapting a sem "stop" to any objective of from 20° to 30° angle in such a that it can be turned so as to cover either its right or its l for not only will the two images of any projecting object fo the rays transmitted through the two uncovered halves b sensibly different, but, if they be photographed or accurately the "pairing" of their pictures in the stereoscope will br the form of the object in vivid relief. What is needed, ther give the true stereoscopic effect to a binocular microscope is of so bisecting the cone of rays transmitted by the object its two lateral halves shall be transmitted the one to the r the other to the left eye, and that the two images shall be (the image formed by the right half of the objective being se left eye, and that formed by the left half of the objective be to the right eye) in order to neutralize the reversing effec microscope itself. If this crossing does not take place, t will be rendered "pseudoscopic," not "orthoscopic,"—it tions becoming depressions, and its depressions being broug prominences. It was from a want of due appreciation of that the earlier attempts at constructing a stereoscopic b gave representations of objects placed under it, not in th orthoscopic, but in their pseudoscopic aspect. This case, for example, with the binocular microscope first de

Professor Riddell of New Orleans in 1851, which separated the cone of rays by a pair of rectangular prisms so placed edge to edge above the objective that the rays passing through its right half were reflected horizontally to the right side, to be changed to the vertical direction and sent to the right eye by a lateral rectangular prism, while the rays from the left half of the objective were sent to the left eye in a similar manner. Professor Riddell describes the "conversion of relief" produced by this arrangement with the ordinary eye-piece as making a metal spherule appear "as a glass ball silvered on the under side, and a crystal of galena like an empty box." And to render the images "normal and natural" he found himself obliged to use erecting eye-pieces, which should produce a second reversal of the images that had been reversed in their first formation.[1] Subsequently, however, Professor Riddell devised and perfected another arrangement giving a true orthoscopic effect, which, after being long disregarded, has been latterly taken up and brought into use by Mr Stephenson. The cone of rays passing upwards from the objective meets a pair of prisms (A, A fig. 21) fixed immediately above its back lens, which divides it into two halves; each of these is subjected to internal reflexion from the inner side of the prism through which it passes; and the slight separation of the two prisms at their upper end gives to the two pencils B,B, on their emergence from the upper surfaces of the prisms, a divergence which directs them through two obliquely-placed bodies to their respective eye pieces. By this internal reflexion a lateral reversal is produced, which neutralizes that of the ordinary microscopic image, so that, while each eye receives the image formed by its own half of the objective, the pairing of the two pictures produces a true orthoscopic effect.[2]

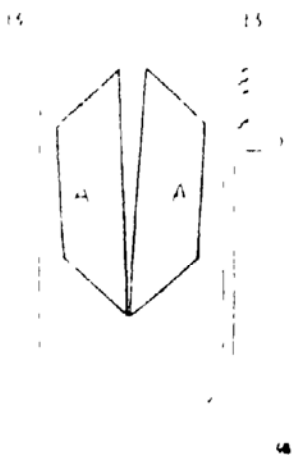


Fig. 21.—Riddell's Binocular Prism.

About the same date MM. Nachet of Paris succeeded in devising a binocular that should give a true orthoscopic image, by placing above the object-glass an equiangular prism (P, fig. 22) with one of its surfaces parallel to its back lens, which, receiving the pencils *ab* forming the right half of the cone, internally reflects them obliquely upwards to the left, and in like manner reflects the pencils *a'b'* from the left half of the cone obliquely upwards to the right. These pencils, passing out of the left and right oblique faces of the prism at right angles (so as not to undergo either refraction or dispersion), enter right and left lateral prisms, also at right angles, and, after being internally reflected by these, pass out vertically, at right angles to their upper surfaces, through two parallel bodies (fig. 23), whose eye-pieces bring them to a focus in the right and left eyes respectively. The distance between these bodies may be adjusted to the varying distances between the axes of individual pairs of eyes, by adjusting screws at their base, which vary the distance of the lateral prisms from the central. This instrument gives a theoretically perfect representation of a microscopic object in relief, as it would appear if enlarged to the size of its image, and brought to within about 10 inches of the eye; and its chief practical defect is that, as the two bodies are parallel, instead of being slightly convergent, it cannot be continuously used without an uncomfortable strain. But, as its performance depends upon the accuracy of the seven plane surfaces of the three prisms, and on the correctness of their relations to each other, it is liable to considerable error from imperfections in its construction; and, as the instrument can only be used for its own special purpose, the observer must be provided with an ordinary single-bodied microscope for the examination of objects unsuited to the powers of the binocular. This last objection applies also to Professor Riddell's model.

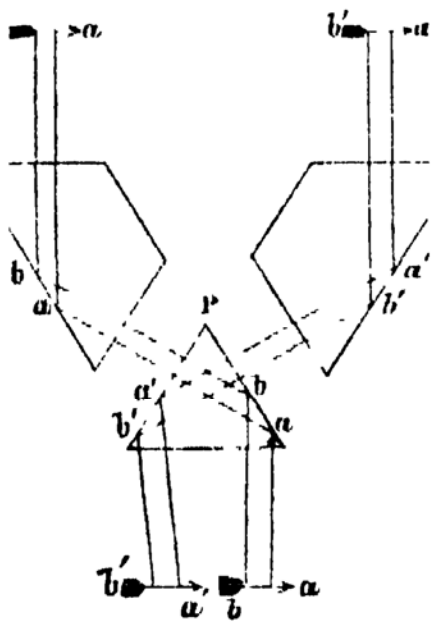


Fig. 22.—Nachet's Binocular Prisms.

It was for these reasons that Mr Wenham, fully impressed with the advantages of stereoscopic vision to the microscopist, set himself to devise a construction by which it might be obtained with the drawbacks inevitable in the working of Riddell's and Nachet's arrangements; and he soon succeeded in accomplishing this on a principle which has proved not only convenient but practically satisfactory, notwithstanding its theoretical imperfection. Only the right half of the cone of rays proceeding upwards from the right half of the objective (*a*, fig. 24) is intercepted by a prism placed immediately over that half of its back lens, which, by two internal reflexions (as shown in fig. 25), sends its pencils obliquely upwards into the left-hand or secondary body L, whilst the pencils of the left half cone pass uninterruptedly into the right-hand body R, and form an image that suffers no other deterioration than that which results from the halving of the angular aperture and the consequent loss of light. The moderate convergence of the two bodies (which, by varying the angles of the prism, may be made greater or less, so as to accord with the ordinary convergence of the optic axes in the individual observer) is much more generally suitable than the parallelism of MM. Nachet's earlier instrument; and the adjustment requisite for variation of distance between the eye-pieces can be made by simply lengthening or shortening both bodies by drawing out or pushing in the diverging eye pieces.

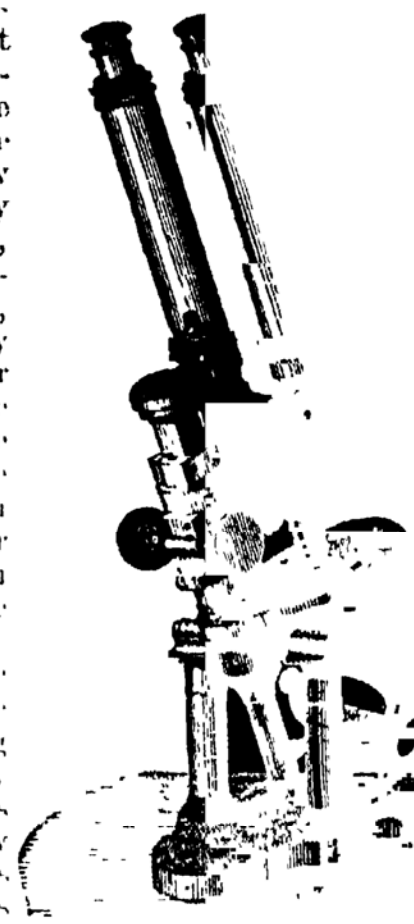


Fig. 23

It may be fairly objected to Mr Wenham's method (1) that, as the rays which pass through the prism and are obliquely reflected into the secondary body travel a longer distance than those which pass on uninterruptedly into the principal body, the image formed by them will be somewhat larger than that which is formed by the other set, and (2) that the image formed by the rays which have been subjected to the action of the prism must be inferior in distinctness to that formed by the uninterrupted half of the cone of rays. But these objections are found to have no practical weight. For it is well known to those who have experimented upon the phenomena of stereoscopic vision (1) that a slight difference in the size of the two pictures is no bar to their perfect combination, and (2) that, if one of the pictures be good, the full effect of relief is given to the image, even though the other picture be faint and imperfect, provided that the outlines of the latter are sufficiently distinct to represent its perspective projection. Hence it, instead of the two equally half-good pictures which are obtainable by MM. Nachet's original construction, we had in Mr Wenham's one good and one indifferent picture, the latter would be decidedly preferable. But, in point of fact, the deterioration of the second picture in Mr Wenham's arrangement is less considerable than that of both pictures in the arrangement of MM. Nachet; so that the optical perfection of the Wenham binocular is in every way superior. It has, in addition, these further advantages over the preceding: greater comfort in using it (especially for some length of time together) which results from the convergence of the axes of the eye at their usual angle for moderately near objects; secondly, this binocular arrangement does not necessitate a special microscope, but may be applied to any microscope which is capable of supporting the weight of the secondary body, the prism being mounted in a movable frame that it may in a moment be taken out of the tube or replaced therein, so that when it has been removed the principal body acts in every respect as an ordinary microscope, the entire cone of rays passing uninterruptedly into it; and, lastly, that the simplicity of its construction renders its derangement almost impossible. Hence it is the one most generally employed by microscopists who use the long-bodied English model.

Fig. 24. Stereoscopic Binocular M

For short-bodied Continental microscopes, however, M

[1] See Silliman's *Journal*, vol. xv., 1853, p. 68; and *Quart. Jour. of Micros. Sci.*, vol. i., 1853, p. 236.

[2] *Quart. Jour. of Micros. Sci.*, vol. ii., 1854. p. 18.

ised an arrangement of two prisms, based on Mr Wenham's ental idea of deflecting one half of the cone of rays into a y body, whilst the other half proceeds onwards without f direction into the principal body. And it is an interest- ure in this construction that, by a simple change in the of the dividing prism, the true "orthoscopic" image may be y a "conversion of relief," to become "pseudoscopic."[1]

ffect of stereoscopic projection may be attained, however, a double body, by the insertion of a suitably constructed r eye-piece into the body rdinary monocular micro A plan of this kind wa- cessfully worked out by s (the very able optician on, United States), who ed a system of prisms to that devised by MM. (fig. 22), but on a much ale, between an "erector ing that used in the eye- n day telescope and a pair ary Huygenian eye pieces, tral or dividing prism aced at or near the plane condary image formed by tor, while the two eye- re placed immediately he lateral prisms, the ion thus making that division in the pencils forming the y erected) image which it makes in the Nachet binocular neil emerging from the objective

Fig. 25. Wenham's Binocular Prism.

oscopic eye piece of a very different construction has been devised by Professor Abbe, who, making use, for the between the two eye-pieces of the rays going to form the ge, of an arrangement of prisms essentially similar to that by Mr Wenham for his non-stereoscopic binocular (fig. 27). either an orthoscopic or a pseudoscopic effect by placing eye piece a cap with a semicircular diaphragm, so as to h half of each of the cones of rays that form the two mages. While in one position of the diaphragms true pic or orthoscopic relief is given, it is sufficient to turn hragms into the opposite position to obtain a pseudo nversion.[2] It appears, however, that this arrangement, possessing points of great interest in relation to the theory ular vision, is not likely to supersede the ordinary Wenham

st be obvious to every one who studies with sufficient the conditions under which true stereoscopic relief can be at no combination of two dissimilar retinal perspectives tisfactory unless the visual pictures represent with tolerable ess the features of the object that lie in different focal planes rovided for, in ordinary vision, by the power of accommo ossessed by the eye, which, while focussed exactly to any e, can also include in its visual picture within certain hat is either nearer or more remote. Now it seems pro , as Professor Abbe has urged, this power of accommoda s into play in microscopic stereoscopy, but there can be on that the visual distinctness of the parts of an object im and beyond the focal plane, and therefore the com- of the stereoscopic image, mainly depends upon the "focal f the objective employed, which, as already explained, is n of its angular aperture. When, however, objectives of long d small aperture are employed in binocular microscopy, each of the two perspective projections may be fairly throughout the effect of solid relief will be very incon- because the pictures are not sufficiently dissimilar to one — the case being exactly analogous to that of the stereo- mbination of two photographic portraits taken at an angle more than a few degrees from each other. Still, with an of 1¼ inches focus and an angular aperture of from 15° to ery distinct separation is made of the focal planes of trans- ections of structure having no great minuteness of detail, especially, as mounted preparations, the solid forms of pillary networks being presented to the mind's eye with a s that no monocular representation of them can afford. 1 inch objective of 20° or 25° is used, the stereoscopic effect much more satisfactory; so that objects of moderate pro- (such as many of the siliceous *Polycystina*, *Diatomaceæ*, be seen in nearly their natural projection, and, if the focal ent. is made for a medium plane, with tolerable distinctness their nearer and remoter parts. With a ⅝ inch of 30° or stereoscopic relief becomes more pronounced; but the ion of the focal depth prevents the several planes of objects relief from being as distinctly seen at the same time. A

½ inch objective of about 40° of aperture, however, affords the satisfactory results with suitable objects,—full stereoscopic being gained without exaggeration, so as to present, *e.g.*, discoidal diatoms and the smaller *Polycystina* in their true f whilst their nearer and more remote parts are seen with suffi distinctness to require only a very slight adjustment of the for their perfect definition. Still more minute objects may be shown by $\frac{1}{16}$ths and ¼th objectives whose angular aperture not exceed 50°; but it can be shown both theoretically practically[3] that the dissimilarity of the two perspective projec of objects in relief formed by objectives of any angle much ex ing 40° is such as to exaggerate the stereoscopic effect; be which, every enlargement of angular aperture so greatly dimin the focal depth of the objectives that only those parts of the ob which lie very near the focal plane can be seen with distinc sufficient for the formation of a good stereoscopic image. H for the purposes of minute histological research, the stereos binocular is (in the present writer's opinion) almost value since, if any distinct perspective differentiation can be gained objectives of the short focus and enlarged angle that are suitable to such investigations, that differentiation will be so as to produce a highly exaggerated stereoscopic effect. If objectives be used binocularly at all, they must be so mounted their back lenses are in very close proximity to the prism; and (transparent) object must be illuminated by an achromatic cond of sufficient aperture to send through it pencils of sufficient d gence to produce the secondary image.

In regard to the advantage derived from the use of the st scopic binocular, with the powers, and upon the objects, suitab produce the true effect of solid form, the writer can unhe ingly assert, as the result of a long and varied experience, in no other way could he as certainly or as vividly image forms to himself, and that in prolonged work upon such sub he is conscious of a great saving of fatigue, which seems attribu not merely (perhaps not so much) to the conjoint use of both as to the absence of the mental effort required for the interpret of the microscopic picture, when the solid form of the object h be ideally constructed from it (chiefly by means of the inform obtainable through the focal adjustment), instead of being di presented to the mind's eye.[4]

Non-Stereoscopic Binoculars.—The great comfort which is ex cured by the microscopist in the conjoint use of both eyes ha to the invention of more than one arrangement by which thi be secured when those high powers are required which cann employed with the ordinary stereoscopic binocular. This is accomplished by Messrs Powell and Lealand by taking advantage of the fact that, when a pencil of rays falls obliquely upon the surface of a refracting medium, a part of it is reflected without entering that medium at all. In the place usually occupied by the Wenham prism they interpose an inclined plate of glass with parallel sides, through which one portion of the rays proceeding upwards from the whole aperture of the objective passes into the principal body with very little change in its course, whilst another portion is reflected from its surface into a rectangular prism so placed as to direct it obliquely upwards into the secondary body (fig. 26). Although there is a decided difference in brightness between the two images, that formed by the reflected rays being the fainter, yet there is marvellously little loss of definition in either, even when the $\frac{1}{16}$ inch objective is used. The disk and prism are fixed in a short tube, which can be readily substituted in any ord binocular microscope for the one containing the Wenham pris

Fig. 26

Other arrangements were devised long ago by Mr Wenham,[5] a view to obtain a greater equality in the amounts of light-rays ing the two pictures; and he has latterly carried one of these into practical effect, with the advantage that the compound prism of which it consists has so nearly the same shape and size as his ordinary stereoscopic prism as to be capable of being mounted in precisely the same manner, so that the one may be readily exchanged for the other. The axial ray *a*, proceeding upwards from the objective, enters the prism ABDEF (fig. 27) at right angles to its lower face, and passes on to *c*, where it meets the inclined face AB, at which this is nearly in contact with the oblique face of the right-a

Fig. 27.

[1] *Trans. of Roy. Micros. Soc.*, N. S., vol. xv., 1867, p. 105; and *Monthly* ., vol. i., 1869, p. 81

[2] *Journ. of Roy. Micros. Soc.*, 2d ser., vol. i., 1881, p. 298

[3] See *The Microscope and its Revelations*, 6t

[4] A very elaborate investigation, by Professor Abbe, "On the Condit Orthoscopic and Pseudoscopic Effects in the Binocular Microscope," will be in the *Journ. of the Roy. Micros. Soc.*, 2d ser., vol. i., 1881, p. 203.

[5] *Transactions of the Micros. Soc.*, N. S., vol. xiv., 1866, p. 105

36 By internal reflexion from the former and external from the latter about half the beam *b* is reflected within prism in the direction *cb*, while the other half proceeds onwards through the second prism, in the direction *aa'*, pass into the principal body. The reflected half, meeting oblique (silvered) surface DE of the first prism, is again in the direction *db'*, and, passing out of that prism perarly to its surface AF, proceeds towards the secondary The two prisms must not be in absolute contact along the B, since, if they were, Newton's rings would be formed h nicety is required in their adjustment, so that the two may be combined without any blurring of the image in dary body

e prolonged observation, under high powers of objects at the extreme of perfection in definition such for example ity of the cyclosis in plants,—great advantage is gained conjoint use of both eyes by one of the above arrangements

IFORANICAL CONSTRUCTION OF THE MICROSCOPE

otical arrangements on which the working of the compound ie microscope depends having now been explained we may onsider the mechanical provisions whereby the architect upon the different purposes which the instrument is designed Every complete microscope must possess in addition to the ombination of lenses which afford its magnifying power a reon the object may securely rest, and by means of which ion of transparent objects from beneath and reflecting he illumination of opaque objects from above

y, in whatever mode these may be connected with each is essential that the optical part and the stage should be ed as either to be altogether free from tendency to vibrate vibrate together, since it is obvious that any movement which the other does not partake will be augmented to of the observer in proportion to the magnifying power In a badly constructed instrument even though placed eady table resting upon the firm floor of a well built house h powers are used, the object is seen to oscillate so rapidly ghtest tremor—such as that caused by a person walking s room, or by a carriage rolling by in the street—as to be y almost indistinguishable, whereas in a well constructed nt scarcely any perceptible effect will be produced by even disturbances. Hence, in the choice of a microscope it ways be subjected to this test, and should be unhesitatingly f the result be unfavourable If the instrument should be e from fault when thus tested with high power its with low powers may be assumed but, on the other ough a microscope may give an image free from perceptible hen the lower powers only are employed it may be quite use with the higher The method still adopted by some of supporting the body by its base alone is the worst especially for the long body of the large English model, vibration of its lower part is exaggerated at its outer end the support of the body along its length the less tremor en in the microscope image

next requisite is a capability of accurate adjustment to iety of focal distance, without movement of the object It ciple universally recognized in the construction of good oes that the stage whereon the object is placed should be the movement by which the focus is to be adjusted being the optical portion. This movement should be such as to e range from a minute fraction of an inch to three or four ith equal power of obtaining a delicate adjustment at any should also be so accurate that the optic axis of the instrument should not be in the least altered by any movement in a direction, so that, if an object be brought into the centre of with a low power, and a higher power be then substituted, t should be found in the centre of its field notwithstanding reat alteration in the focus In this way much time may aved by employing a low power as a "finder" for an object to ed by a higher one; and when an object is being viewed ession of powers little or no readjustment of its place on should be required. A rack and pinion adjustment if to work both tightly and smoothly, answers sufficiently he focal adjustment, when objectives of low power only ; But for any lenses whose focus is less than half an inch djustment," or "slow motion," by means of a screw movrating either on the object-glass alone or on the entire body ly on the latter), is of great value: and for the highest is quite indispensable. It is essential that in this motion uld be no "lost time," and that its working should not any "twist" or displacement of the image In some microhich are provided with a fine adjustment the rack and ovement is dispensed with, the "coarse adjustment" being merely sliding the body up and down in the socket which ; but this plan is only admissable where, for the sake of heapness or portability, the instrument has to be reduced rm of utmost simplicity, as in figs. 28, 29.

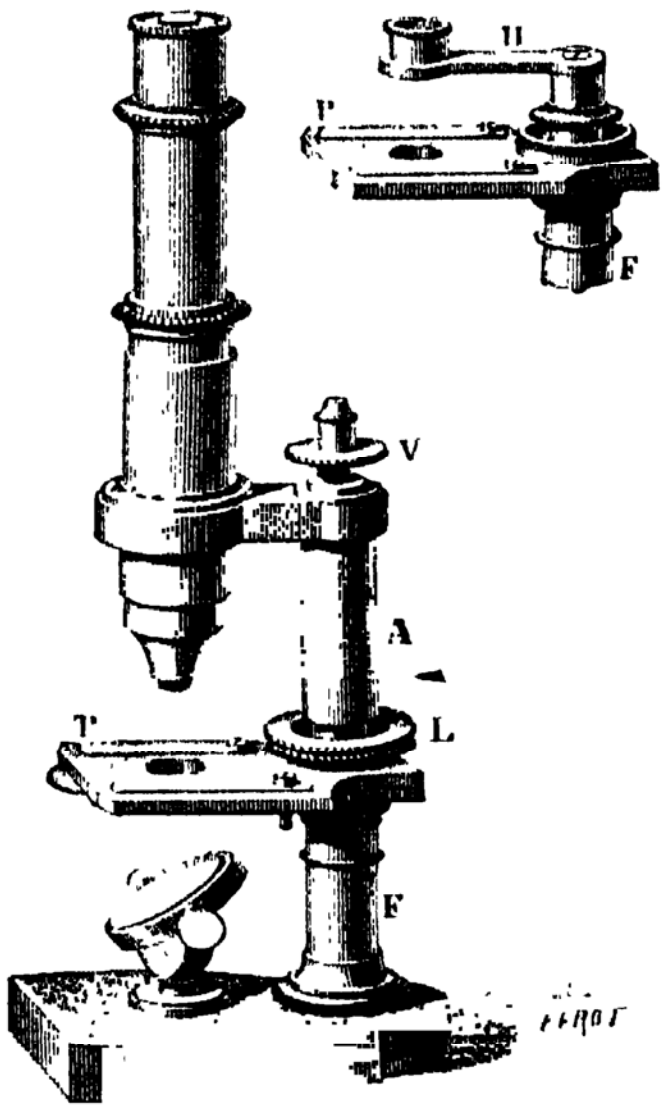
3. Scarcely less important than the preceding requisite, case of the compound microscope, especially with the long the ordinary English model, is the capability of being placed a vertical or a horizontal position, or at any angle with the without deranging the adjustment of its parts to each oth without placing the eye piece in such a position as to be venient to the observer It is certainly a matter of surpr some microscopists, especially on the Continent, should stil the advantages of the inclined position, these being attaina very small addition to the cost of the instrument, but the venience of the vertical arrangement is much less when t of the microscope is short, as in the ordinary Continental and there are many cases in which it is absolutely necessa the stage should be horizontal This position, however, can time be given to the stage of the inclining microscope, by l the optic axis of the instrument into the vertical directi ordinary cases an inclination of the body at an angle of ab to the horizon will usually be found most convenient for strained observation and the instrument should be so con when thus inclined to give to the stage such an elevatio the table that when the hands are employed at it the arm rest conveniently upon the table In this manner a de support is attained which gives such free play to the muscle hands that movement of the greatest nicety may be exec them and the fatigue of long continued observation is diminished When the ordinary camera lucida[1] used for or measuring it is requisite that the microscope should be horizontally It ought, therefore to be made capable of eve variety of position and the stage must of course be provid some means of holding the object whenever it is itself p such a position that the object would slip down unless susta

4 The last principle on which we shall here dwell as to the value of a microscope designed for ordinary work, is ity in the construction and adjustment of every part M genious mechanical devices have been invented and exec the purpose of overcoming difficulties which are in themselve trivial A moderate amount of dexterity in the use of the sufficient to render most of the operations and without dexterity no one, even with the most complete mechanical will ever become a good microscopist There is of course, to this simplification and no arrangement can be objecte this score which gives advantages in the examination of objects, or in the determination of doubtful question such simpler means can afford The meaning of this distinct become apparent if it be applied to the uses of the mec stage and the achromatic condenser For although the mec stage may be considered valuable and in observation as for the finding of a minute object or the examination of the surface of a large one yet it adds nothing to the clearness view of either and its place may in great degree be supplied fingers of a good manipulator On the other hand, the use achromatic condenser not only contributes very materially absolutely indispensable to the formation of a perfect image case of many objects of a difficult class the want of it ca compensated by the most dexterous use of the ordinary app and consequently although it may fairly be considered supe as regards a large proportion of the purposes to which the scope is directed whether for investigation or for display regards the particular objects just alluded to it is no less ne part of the instrument than the achromatic objective itself

A typical example of the simplest form of compound scope that is suitable for scientific research which, with modifications of detail is the one generally employed on t ment the *Working Microscope for Observation* (fig 28 Nachet especially as constructed for portability (figs 29 31 particularly worthy of description In its vertical form (fig solid foot to which the mirror is pivoted gives support pillar I to the top of which the stage P, having a diaphrag by a thumb screw attached On the top of this pillar the barrel or tube A is fitted in such a manner that it may be rem unscrewing the large milled head I — though when this screwed down the system stands quite firmly This stem has its summit a short horizontal arm which carries a strong tube that firmly grasps the 'body' of the microscope wh mitting this to be easily slid upwards or downwards so as a coarse adjustment of the focus The 'fine adjustment made by turning the milled head V which either presses de outer tube of the stem, or allows it to be raised by the upwa sure of a strong spiral spring in its interior By means of milled head I the stem A with its arm and compound body detached from the pillar and, a small brass arm H holding single lenses or doublets being slid into the accompanying di microscope is thus provided The only drawback in the co tion of this simple model is its not being provided with a j

[1] A camera lucida adapted for use with the vertical microscope has vised by M Nachet

ination of the body; but this is introduced into the port- on of the instrument shown in fig. 29, the basal portion of fig. 30) can be used, like that of the preceding model, as a microscope, and, by a most ingenious construction, can be d as to lie flat in a shallow case (fig. 31) that holds also the part with the objectives of both the simple arm and the com-



28.—Nachet's Combined Simple and Compound Microscope.

body. M. Nachet now connects his objectives with the his microscopes, not by a screw, but by a cylindrical fitting place by the pressure of a spring-clip against a projecting e. This method not only allows one objective to be re- and replaced by another much more readily than does the ring, but also renders the centring of different objectives actly con- e. It may y affirmed very large on of the pic work last half- which has n entirely ect to bio- rience, has ne by in- ts of this ontinental

er model, , was from t adopted ritish opti- and, as a example of neral plan onstruction st followed England he United the im- Jackson- ver micro- of Messrs g. 32) may be appropriately selected. The tripod base of rument carries two pillars, between which is swung upon a al axis (capable of being fixed in any position by a tighten- w) a solid "limb," with which all the other parts of the nt are connected,—a plan of construction originally devised eorge Jackson. The binocular body, having at its lower end g. 24) an opening into which either of the Wenham prisms serted, and at its top a rack movement for adjusting the eye-

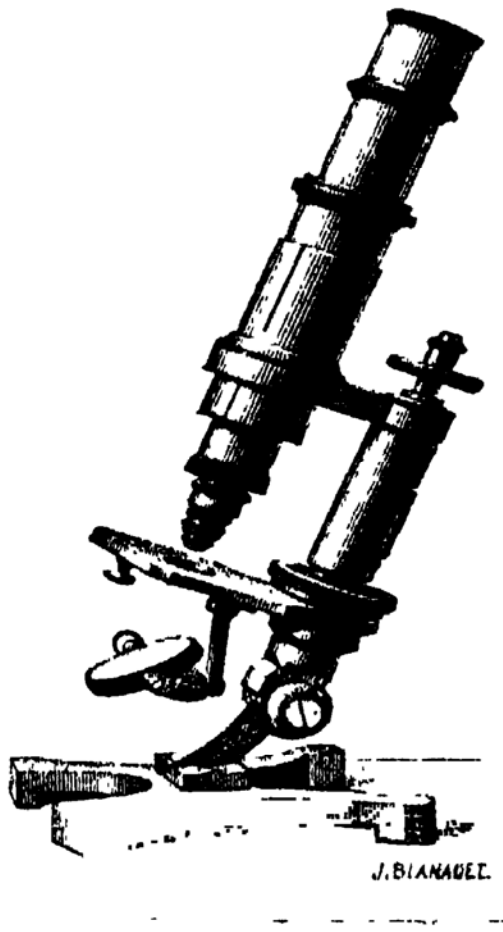
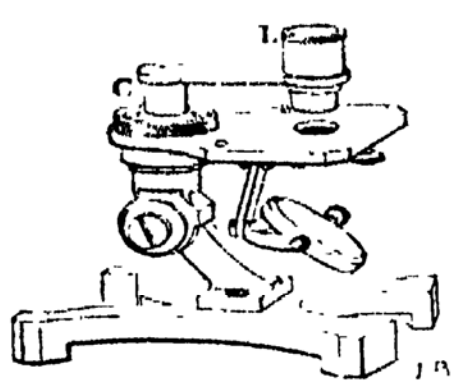


FIG. 29.—Nachet's Portable Compound Microscope.

pieces to the distance between the eyes of the observer, is to a racked slide, which is so acted on by the large doubl



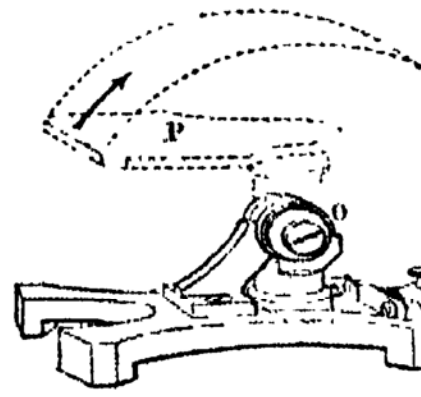


FIG. 30. Nachet's Portable Dissecting Microscope, on the l up for use, on the right as having the stage P turned back joint O, so as to lie flat on the bottom of the case.

head in the upper part of the limb as to give a "quick" u downward motion to the body; while the "slow" motion

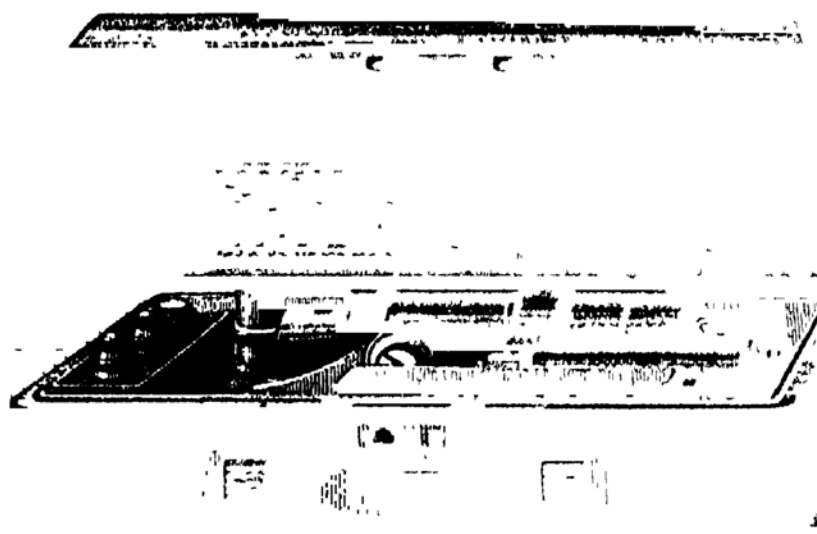


FIG. 31.—Nachet's Portable Compound and Dissecting Micr as packed in case.

adjustment, is given by means of the vertical micrometer the back of the limb, which raises or lowers a second slide be rack.[1] The stage is supported upon a firm ring, which is immovably fixed, not to the limb, but to a strong conical pivot which passes through the limb, to be clamped by a screw-nut at its back,—the purpose of this being to allow the whole stage to be inclined to one side or the other at any angle, so that a solid object may be viewed sideways or from below, as well as from above. Upon this ring the stage rotates horizontally, its angular movement being measured by a graduated scale and vernier at its edge; and it can be fixed in any azimuth by a clamping screw beneath. Rectangular movement is given to the traversing platform which carries the object by two milled heads on the right of the stage, the whole construction of adapted to allow light of extreme obliquity to be thrown u object from beneath. On the strong pivot by which the

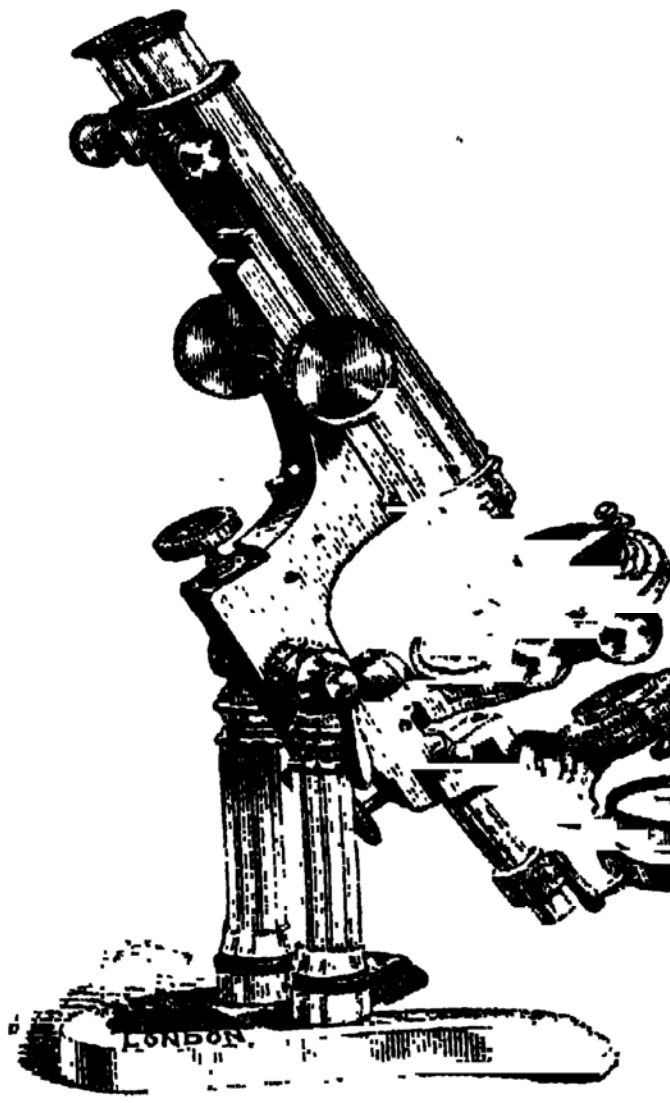


FIG. 32.—Ross's Jackson-Zentmayer Co Microscope.

[1] In the older form of construction still retained by some maker adjustment acts directly on the objective, the fitting of which is mad up and down within the nose of the body; but this plan is attended w disadvantages.

to the limb (the axis of which passes through the point at he object-plane is intersected by the optic axis of the hung the swinging tail-piece invented by Mr Zentmayer of phia, which, carrying the whole illuminating apparatus, so set as to give to the axis of the illuminating pencil any degree of obliquity. To the upper part of it is attached nd-pinion movement carrying the "substage," which is with two milled-headed screws for centring it pre- ith the microscope-body. Into this may be fitted the tic condenser, parabolic illuminator, polarizing prism, or r kind of illuminating apparatus; whilst at its lower end s the mirror, the position of which may be varied by sliding ng up or down the "tail-piece," or by turning the arm rries it to one side or the other; while, if direct illumina- n a lamp should be preferred, it may be turned altogether By swinging the tail-piece round above the stage, oblique y be reflected from the mirror, through the condenser, upon er surfaces of objects. The condenser usually fitted to rument is of about $\frac{4}{10}$ inch focus, with a large back lens; which are placed an iris-diaphragm for reducing the light entral rays, and a diaphragm-plate with apertures of the forms most suited for the resolution of lined objects by rays.

strument, in the writer's judgment, is better adapted than the highest purposes of microscopical research It works ly with every power from the lowest to the highest, and is of receiving any one of the numerous pieces of apparatus ave been devised for special researches of various kinds. iled description of these not being here admissible, it will ient to indicate the polariscope and the spectroscope as the portant of these accessories.

Micrometry.

icroscopist has constant need of some means of taking exact ments of the dimensions of the minute objects, or parts of on the study of which he is engaged; and the accuracy of ation will of course be proportioned to the correctness of dard used, and the care with which it is applied.

nstruments employed in microscopic micrometry are of two he measurement being taken in one by the rotation of a w with a divided milled head, whilst in the other a slip ruled with lines at fixed distances gives a scale which forms f computation. Each of these has its advantages and its ntages.

tage-micrometer constructed by Frauenhofer was formerly ed by Continental microscopists, and has the advantage of ng the actual dimensions of the objects to be measured; as the two special disadvantages that a sufficiently small nnot be conveniently given to its divisions, and that any its construction and working is augmented by the whole ing power employed. This instrument has now, however, ntirely given place to one of those to be next described.

crew-micrometer ordinarily used in astronomical measure- see Micrometer) can be adapted to the eye-piece of the pe in a manner essentially the same as that in which it is to the telescope,—its two parallel threads of which one is d the other made to approach towards or recede from this urning of the screw—being placed in the focus of the eye- d being therefore seen as lines crossing its field of view. et is so focussed that its image is formed in the same plane; latter being brought into such a position that one of its ends ns lies in optical contact with the fixed line, the screw is o as to bring the movable line into the like coincidence other. But the distance between the lines, as given by the of divisions of the micrometer, will here be the measure- ot of the object itself, but of its magnified image; and the these divisions, therefore, will depend upon the amplifica- on by the particular objective used. Thus, suppose each of the micrometer to have an actual value of $\frac{1}{10000}$th of an d the visual image to have one hundred times the linear ons of the object, the theoretical micrometric value of each would be $\frac{1}{100}$th of $\frac{1}{10000}$th, or one-millionth, of an inch,— of minuteness, however, not practically attainable. It is y, moreover, to determine the micrometric value of the s of the micrometer, not only for every objective, but for ns in the conditions under which that objective may be d, as regards the length of the tube or "body" of the pe, which is varied not only by the draw-tube, but also, y cases, in the working of the fine adjustment or slow and also, in the case of the large-angled powers furnished justment for thickness of the covering-glass, for the degree ation of the front- from the back-glasses of the objective, nakes a very sensible difference in its magnifying power. termination is made by means of a divided glass stage- eter put in the place of the object, so that the lines ruled upon ed intervals shall be projected upon the field of view. The icrometer is usually ruled either to 1000ths of an inch or 100ths of a millimetre; and it is convenient that one of the d of its image should be made to coincide exactly with a certain of divisions of the screw-micrometer. This may be done by le ing the draw-tube, so as to increase the amplification of t until coincidence has been reached; and the exact amount lengthening should be noted,—as should also the precise of the milled head of the slow motion (if it acts on the ob instead of on the body as a whole), and of the adjusting scre of the objective itself. Thus, if two lines of the stage-mic separated by 1000th of an inch be brought into coinciden the two threads of the eye piece micrometer, separated b divisions of the screw milled head, the value of each of tho sions is $\frac{1}{10000}$th of an inch. If the above conditions be p recorded for each objective used in micrometry, the micr value of the divisions remains the same for that objective, w it is employed under the same conditions.

The errors to which micrometers are subject arise (1) fr equalities in the ruling of the stage micrometer, (2) from irr ties in the screw of the eye-piece micrometer, (3) from "los in its working, and (4) from the thickness of its threads. I to eliminate the first and second, it is well to determine t tion of the divisions of the two micrometers by the compa a considerable number of both; the third proceeds from an fection of workmanship which, if it shows itself sensibly, destroys the value of the instrument, while the fourth rectified by the exercise of skill and judgment on the part observer. For, if the micrometer is so constructed as to re when one thread lies exactly upon the other, its divisions i the distance between the axes of these threads when separate the dimensions of any object (such as a blood-corpuscle between their borders will obviously be too great by half th ness of the two threads, that is, by the entire thickness thread. When, on the other hand, the measurement is bei (as of the distances of the striæ on diatoms) by the coin between certain lines on the object and the axes of the th the micrometer, the dimensions indicated by the division screw milled-head will be correct.

The costliness of a well-constructed screw micrometer formidable obstacle to its general use, a simpler method (de Mr George Jackson) is more commonly adopted, which co the insertion of a ruled-glass scale into the focus of an Huygenian eye-piece, so that its lines are projected on the view. This scale (ruled, like an ordinary measure, with ev line long, and every tenth line double the length of the fixed in a brass inner frame, that has a slight motion in th tion of its length within an outer frame; and this last, bein duced through a pair of slits into the eye piece just ab diaphragm, and being made to occupy the centre of the brought exactly into focus by unscrewing the eye glass a may be requisite. When the image of the object to be mea brought by the focal adjustment of the object-glass into t plane, a small pushing-screw at the end of the micrometer action is antagonized by a spring at the other end) is turn one of the long divisions of the scale is brought into optical with one edge of the image of the object to be measured, number of divisions is then counted to its other edge, the op being exactly that of laying a rule across the real object if e to the size of its image. The micrometric value of each div this eye-piece scale must be carefully ascertained for each ob as in the case of the screw micrometer, the error arising f equality of its divisions being eliminated as far as possible by an average of several. The principal point of inferiority form of micrometer is that, as its divisions cannot be nearly so small a value as those of the screw-microm estimate of fractional parts of them often becomes necessary is objectionable as involving an additional source of error. this objection, Hartnack has introduced the diagonal scale mathematical instruments before the invention of the verni

Another mode of making micrometric measurements, w some purposes has considerable advantages, is to employ micrometer in combination with some form of camera attached to the eye piece of the microscope, so that the its divisions may be projected upon the same surface as which the image of the object is thrown. By first using t stage-micrometer, and marking on the paper the average of its lines as seen in the central part of the field, and the the paper accordingly, the micrometric value of the divi projected may be exactly determined for the objective emplo the distance of the drawing-plane from the eye-piece,—so th the image of any object is projected under the same condit dimensions of that image or of any parts of it can be exactly m upon the divided scale previously projected, and the true sions of the object thus easily ascertained. If, for exam lines of a stage-micrometer ruled to the thousandth of should, when thus projected, fall at a distance of an inc then the application of an ordinary scale of inches (divi tenths) to the image of an object projected by the same

the same plane would give its real dimensions in dths of an inch, while the tenths of the inch scale would nt a real dimension of as many ten-thousandths. It is often le to make such measurements from careful tracings of the s of objects, rather than from the visual images,—this plan specially advantageous when the exact dimensions of many objects have to be compared, as in the case of blood-cor-, precise measurements of which are not unfrequently required cial inquiries. It was by the use of this method that the Gulliver made his admirable series of measurements of the and extreme dimensions of the blood-corpuscles of different s. And more recently Mr Dallinger has shown, by first making a very fine camera lucida tracing of *Bacterium* under an amplification of 2000 diameters, and measuring the of its body in the mode above indicated (which gave it as of an inch), and then by magnifying his tracing from fiv diameters, and comparing, by means of the screw-microm breadth of the flagellum with that of the body (which las to be just ten times as great),—that, although the theoreti of resolving power for closely approximated lines is $\frac{1}{120,000}$ inch, a semitransparent filament whose breadth is not grea $\frac{1}{2,000,000}$th of an inch may be clearly discerned, and even n with a close approximation to accuracy (*Jour. of Royal Society*, vol. i., 1879, p. 169). W.

DAS, king of Phrygia, is one of those half-legendary in whom religious legends have gathered round a rson. The name Midas the king, ΜΙΔΑΙ ΓΑΝΑΚΤΕΙ, on a very ancient tomb in the valley of the Sangarius, gendary seat of the Phrygian kingdom (*Iliad* iii. The Phrygian monarchy was destroyed by the rians about 670 B.C., and the last king Midas com-suicide by drinking bull's blood. The name Midas in Greek tradition the representative of this ancient y, but all that is told of him is religious myth. He ure in the cycle of Cybele legends, the son of the s and her first priest. He is also closely connected e cultus of Dionysus, like the two heroic personages s and Silenus. The Midas legend was known on Bermius in Macedonia, and must at one time have in Greece; two cities Midea, in Argolis and in , recall the Phrygian city Midaeum.

erod. viii. 138; Xen., *Anab.*, i. 2, 13; Paus. i. 45, &c.

DDELBURG, in Holland, the ancient capital of the e of Zealand, situated in the middle of the island cheren, is mentioned as early as 1153, and receives e "town" in a charter granted it in 1227. It has characteristics of an old and worn-out place. The ion (25,000 in 1739) had sunk to 12,000 or 13,000 beginning of the 19th century, and has only begun to increase again, being 15,939 in 1882. The g-houses, which in 1739 were about 3800, are now 00, and of these about 600 are unoccupied. The archouses and imposing mansions once belonging to families, which have either died out or left the all up the memory of that prosperity which Middel-njoyed before its extensive trade, with the East and ndies, with England and Flanders, was ruined by r with England and the French occupation. By ning of the railway (1872) and of the ship canal to Flushing Middelburg was lifted out of its isola-d, with the assistance of the chamber of commerce, eturing industries (iron, machinery, furniture, oil, &c.) were established; but the prosperity anticipated shing, and consequently for Middelburg, remains zed. One of the chief sights of Middelburg is the d town-house, for the most part erected in 1512–13, s front gable adorned with twenty-five statues of and countesses of Holland and Zealand; it contains hives, and a most valuable antiquarian and historical on. The abbey, begun in 1150, has frequently been idence of royal visitors (Maximilian, Philip the Fair, s V., and so on down to Napoleon I., and William I., l III.); part of it is now an hotel, and part of it is d by the provincial authorities. The great hall of lding, in which the states of Zealand assemble, is l with beautiful tapestries by Jan de Maecht, repre-the heroic feats of the men of Zealand in the with Spain. What was formerly the nave of the hurch is now the New Church, and the ancient choir ates the Choir Church. The former contains a fine resting on an eagle, the monument of William, king of the Romans (d. 1256), and the tombs of Ja Cornelis Evertsen, two naval heroes who fell in t against England in 1666; the latter has the mon of the learned Hadrian Junius and of Jan Piete The provincial court, the corn exchange, the Hof S and the Hof St Sebastian (formerly buildings belon the guilds of archers, and now places of amusement) mention. The great museum of Zealand antiquit lected by the Zealand Society of Arts and Sciences (f at Flushing in 1769 and transferred to Middelb 1801), shows that the town is the intellectual centre province.

The principal facts in the history of Middelburg are the s the Flemings in 1288, 1296, and 1303 (the last resulting capture of the town by Guy of Dampierre); the recovery town from the Spaniards in 1574, after an investment of ne years; the frequent disturbances among the townsfolk in t and 18th centuries; the surrender to the English in 1809; arrival and departure of the French in 1809 and 1814.

MIDDLEBOROUGH, a town of the United St Plymouth county, Massachusetts, 34 miles south of It has a handsome town-hall and a public library, m tures woollen goods, straw goods, shovels, shoes, ca &c., and in 1880 had 5237 inhabitants.

MIDDLESBROUGH, situated near the mouth Tees, on its south bank, in the North Riding of Yor has now become the principal seat of the Englis trade. It is a municipal and parliamentary bo locally governed by a mayor and corporation, and a member to parliament. The earlier history of th is meagre. Where Middlesbrough now stands (C *History of Cleveland*) there were at one time a small and priory founded by Robert de Brus of Skelton These were dedicated to St Hilda, and with some were given by De Brus to the abbey of St Hilda at W in 1130. The priory fell into ruins at the time Reformation, and no trace now remains beyond some built into the wall of a brewery. The mayor's cha is made from a fragment. In 1801 there were up site of Middlesbrough only four farm-houses. In company styling itself the Middlesbrough Owners 500 acres of land, and commenced building the tow 1830 the Stockton and Darlington Railway was ex from Stockton to Middlesbrough; four years later th was lighted with gas; and after six years more a market was established. The census of 1831 show population to be 154; that of 1841 showed 570 1842 the opening of the docks gave additional impe to the town. First containing an area of 9 acres were extended in 1872 to 12 acres, with 1700 quays. Vessels of 3000 tons burden can be accomm From the year 1851, when J. Vaughan discover presence of ironstone in the Eston Hills, the town ad with rapid strides. When the jubilee of the town w in 1881 (a year late) the population had risen to the area to 2731 acres, and the rateable value to £1 the population of the parliamentary borough (are acres) being 72,145. In the district there are upw

LONDON
KENT
ESSEX
HERTFORD
BUCKINGHAM
BERKS
RIVER THAMES
Hampstead
Highgate
Finchley
Hendon
Harrow
Willesden
Kensington
Chelsea
Fulham
Hammersmith
Richmond
Kingston
Wimbledon
Croydon
Dulwich
Greenwich
Deptford
Woolwich
Lambeth
Battersea
Clapham
Streatham
Tooting
Balham
Norwood
Sydenham
Lewisham
Blackheath
Bromley
Eltham
Plumstead
Barnet
Edgware
Hendon
Harrow
Uxbridge
Hayes
Ealing
Brentford
Isleworth
Twickenham
Hounslow
Staines
Windsor
Slough
Eton
Datchet
Chertsey
Weybridge
Walton
Esher
Epsom
Ewell
Sutton
Cheam
Mitcham
Wandsworth
Putney
Barnes
Mortlake
Kew
Richmond
Hampton
Teddington
Thames Ditton
Surbiton
Kingston
Malden
Coombe
Wimbledon
Merton
Morden
Carshalton
Beddington
Croydon
Addington
Selsdon
Sanderstead
Purley
Coulsdon
Caterham
Warlingham
Chelsham
Farleigh
Godstone
Oxted
Limpsfield
Westerham
Edenbridge
Penshurst
Tonbridge
Sevenoaks
Otford
Shoreham
Eynsford
Dartford
Crayford
Bexley
Erith
Belvedere
Abbey Wood
Woolwich
Charlton
Greenwich
Deptford
New Cross
Peckham
Camberwell
Dulwich
Norwood
Streatham
Tooting
Balham
Clapham
Battersea
Lambeth
Kennington
Vauxhall
Chelsea
Kensington
Hammersmith
Fulham
Putney
Barnes
Mortlake
Kew
Brentford
Chiswick
Acton
Ealing
Hanwell
Southall
Hayes
Uxbridge
Ruislip
Northwood
Pinner
Harrow
Wembley
Kingsbury
Hendon
Finchley
Barnet
Edgware
Stanmore
Bushey
Watford
Rickmansworth
Chorleywood
Amersham
Chesham
Berkhamsted
Tring
Hemel Hempstead
Kings Langley
Abbots Langley
Watford
St Albans
Harpenden
Redbourn
Hemel Hempstead
Berkhamsted
Tring
Wendover
Aylesbury
Thame
Watlington
Henley
Maidenhead
Windsor
Slough
Eton
Datchet
Staines
Sunbury
Hampton
Teddington
Twickenham
Isleworth
Hounslow
Feltham
Bedfont
Ashford
Chertsey
Weybridge
Walton
Esher
Epsom
Ewell
Sutton
Cheam
Morden
Mitcham
Carshalton
Beddington
Croydon
Addington
Selsdon
Sanderstead
Purley
Coulsdon
Caterham
Warlingham
Chelsham
Farleigh
Godstone
Oxted
Limpsfield
Westerham
Edenbridge
Penshurst
Tonbridge
Sevenoaks
Otford
Shoreham
Eynsford
Dartford
Crayford
Bexley
Erith
Belvedere
Abbey Wood
Woolwich
Charlton
Greenwich
Deptford
New Cross
Peckham
Camberwell
Dulwich
Norwood
Streatham
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Ruislip
Northwood
Pinner
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Wembley
Kingsbury
Hendon
Finchley
Barnet
Edgware
Stanmore
Bushey
Watford
Rickmansworth
Chorleywood
Amersham
Chesham
Berkhamsted
Tring
Hemel Hempstead
Kings Langley
Abbots Langley
Watford
St Albans
Harpenden
Redbourn
Hemel Hempstead
Berkhamsted
Tring
Wendover
Aylesbury
Thame
Watlington
Henley
Maidenhead
Windsor
Slough
Eton
Datchet
Staines
Sunbury
Hampton
Teddington
Twickenham
Isleworth
Hounslow
Feltham
Bedfont
Ashford

130 blast furnaces, besides large iron and steel works; and the Thomas-Gilchrist process of making steel promises for Middlesbrough importance in the future as a steel entrepôt. The make of pig-iron in 1880 was 1,991,032 tons. There are also shipbuilding, potteries, chemical works, and a salt trade. Middlesbrough is well laid out, nearly all the streets lying at right angles to one another. Many of the churches and the exchange are handsome buildings, while the station of the North Eastern Railway is probably the finest in the north of England. A splendid park of 72 acres, the gift of the late H. F. W. Bolckow, adds greatly to the amenity of the town.

MIDDLESEX, an inland county in the south east of England, lying between 51° 25′ and 51° 40′ N. lat., and between 0° and 0° 36′ W. long. On the south it is divided from Surrey and Kent by the Thames, on the east from Essex by the Lea, on the west from Buckinghamshire by the Colne, and on the north from Hertfordshire by a partly artificial and very irregular line. Although with the exception of Rutland it is the smallest county in England, its population is exceeded by that of Lancashire only. Its total area is 181,317 acres, of which 2592 acres are common or waste lands. The longest straight line that can be drawn in the county is one of nearly 28 miles from the north-eastern extremity near Waltham Abbey to the south-western at Staines. From north to south in the broadest part the distance is about 15 miles.

Surface and Geology.—The greater portion of the county is flat, although there are sufficient undulations to allow of a proper drainage of the land. A range of hills runs along the Hertfordshire border by Barnet, Elstree, Stanmore, and Pinner, averaging 400 feet in height; another range occupies the ground just north of London by Hornsey, Highgate, and Hampstead; Harrow occupies an isolated eminence between the two ranges.

The county lies entirely within the basin of the Thames, and the London Clay extends over a large portion of the surface. This formation stretches from the mouth of the estuary of the Thames to the neighbourhood of Marlborough. It attains its greatest breadth (little short of 30 miles) in the neighbourhood of London, and extends northward until it is lost beneath the drift of Suffolk and Norfolk. The following is a table of the various beds of rock which occur at the surface, with their greatest thickness (in feet) in the district:—

Alluvium (recent river deposits)	15
Post-Pliocene Tertiaries.	
Post-glacial beds (brick-earth, gravel, &c.)	50
Glacial drift (boulder clay, gravel, &c.)	80
Eocene Tertiaries.	
Lower Bagshot sands	100
London Clay	420
Woolwich and Reading beds	90
Cretaceous.	
Chalk with flints	800

Chalk comes to the surface in so very few places that it is scarcely worth mention. It is seen near Harefield and on the north-west side of South Mimms. The depth from the surface to the chalk varies greatly in different parts of the county. This has been proved by the borings for wells, thus at Isleworth the depth is 400 feet and at Hampstead 378, while at Ruislip it is 76 feet and at Pinner only 60. The Reading beds (plastic clays) are brought to the surface at Windsor. They follow roughly the course of the river Colne from the north of Uxbridge along the flank of the hills north-eastward, but are sometimes cut back southward along small side valleys. An outlying mass is exposed at Pinner. The Bagshot sands, consisting of gravel and sand permeable to water, once stretched over the whole extent of the London Clay, but they are now to be found only on the high grounds at Hampstead, Highgate, and Harrow. A corner of the main mass ent south-west corner of the county near Littleton. I brick-earth occur in the drift between West Drayt Uxbridge.

Several deep borings in the London basin pro existence beneath the chalk of beds which do not c in Middlesex. Three of these are in the county; a most interesting is that at Meux's Brewery, Tot Court Road (about 1146 feet), which passes throu following formations: gravel and clay, 21 feet; Clay, 61 feet; Reading beds, 51 feet; Thanet sand, chalk, 655 feet; Upper Greensand, 28 feet; gau feet; Lower Greensand, 64 feet; Devonian, 80 fee

Rivers and Canals.—The Thames is very tortuous 14 miles of its course from Staines to Blackwall, and a remarkable bend at the eastern limit of the county it forms the so called Isle of Dogs. The width at is 200 feet, at Chiswick opposite Barnes 310 Hammersmith 525 feet, at Fulham 820 feet, at W ster Bridge 1100 feet, but at London Bridge it is le 800 feet; above the junction of the Lea at the Isle the width is 1350 feet. The ordinary rise of the London Bridge is 16 feet, and the tide-way ends a dington. The port of London begins below London and the channel for from 2 to 3 miles is called the

The Colne from Hertfordshire enters Middlesex north-western corner of the county. It then runs joining the Thames at Staines, and in its course Middlesex from Buckinghamshire for 15 miles. A river leaves Uxbridge it divides out into severa channels. The Lea from Hertfordshire enters Mi at the north eastern corner of the county near W Abbey. It runs south, dividing Middlesex from E 15 miles, and falls into the Thames at Bow Cree branches flow off from the river during its course Brent from Hertfordshire enters Middlesex near F It takes a circuitous direction southward throu middle of the county by Hendon, Kingsbury, T Greenford, and Hanwell to the town of Brentford, unites with the Thames. Where the river crosses th ware Road (about 3 miles south of the town of Ed it is expanded by artificial means into an extensiv voir. The Cran (or Yedding Brook) rises in the between Harrow and Pinner and flows under Bridge; it crosses Hounslow Heath, and bends r Twickenham and Isleworth, where in a divided st falls into the Thames.

There were several other small streams in the nei hood of London which have left their mark in th of places, but which are now merely sewers, such Wallbrook, the Westbourn, the Tyburn, the Fle &c. The last mentioned, which runs into the Than Blackfriars Bridge, was formerly navigable as Holborn Bridge, but, the Fleet Ditch, as it was the having become in the last century a dangerous n the lord mayor and citizens were empowered by Parliament to arch it over. The work was comme 1731, and in 1737 Fleet market, occupying the sit space from Holborn Bridge to Fleet Bridge, was o the public. The New River, an artificial water co structed by Sir Hugh Myddelton in the reign of J to supply London with water, runs through the cou north to south a little to the west of the river derives its waters from the springs of Amwell and C increased by a cut from the Lea, in the neighbour Ware, and enters Middlesex from Hertfordshire miles north of Enfield. It passes Enfield, Tot Hornsey, and Stoke Newington, and is received reservoir in Clerkenwell known as the New River

The Grand Junction Canal leaves the Thames a

roceeds in a westerly direction by way of Hanwell
anford to West Drayton; thence in a northerly
n it follows the valley of the Colne. It passes
lge, and after leaving the county takes its further
by Rickmansworth through Hertfordshire. The
gton Canal leaves the Grand Junction Canal at
rd, and passes Northolt, Apperton, Twyford (where
rried over the Brent by an aqueduct), and Kensal
At Paddington it joins the Regent's Canal, which
the north of Regent's Park, and after proceeding
h the eastern portions of London joins the Thames
house. The Regent's Canal is joined to the river
means of Sir George Duckett's Canal, and thus
s a through communication from the north eastern
of the county to the south-eastern corner, thence
st to west, and northward to the north west corner.

ate, Soil, Agriculture, &c. The climate of the
is equable and good, and the shelter of the northern
akes the air mild. Highgate, Hampstead, and
ther parts are supposed to be specially healthy, and
ommended for invalids by the medical profession.

heavy poor clay in the north and north-western por-
Middlesex is chiefly covered with permanent grass
parts it has been made fit for arable cultivation
addition of chalk, lime, and ashes. The rich
s from the Thames have formed a soil which when
anured is specially suitable for market gardens.
ts nearness to London the district has long been
for high farming, and the divisions devoted to
t kinds of farming are well marked. The greater
Gore and Ossulston hundreds, portions of Spel
and Edmonton hundreds, and a strip down the
side of Elthorne hundred are devoted to meadow
sture. The arable land is chiefly found on the
side, and between the Great Western Railway and
anes It is also to be seen in the north-western
With the constant increase of London, houses
eroached upon the fields, and most of the market
which were situated in the neighbourhood of
n and Hackney have disappeared. The strip of
the Thames from Brentford to Chelsea was given
st entirely to market gardens, but Fulham is fast
ult over.

ding to the returns for 1882, the area occupied by grain
n crops, grass, &c., was 116,470 acres Of this amount,
eres were under corn crops (wheat, 6110, barley, 3083;
5; and beans and pease, 2636), 13,151 under green crops
g potatoes, 3019; turnips, 1539; mangolds, 1692; cabbage,
s; 3025 under clover and grasses sown in rotation, and
under permanent pasture. Orchards occupied 3419 acres;
garden, 6900; nursery grounds, 417, and woods, 2382
same year the horses numbered 5939 (4188 used for agri-
purposes), cattle, 23,283 (cows, 15,390); sheep, 23,916;
, 12 035

ollowing were the landowners in the county (exclusive of
at the time of the Domesday survey - the king, the arch-
of Canterbury, the bishop and canons of London, the abbeys
minster and Holy Trinity at Caen, the nunnery of Barking,
ls Roger and Morton, Geoffrey de Mannevele, Ernulf de
, Walter Fitz Other, Walter de St Walery, Richard Fitz
Robert Gernon Robert Fulton, Robert Fitz Roselin,
Blund, Roger de Rames, William Fitz Anculf, Edmund de
y, Aubrey de Vere, Ranulf Fitz Ilger, Derman, Countess
and the king's almoner

73, according to the *Return of Owners of Land*, the total
of owners in the county (also exclusive of London) was
of whom 9006 owned less than an acre. The extent of
including common or waste land) is given as 145,605. The
timated rental was £1,611,655. Sixteen owners each pos-
over 1000 acres. The crown owned 2382 acres (annual
5503); the duchy of Lancaster, 2273 acres (£4492); Eccles-
Commissioners, 1308 acres (£46,519); All Souls' College,
1813 acres (£4724); Christ Church, Oxford, 1132 acres
; and King's College, Cambridge, 1097 (£1084).

y villages of Middlesex, especially those near to
, were formerly famous for their mineral springs.
Some places are still supplied with water from wel
the Barnet, the East Middlesex, the Grand Junct
West Middlesex, and the New River Water Co
serve a large part of the county.

Manufactures and Trade.—There is little to rema
regard to the manufactures of the county outside of L
Brick-making and tile-making have always flourish
malting, distilling, and soap-making are favourite ind
Gunpowder mills exist at Twickenham and B
The market-towns for corn are Uxbridge, Brentfo
Staines, for cattle and sheep Southall. A horse an
fair is held at South Mimms and Barnet.

Railways and Roads. As London is the centre of the
system of England, it is evident that many of the lines n
through Middlesex. For similar reasons it is well provid
roads.

Population. The total population of Middlesex was 2,53
1871 and 2,920,485 in 1881, or excluding the seven metr
boroughs lying within the county 276,028 in 1871 and
in 1881. Most of the towns and villages have largely i
during the period between 1871 and 1881; the populations
and Tottenham have more than doubled, and Chiswick,
Edmonton, and Willesden have almost doubled. Of th
places the least increase has been at Brentford, which n
10,271 in 1871, and reached 11,808 in 1881. At the tim
Domesday survey the population of Middlesex, exclusive of
was 2302.

Government. Unlike other counties, Middlesex has
sheriff appointed by the sovereign. It is subject to the
London, and one of the sheriffs appointed by the lord mayor
for Middlesex. When Henry I. came to the throne he gave
an extensive charter, and one of the privileges either gr
confirmed by the king was the perpetual sheriffwick of Mi
The whole of the county is included in the diocese of
and is divided between the archdeaconries of London and Mi
When Henry VIII. created the bishopric of Westminster he
the whole county (the parish of Fulham alone excepted)
diocese. Edward VI., however, dissolved the bishopric
fourth year of his reign.
The county is divided into six hundreds, which remain t
as they were at the time of the Domesday survey, except
name of one has been changed:—Ossulston (Osulvestane D.),
ton (Delmetone D.), Gore (Gara D.), Elthorne (Helet
Helethorne D.), Spelthorne (Speletorne or Spelethorne D
worth (Honeslaw D., *i.e.*, Hounslow). The division into h
is now merely a name, and a record of a former system
government.
There are thirty two poor-law unions, but the unions
London are only eight in number, viz., Brentford, Ed
Fulham, Hackney, Hampstead, Hendon, Staines, Uxbridg
The majority of hospitals are in London, but there is a
hospital at Tottenham, St John's Hospital at Twickenh
cottage hospitals at Enfield, Ealing, Hayes, Hillingdon, S
and Teddington. The Royal India Lunatic Asylum is at
and the two county asylums at Colney Hatch and Hanwell
The county is within the jurisdiction of the central crimi
and also of the metropolitan police (with the exception of t
Parliamentary Representation.—There are nine constitue
Middlesex, returning nineteen members, viz., two for the
four for the City of London, two for each of the boroughs
minster, Finsbury, Marylebone, the Tower Hamlets, Chel
Hackney, with one for the university of London.
In the parliament of 1295 Middlesex was represented,
members; in 1298 London sent two members as well as the
For the parliament of 1320 and subsequent parliaments
elected four members, but it does not appear that all were
to sit. From the 15th century, however, the city has alw
four members to parliament. In 1547 Westminster first
two members, and from that time until 1832 the only se
those for the county and the two boroughs. In 1832 the bor
Finsbury, Marylebone, and Tower Hamlets were added, and
the boroughs of Chelsea and Hackney and the university of
History.—The district now included in Middlesex was
occupied by forest up to a comparatively recent period,
population must always have been very sparse. A few pre
remains have been discovered at various times,—bones
elephant, hippopotamus, deer, &c., at Old Brentford, el
near Chelsea Hospital, fossil teeth, fish, fruit, &c., at H
and quite recently, in 1879, while the foundations were be
out for Drummond's New Bank at Charing Cross, a large
of prehistoric animal remains. Flint instruments have a
found to cover a considerable area. During the British pe
district is supposed to have been inhabited by the Trinobar

MIDDLESEX

Dr Guest affirms that the valley of the Lea was the western
y of that tribe. In answer to the question— What became
strict between the Lea and the Brent? this great authority
at the district was merely a march of the "Catuvellauni,"
on through which ran a wide trackway, but in which was
town, village, nor inhabited house. Dr Guest also declares
boundaries of the Catuvellaunian state, a central kingdo
or much extended by Cassivellaunus, can be traced in part
e northern limit of Middlesex by following an earthwork
Grimesditch "from Brockley Hill to the woodland of the
alley and thence to the Brent, and down the Brent to the
."[1] Some earthworks and encampments still exist which
buted to the Britons.

the country was under Roman rule great improvements,
the growing importance of Londinium, were made in this
Several roads in connexion with the city must have been
ted, more especially the great northern and eastern roads
t does not believe that the present Watling Street could
d any connexion with the Watling Street which came down
geware Road, passed along by Park Lane, and crossed the
at Westminster. In the Antonine Itinerary mentio
three stations, viz., Londinium, Sullomacæ, and Pon
ca is now Brockley Hill; Pontes is supposed by Stukeley
Staines, but Horsley held that it was intended for Old
r, and others supported the claims of Colnbrook and Le
Roman camps have been found in many parts of the county.
Stukeley supposed that the Brill, near St Pancras, was the
e battle between Boadicea and the Roman legions which has
light record in the name of Battle Bridge. The Roman
found at different times are too numerous to mention here
l. Coins, urns, and tiles were found at Enfield, a sepulchral
Hampstead, and numerous gold coins and ornaments at
Priory, Great Stanmore, in 1781.

y Stakes, about a furlong west of Walton Bridge, is supposed
e locality of the ford by which Julius Cæsar crossed the
. Cæsar makes special mention of the sharp stakes which
to encounter, and Bede says that the remains of the stakes
be seen in his day. Camden was the first to fix upon this
pot where Cæsar crossed, and he is supported by Dr Guest,
identification is not undisputed. Although a ford existed
late as 1807, and stakes were found up to the end of the
ntury, it has been affirmed that they were placed in the r
with another object than to oppose an enemy's progress.
remains have been found at Shepperton near Halliford, at
ddlesex end of the ford. A vase was dug up in 1817, and
ains of a Roman cemetery have also been discovered.

the earliest Saxon occupation we are left very much to
and the name itself is somewhat of a puzzle. It is evident
tribe could have obtained the name of Middle Saxons until
e settlement of the districts on each side of it by the East
West Saxons. As Middlesex was for a period dependent
e kingdom of Essex, it is probable that the name did not
to use until London had become a Saxon city, although there
n to believe that previously Saxon settlements had been
n several places by the river and elsewhere. Bede tells us
ondon was in the hands of King Sæberet in 604, and was then
ef town of Essex. Just a century afterwards - that is, in 704
king of the East Saxons granted away land at Twickenham,
g that Middlesex was then dependent upon Essex. It is
of note that the two districts now forming the counties
ch London and Southwark are situated were separated
he kingdoms to which they originally belonged probably
unt of the importance of the city of London and the borough
thwark, Middlesex from the kingdom of Essex and Surrey
South Ridge (A.-S. Suð-rige) from the kingdom of Kent.
ddlesex appears never to have been independent. The admin
shire was let to the men of London and their heirs to be
farm of the king and his heirs, and "the subject shire has
mit to the authority of the sheriffs chosen by the ruling

ddlesex is only once mentioned in the Saxon Chronicle, under
011, where it is noticed as one of the districts overrun by
nes. One manuscript (A. Winchester) mentions the Middle
as receiving the true faith under their alderman Peada
; but this is evidently a mistake of the scribe, for the fact i
from Bede, and he writes Middle Angles, as do the other
of the Chronicle.[3]

The Saxons appear to have settled over a large portion
district, and for the purpose of settlement they must have
considerable clearings in the vast forest of Middlesex. There
to be good reason for believing that previous to their comi
roads passed through waste lands. By the time of Edwa
Confessor a large proportion of the present towns and villag
in existence. Mr Elton, in his *Origins of English History*,[4] m
a curious fact with relation to the tenures which prevailed i
of these places. He alludes to a ring of manors encircling
London where the custom of Borough English or junior rig
prevalent." He then goes on to point out that in this clu
manors there are several varieties of the custom:- "Its ben
Islington and Edmonton was confined to the youngest s
Ealing, Acton, and Isleworth it extended to the brothers an
collateral heirs; and in a great number of instances the p
was given to females as well as to males in every degree of r
ship. These variations are of no very great importance, the
being modified in all parts of the country by the rule that
proof must be given of any extension of that strict form of
English for the benefit of the youngest son of which alone the
have cognizance. But it is of the greater interest to obser
in several places near London 'it is the custom for the
descend to the youngest, if it is under a particular value
pounds, but if it is worth more, it is parted among all th
First Real Property Commission Evidence, p. 254.

The great forest of Middlesex continued long after the N
Conquest, and even as late as the reign of Elizabeth portio
stud existed quite close to London. Fitz Stephen, the
Canterbury and secretary to Thomas à Becket, mentions
interesting description of London the immense forest w
densely wooded thickets, and its coverts of game, stags,
e, boars, and wild bu A few years after Fitz Stephen's
n the reign of Henry III. (1218), the forest was disafforest
some of the wealthy citizens took the opportunity of pur
land and building upon it. Matthew Paris, in his life of the
abbot of St Albans, describes the woods contiguous to the
Street between London and St Albans almost impenetral
so much infested by outlaws and by beasts of prey that the
ous pilgrims who travelled along the Roman road to the s
Albans were exposed to imminent danger.

There is little further history that can be told of Mi
There are many interesting incidents connected with some
places, but corporate life has been crushed out of the count
greatness of London. Not a single place except London ha
nto importance, and nowhere outside of London is there a
of first-rate interest. The villages on the Thames early b
increase in size on account of the convenience of loc
supplied by the river. It is only since the extension of the
system that the villages to the north and north west of
have grown in size, and this growth has been mainly due
building of houses for the use of the Londoners.

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[1] "Lecture on the Origin of London," *Athenæum*, 1866, No. 2022.
[2] Freeman, *Norman Conquest*, vol. v. (1876) p. 468.
[3] The above passage from the Chronicle, where the districts overrun by the
in 1011 are enumerated, the shires, which took their names from them
owns, are distinctly marked off from the districts which took their names
the peoples who inhabited them. Of the latter there are, besides the
Saxons, the East Angles, the Kentings, and the South Saxons. Middlesex
an administrative shire, because it was not historically a shire, but
e for the purposes of administrative organization. Of the present forty
twenty-eight are and twelve are not shires. Wessex was divided into six
and Mercia into eighteen, with the subsequent addition of Rutland taken
(it is believed) from Northamptonshire. Yorkshire was taken from No
Lancashire from Cumbria, and last of all, Monmouthshire from W
Act of Henry VIII.'s reign.
[4] Pp. 188-89, and note.
[5] Mr Corner gives the number of instances he has found at sixteen.

MIDDLETON

ODDLETON, a market and manufacturing town of shire, is situated on the Irk, near the Rochdale and on the Lancashire and Yorkshire Railway, 5 miles north of Manchester and 4 west of Oldham. ludes the township of Tonge, an isolated portion of arish of Prestwich. The church of St Leonards is an rncture of mixed architecture, with a low square The oldest portion of the building dates from the rentury, but the main portion from 1412, and the aisle from 1524. It underwent extensive restoration 59. The Queen Elizabeth Grammar School, a build the Tudor style, was founded in 1572. There are baths and a free library. The prosperity of the town from the introduction of manufactures at the close of entury. The staple trade is the spinning and weaving ton, and the other industries include silk weaving, printing, bleaching, dyeing, roundings, and the facture of soap and chemicals. There are several nes in the neighbourhood. The town was at an early in possession of the Bartons, from whom it passed rriage in the 16th century to Sir Ralph de Assheton. opulation of the urban sanitary district of Middleton onge in 1881 was 18,952.

DDLETON, Conyers (1683–1750), the earliest and eminent example of the spirit of theological rational the English Church of the 18th century, was the the rector of Hunderwell near Whitby, and was born hmond in Yorkshire, on December 27 (or, according other account, on August 3), 1683. He graduated at dge, took orders, and in 1706 obtained a fellowship, he soon resigned upon contracting an advantageous ge. In 1717 a dispute with Bentley, upon an ionate demand of the latter on occasion of Middleton's created D.D., involved him in an acrimonious con sy, which called forth several pamphlets from his ll of powerful invective, and among them his first erable literary performances, the *Remark* and *r Remarks* on Bentley's *Proposals for a New Edition Greek Testament* (1721). "You have laid Bentley pon his back," wrote Colbatch. "I scorn to read the rascal has written," wrote Bentley, who, how only resorted to this affected disdain after a fruitl pt to fix the authorship upon Colbatch, but who gratly have commented upon the impropriety of ton's endeavour to vent his grievances upon the text New Testament. Private resentment and uncharit ality were throughout his life too frequently the and the note of Middleton's controversial publica In 1723 he was involved in a law suit by person against Bentley, which had found their way into the were judicious tract on library administration, n occasion of his appointment to the honourable of university librarian. In 1726 he gave great to the medical profession by a dissertation contend ing the healing art among the ancients was only ised by laws or freedmen. Between the dates of publication he visited Italy, and made those observa on the parent pedigree of Italian superstitions which subsequently embodied in his *Letter from Rome* (1729). cogent tract, while establishing the author's man sition with abundance of learning and wit, gave at the time the best clear indication of the anti-supernatural bias of his intellect, and probably contributed to re the storm which burst out against him on his next cation (1731). In his common trance with Waterland asion of the latter's reply to Tindal's *Christianity as s the Creation*, Middleton takes a line which in his ould hardly fail to expose him to the reproach of lity. He gives up the literal truth of the primeval e narratives; and, in professing to indicate a short and easy method of confuting Tindal, lays principa on the indispensableness of Christianity as a main social order. This was to resign nearly everythin divines of the Waterland stamp thought worth def Middleton was warmly assailed from many quarte retreated with some difficulty under cover of a s apologetic pamphlets, and a more regular attenda church. A freethinker in the strict sense of the t certainly was, but how far freedom of thought was by him it is not easy to ascertain. His adversaries of them men who gravely maintained that E civilization originated in the age of Solomon—were to fix any serious imputation upon him; on the oth it is clear that the natural attitude of his mind t supernatural pretensions was one of suspicion, and t temperament was by no means devout. That nevertheless not incapable of a disinterested hero was exceeded by his next important publication, the but partial *Life of Cicero* (1741), a work which, below the standard of modern exactness, may yet c in spirit and execution with the best productions Italian Renaissance. It is, indeed, as remark Forsyth, "rather an historical composition, in Cicero is the principal figure, than the portrait of t himself"; and Dr Parr has pointed out Mid unacknowledged obligations to the forgotten Belle which, however, with the ardour of a discoverer, h to have considerably overrated. The work was und at the instance of Lord Hervey, in correspondenc whom also originated his disquisition on *The Senate*, published in 1717. The same year and the ing produced the most important of all his writi *Introductory Discourse* and the *Free Inquiry* con the miraculous powers then commonly deemed t subsisted in the church after the apostolic age. I bating this belief Middleton indirectly established t positions of capital importance. He showed that a tical miracles must be accepted or rejected in th and he distinguished between the authority due early fathers' testimony to the beliefs and practices times and their very slender credibility as witn matters of fact. Some individual grudge seems prompted him to expose, in 1750, Bishop Sh eccentric notions of antediluvian prophecy, which h been before the world for a quarter of a century same year he died of a decline at his seat at Hilde Cambridgeshire, leaving a widow, but no children.

Middleton's most ambitious work is obsolete from no his, but his controversial writings retain a permanent plac history of opinion. In his more restricted sphere he may appropriately be compared to Lessing. Like Lessing's, the of his intellect was captious and iconoclastic, but redeem mere negation by a passion for abstract truth, too apt to until called into activity by some merely personal stimul diction is generally masculine and harmonious. Pope thou and Hooke the only prose writers of the day who deserv cited as authorities on the language. Parr, while expo plagiarisms, heaps encomiums on his style. But his best his impatience of superstition and disdain of mere authority, are rather moral than literary. As a scholar he elegant than profound; as a controversialist he has more vig urbanity, and more wit than humour. He has been attacked both as author and as man by De Quincey, who accuses his style of colloquialism, and taxes him with ea church's bread while denying her doctrines. In fact Mi private means were ample, his ecclesiastical emoluments and his candour obstructed his path to much more conside ferment. The best general view of his intellectual chara influence is to be found in Leslie Stephen's *English Thoug Eighteenth Century*, chap. vi. A handsome edition of hi containing several posthumous tracts, but not including *of Cicero*, appeared in 1752.

MIDDLETON, Thomas (*c.* 1570–1627), held a place among the dramatists of the reign of James

popularity would seem to have first come to a height about 1607. This is a fair inference from the fact that in this and the following year a whole swarm of comedies from his pen were licensed and published—*A Trick to Catch the Old One*, *The Family of Love*, *The Phœnix*, *Michaelmas Term*, *Your Five Gallants*, *A Mad World My Masters*. Only the first of these kept the stage after the author's own generation, though in point of wit and constructive skill it is not superior to *The Phœnix* (a serious comedy) or *Your Five Gallants* (a bustling and gaily humorous farcical comedy). The plot of the *Trick* bears a family likeness to that of Massinger's *New Way to Pay Old Debts*; the titles in fact might be interchanged. A ruined scapegrace outwits his creditors and a usurious uncle by coming to town with a courtesan and passing her off as a widow with a fortune, whom he treats with deferential friendship, but hardly dares to love, ruined and hopeless as he is. His uncle lends him money that he may woo in proper state: his creditors also intrigue to have the honour of supplying him with all the needs of fashion; and the lady receives many costly presents from aspirants to her hand and fortune. Though Middleton was apparently not in high popularity till 1607, he had made his debut as a satirist ten years before; and if Malone is right in his conjecture that the *Mayor of Queensborough* is identical with the *Randall Earle of Chester* mentioned by Henslowe in 1602, he had done dramatic work of a much higher kind. Like *The Changeling*, a later production, in which Middleton had the assistance of Rowley, the tragedy of the *Mayor* is named after a character in the insignificant comic underplot. Such a title scares away readers weary of half intelligible Elizabethan fun and satire; but Simon the comic mayor is a very subordinate figure in the play, and the tragic portions alike in situation, characterization, and language rank among the very noblest productions of the Shakespearian age. There are scenes in the *Changeling* also which Mr Swinburne, with a judgment that will not be disputed, assigns to Middleton, unsurpassed for intensity of passion and appalling surprises in the whole range of Elizabethan literature. The execution of these scenes is far beyond any power that Rowley showed in single handed work, but well within the scope of the author of the *Mayor of Queensborough* and *Women Beware Women*. This last play, in which every one of the characters important enough to be honoured with a name perishes at the end in a slaughter so rapid as to be somewhat confusing, was apparently one of Middleton's later works, and the simple and measured development of plot in the first acts seems to show traces of the influence of Massinger. Middleton's verse, when charged with the expression of impassioned love, contains many echoes of the verse of *Romeo and Juliet*, as if his ear had been fascinated by it in his youth. His language generally proclaims him an admiring disciple of Shakespeare's; and in daring and happy concentration of imagery, and a certain imperial confidence in the use of words, he of all the dramatists of that time is the disciple that comes nearest the master. *The Witch*, by which Middleton's name has of late been linked with Shakespeare's in groundless speculation as being part author of *Macbeth*, is by no means one of Middleton's best plays. The plot is both intricate and feeble, as if the play had been written with a view to the half-comic spectacular exhibition of the witches, with their ribald revelry, their cauldrons, hideous spells, and weird incantations. Charles Lamb's comparison of Middleton's witches with Shakespeare's is one of the most exquisite morsels of criticism; but, when he says that Middleton's witches are "in a lesser degree fine creations," he ought perhaps to have added that they are merely embodiments of the vulgar superstition, put on the stage to excite laughter rather than fear among a half believing au an audience ready to laugh at them in the light m crowded meeting, whatever each might do in th alone. That Middleton had any share in *Macbe* conjecture resting solely on the fact that the words of the song of the witches about the caul Shakespeare's *Macbeth* occur also in the incantation a cauldron in the last act of Middleton's *Wit* that Middleton's song was inserted by Davenant "amended" reproduction of *Macbeth*. If either h the words of this song from the other, that is no of further co-operation; besides all that is common two was probably as much public property as a rhyme. There is no evidence as to whether *The* appeared before or after *Macbeth*. Middleton co-o with Dekker in the *Roaring Girl*, with Rowley in *Quarrel*, *The Spanish Gipsy*, and *The Changelin* with Jonson and Fletcher in *The Widow* (one of of Middleton's plays reproduced after the Resto Towards the close of his life Middleton got into dif with the privy council from writing a very clever play apropos of Prince Charles's unsuccessful wooing Spanish infanta in 1623. The chief personages in politics and their manœuvres were represented wi ingenious skill in the pieces and movements of *A G Chess*. This play was stopped by royal authority, prosecution of the author was allowed quietly t The few unimportant facts known in Middleton's history are collected in Mr Dyce's admirable editio plays. He enjoyed the office of city chronologer, a often employed to write pageants and masques, in c at least contracting for the whole exhibition, besi nishing the words. He died in 1627, and was b Newington Butts.

MIDDLETOWN, a city and port of entry United States, and one of the shire towns of Mi county, Connecticut, lies on the right bank of th necticut river, about 30 miles from its mouth, direct site the well known Portland quarries, and 24 mil New Haven by rail. Built on ground rising gent the river, with its principal streets keeping the dire the valley, and the cross streets climbing the slope, town is a place of considerable attractiveness, and th from the higher points are particularly fine. Wate with the wharves and shipping, Main Street, w commercial houses and hotels, and High Street, v mansions and gardens and trees, are the leading the city. On the high grounds behind stand the ha buildings of the Wesleyan (Methodist Episcopal) Uni The institution, mainly organized by Wilbur Fisk was chartered in 1831. To the two buildings with it started have been added Rich Hall, with the li about 30,000 volumes, Judd Hall, with scientific co of great value, the Memorial Chapel, erected centenary year of American Methodism, and the C tory Hall. Since 1872 the courses of the univers been open to both sexes. In 1882 the number fessors was 20, and of students 191, including 14 The Berkeley Theological School (Main Street), by the Episcopal Church in 1851, had in 188 fessors and 41 students, with a library of 17,000 A hill 1¼ miles to the south east of the city is occ the State General Hospital for the Insane, the building having a frontage of 768 feet, and the extending to 230 acres; and on another hill to th west of the city stands the State industrial school f As vessels drawing 10 feet of water can reach its Middletown carries on a considerable trade by the r 1882 1613 vessels, with a burden of 240,000 tons, the port, and 1613 vessels, with a burden of 350,0

; and the Middletown district owned 83 sailing and 22 steamers. Both the silver and the lead which were formerly worked in the vicinity have abandoned, but cast iron, britannia, and silver plated sewing-machines, pumps, webbing, and tape are the local manufactures. The population of the city ed from 5182 in 1860 to 6850 in 1880. First in 1636, Middletown was incorporated as a town in and as a city in 1781.

DDLETOWN, a manufacturing village of the United in Wallkill township, Orange county, New York, N.N.W. of New York, at the junction of four ds. It is a clean well built place, in the midst of a ary farming and stock raising district, manufactures files, felt hats, blankets, agricultural implements, s' materials, &c., and is the seat of the State opathic Insane Asylum. The population was 6049 0 and 8191 in 1880.

DHURST, an ancient parliamentary borough and town of Sussex, is picturesquely situated on a eminence above the south bank of the West Rother, e railway lines, 50 miles south west of London and th from Chichester. The church of St Denis (re in 1881–83) is chiefly Perpendicular in style, but er part of the embattled tower is probably Norman. grammar school, founded in 1672, Richard Cobden r Charles Lyell were educated. A new public hall ened in 1882. The old castle of the De Bohuns on a mound above the river, now overgrown with In ancient times a commandery of the Knights of n of Jerusalem had jurisdiction over the district rming the liberty of St John. The prosperity of n depends chiefly on agriculture. A market is held , and a fair three times a year. The population of liamentary borough, which has an area of 26,172 was 6753 in 1871, and 7221 in 1881.

urst is not mentioned in Domesday, being included under me. In the reign of Henry I. it was held by the king nor barony. In the time of Edward I. it passed into session of the De Bohuns. From the time of Edward II. it returned two members to parliament, but since then .

DIAN was one of the peoples of North Arabia whom ebrews recognized as distant kinsmen, representing as sons of Abraham's wife Keturah. The word ah means "incense"; thus the sons of Keturah are ncense men," not indeed inhabitants of the far south land, but presumably the tribes whose caravans t the incense to Palestine and the Mediterranean So the Midianites appear in connexion with the d incense trade from Yemen (Isa. lx. 6), and with de between Egypt and Syria (Gen. xxxvii. 28, 36). time of the exodus the pastures of the Midianites, he branch of Midian to which Moses's father in-law or Reuel, or Hobab) belonged, lay near Mount (Exod. iii. 1, and Num. x. 29 *sq.* implies that the was at home in the desert of the wanderings. The s, who, in spite of their connexion with Amalek (1 xv. 6), had friendly relations with Israel, and ulti de with the tribe of Judah, are represented g. i. 16, iv. 11 as the kin of Moses's father-in-law. entites, however, can have been but one fraction of which took a separate course from their early ns to Israel.[1] The main body appear in Judg. vi. as erful Bedouin confederation, invading Canaan from stern desert, and ravaging the land as similar tribes done in all ages when Palestine lacked a strong

[1] admixture of Midianite element in Judah and the other tribes of Israel is confirmed by a comparison of the names of Midianite clans in Gen. xxv. 4 with the Hebrew genealogies n. ii. 46, iv. 17, v. 24; Gen. xlvi. 9;

government. With their defeat by Gideon and a defeat by the Edomites in the field of Moab, pr about the same time (Gen. xxxvi. 35), the recorded of Midian closes.

A place Midian is mentioned 1 Kings xi. 18, and in late the name lingered in the district east of the Gulf of 'Akab Eusebius knows a city Madian in the country of the Sarac Ptolemy places Modiana. Still later Madyan was a station pilgrim route from Egypt to Mecca, the second beyond Aila Here in the Middle Ages was shown the well from whic watered the flocks of Shoʻaib (Jethro), and the place is still as "the caves of Shoʻaib." It has considerable ruins, whi been described by Ruppell (*Reisen*, 1829) and Burton (*Midian*, 1879).

MIDNAPUR, a district in the lieutenant-govern of Bengal, India, between 21° 37′ and 22° 57′ N. la between 86° 35′ 45″ and 88° 14′ E. long., is boun the N. by Bánkurá and Bardwán, on the E. by H and Howrah, on the S. by the Bay of Bengal, and W. by Singbhúm and Mánbhúm, with an area o square miles. Its general appearance is that of open plain, of which the greater part is under culti In the northern portion the soil is poor, and there wood. The country along the western boundary, as the Jungle Mahals, is undulating and pictures is almost uninhabited. The eastern and south- portions are swampy and richly cultivated. Th rivers of the district are the Hooghly and its three taries, the Rupnarayan, the Haldi, and the Ra The Midnapur high-level canal runs almost due e west from the town of Midnapur to Ulubariá Hooghly 16 miles below Calcutta, and affords a con navigable channel 53 miles in length. There a tidal canal for navigation, 26 miles in length, ing from the Rúpnáráyan river. The jungles west of the district yield lac, *tasar* silk, wax, resi wood, charcoal, &c., and give shelter to large an game.

The census of 1872 returned the population of Midn 2,540,963 (1,257,194 males and 1,283,769 females), includ 122 Europeans and 157,030 Mohammedans. The aborigin belong chiefly to the jungles and hills of Chutiá Nágpur kurá; the most numerous of them are Santáls (96,921) and (35,344). Of high-caste Hindus the returns show 136,500; number of Káyasths is given as 101,663. Among the semi ized aborigines, the most numerous are the Bágdís, a tribe vators, fishermen, and day-labourers (76,825). Belonging cultural castes there are 1,018,686. The four municipal Midnapur (31,491), Chandrakona (21,311), Ghatal (15,4 Tamlúk (5849). Rice is the staple crop. Irrigation is chiefly from the high-level canal. Rent rates vary from acre for the poorest quality of rice land to 18s. an acre for irrigable lands. The district suffers occasionally from floods are common, and very disastrous in their results. T cipal exports are rice, silk, and sugar; and the chief impo sist of cotton cloth and twist. Salt, indigo, silk, mats, and copper utensils are manufactured. Apart from the rive munication is afforded by 482 miles of road. The total re 1870–71 was £262,578, and the expenditure £53,777. vailing diseases are fever, diarrhœa, dysentery, and chole average mean temperature is 80° Fahr., and the average rainfall 66 inches.

The early history of Midnapur centres round the ancient Tamlúk, which in the beginning of the 5th century was an ant Buddhist settlement and maritime harbour. The f nexion of the English with the district dates from 1760, w Kasim ceded to the East India Company Midnapur, Chi and Bardwán (then estimated to furnish one-third of th revenue of Bengal) as the price of his elevation to the t Bengal on the deposition of Mír Jafar.

MIDNAPUR, chief town and headquarters station above district, is situated on the north bank of th river, with a population in 1872 of 31,491. The to a large *bái ár*, with commodious public offices. It is h dry, and well supplied with water. An American maintains an excellent training school, together printing press, and has founded several village sch

rict. Its efforts have been particularly successful the Santáls, and some of the earliest and most e works on their language have issued from the our mission press. A brisk manufacture of brass per utensils takes place in the town; it is also the of a large indigo and silk industry.

RASH. Like all nouns of a similar form *Midrash* equivalent of the Niph'al participle,[1] and as such as many modified meanings as the root *Darash* to search, &c., itself has. The practical significa- however, of *Midrash*, taken in historical order, are ows: (1) a book of records; (2) a recension of especially historical, materials; (3) search in and ation of the Scriptures, notably the Pentateuch (in ase the plural is invariably *Midrashoth*); (4) theory nguished from practice; (5) a college for study ching; (6) an *Agadic* (that is, a free) explanation, radistinction to an *Halakhic* one; (7) a collection free explanations (in which case the plural is *him* and occasionally also *Midrashoth*). Of these ignifications (1) and (2) are to be found in the Bible,[2] (4) are mentioned for the first time in the *Mish-* 5) is to be met with in the *Midrash*,[4] while (6) and to be found in early Rabbinic writings.[5]

subject of this article will be (1) the nature of *sh* in the sense of *Agadah*, to the exclusion of *ah* (for which see MISHNAH), and (2) the develop- f this *Midrash Agadah* into books (*Midrashim*).

thinking reader of the Scriptures cannot have failed rve that by the side of their ceremonial element, be tive or affirmative, permissive or jussive, there is en to be met with (and sometimes so as to be inspar- om it) a spiritual element. This spiritual element hiefly on feeling or emotion, and produces pious only indirectly. Now the explanation or application element, either by the Scriptures themselves or by bbis, is traditionally called *Midrash Haggadah* ion, preaching) or *Midrash Agadah*[6] (binding the God and all that is godly).

Haggadah or *Agadah* varies considerably both in and form. In its nature it sometimes humours, at imes threatens; it alternately promises and admon- ersuades and rebukes, encourages and deters. In it always consoles, and throughout it instructs and s. In form it is legendary, historical, exegetic, c, theosophic, epigrammatic; but throughout it is varied as was and is the *Midrash Agadah*, so varied been its fortunes. Whilst at times it stood very the estimation both of the teachers and the con ons in Israel,[7] it sank at other times very low .[8] Nay, at one and the same time, whilst some rabbis exalted it to the skies,[9] other rabbis trea with hatred,[10] or, worse still, with contempt.[11] Ther actually been teachers whose treatment of it differe the difference of the occasion.[12] The fact is the liked or disliked the *Midrash Agadah* according t political condition on the one hand and their pro to Jewish professors of Christianity on the other. hour of prosperity the Jews preferred the *Halak* in that of adversity they ran to hear the consoling of the *Agadah*.[13] When near Judæo-Christians, religious strength and argument chiefly rested on *Ag* the Jews disliked it: when among themselves, or dwelling among Gentiles (heathen or Christian), showed their wonted partiality for it.

But, whatever were the likings or dislikings of th for the *Midrashoth*, it is certain that these tradition early[14] committed to writing, and formed into volumes, known as "Books of *Agadah*."[15] Such we some of the *Targumim* and then the *Midrashim*. A writing down the traditional explanations of the ceremonial there existed a distinct law,[16] which was ob down to near the end of the 6th century. At an period isolated disciples only, in order to refresh memory, wrote down short Halakhic notes, which ever, they kept in secret.[17] The *Targumim* and *Midr* on the other hand, were composed very early and numerous, while their extensive contents were cir in public.

The *Midrash*, from whatever point of view it m regarded, is of the highest value. It is of the h value, of course, to the Jew as Jew first, inasmuch finds there recorded the noblest ideas, sayings, and ings of his venerable sages of early times. In th place it has value to the Christian as Christian, sin by these ideas, teachings, reasonings, and descriptio the beautiful sayings of the Founder of Christiani reasonings of the apostles, and the imagery of the s but enigmatic Apocalypse be rightly understood. importance appeals also to the general scholar, bec the inexhaustible mines of information of all kinds tains. The philologist will find here numerous hints eography and grammar, chiefly, of course, of the S languages, but also of other tongues, notably Gree Latin. The historian will gather here a rich har geography, chorography, topography, chronology, matics, &c. The philosopher will find here abunda

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p. Nehem. viii. 8, where במקרא evidently stands for בנקרא. Kimhi on 2 Chron. xiii. 22, and Schiller-Szinessy, *Exposition*, nbridge, 1882, p. 11. [2] 2 Chron. xiii. 22 and xxiv. 27.

Nedarim, iv. 3, and *Aboth*, i. 17.

eshith Rabbah, c. lxiii. (on Gen. xxv. 22): והלא לא הלכה אלא למדרשו של (שם ו). *Midrash* is used in the East to this *Beth Hammidrash*. See MS. Oo. 6, 63 (of the Universaty Cambridge), leaf 135*a*, lower margin (והם קדיש למדרשו של).

ni (*e.g.*, on Gen. iii. 8) and *Tosaphoth*, *passim*.

se who identify this word as merely the Chaldaic form of the *Haggadah* (and they have, certainly, some authority on their ght to write it *Aggadah* (אַגָּדָה), which, however, is not the al spelling of it (אַגָּדָה). Singularly enough, the Latin *religio* rly derived by some from *religare* and by others from *religere*.

here on Deut. § 49: "If thou wishest to know Him who hut d the world came into being, learn *Haggadah*; for by so doing lt recognize the Holy One (blessed be He!) and cling to His

., *M'aseroth*, iii. 4. "And R. Ze'erah was teasing those rabbis *aadah*."

[9] *Ibid.* "Then said to him R. Bo bn [son of] Kohano, W thou tease them? Ask, and they will surely answer thee!"

[10] T. Y., *Shabbath*, xvi. 1. "He who holds it forth become by it; he who listens to it gets no reward."

[11] *Ibid.* "I never in my life looked into Agadic books."

[12] *Ibid.* "Let the hand of him who wrote it be cut off"; a pare with this T. B., *Baba Bathra* 123*b*, "goodly pearl."

[13] Beginning of *Peskatha Bahodesh b Hasshebi'i*. "First w money was at hand one decreed to hear the word of the *Mish* the word of the *Talmud*."

[14] *Ibid.* "Now, however, when the money is not to be moreover, when we are sick in consequence of the (treatmen government, one pines for the word of the Bible and for the the *Agadah*."

[15] T. Y., *Shabbath*, xvi. 1, and T. B., *Shabbath*, 116*a*: "T *gelion* and other Christian writings."

[16] See *Tosephta Shabbath*, xiv.: "I remember that one brang Rabban Gamliel the elder [St Paul's teacher] the book of J Chaldaic paraphrase", and T. Y., *Kelayim*, ix. 4: "At tha ran (my) eyes through the whole Book of the Psalms in the the *Haggadah* [*Agadah* of the Psalms]." R. Hyya *Rabbah* to the middle of the 2d Christian century.

[17] ספרי דאגדתא. See T. B., *Berakhoth*, 28*a*, *Temurah*, the *Talmudim*, *passim*.

[18] T. B., *Gittin*, 60*b*: "In the college of R. Yishm'ael it wa 'These [see Exod. xxxiv. 27] thou oughtest to write down, must not write down *Halakhoth*.'"

[19] T. B., *Shabbath*, 6*b*: "I found a 'secret roll,'" that is, *Halakhoth* kept secret. Comp. Rashi, *in loco*.

ble notices on logic, psychology, metaphysics, theo-
theosophy, æsthetics, rhetoric, poetry, mathematics,
try, astronomy, zoology, botany, biology, morphology,
stry, medicine, physics, &c. The statesman parti-
y if he be inclined to follow the Psalmist's advice
the ancient "I gather understanding" (cxix. 100) -
nd here valuable information on ancient ethnography
full sense of the term politics, political economy,
ilitary science naval affairs, &c. The true scholar
nd out by the study of the *Aggadah* that many a dis
y thought to belong to a recent age was well known
se ancient divines.

sources of the *Aggadah* are five: (1) the *Targumim*
specially those on the Prophets and Hagiographa;
non-canonical *Midrash* (*Mathnitha Boraitha*, see
SAID), which contains many valuable pieces, the age
ich is often anterior, in essence if not in form, not
those contained in the canonical *Mishnah*, but
the writings of the New Testament; (3) the canonical
lly recognized *Mishnah*, which contains several
treatises of an *Aggadic* nature, as *Aboth*,[1] *Middoth*,
nd numerous pieces scattered here and there among
alakhah; (4) both *Talmudim*[2] (the Palestinian and
nian), which have thousands of Aggadic notices
er ei in their *Halakhoth*; and (5) the *Midrashim*,
oxime. It is of the last alone, as represented by their
al collection, that we give an historical enumeration

Seder Tannaïm is an historical *Midrash* consisting of
Peraïm, and is called so on the principle of *locus a non*
, seems that in it are enumerated the days of the year on
a Jew must not fast. The Aramaic part of it alone consti-
he real *Megillah*, and belongs to the beginning of the 2d
n century.[4] The *editio princeps* came out at Mantua, 1513.
t cheap editions have been printed at Warsaw and elsewhere.
phar Yezirah is a philosophico-cabbalistic *Midrash* divided
x *Perakim*, which, in their turn, are subdivided into
nyoth. It is variously ascribed to the patriarch Abraham
R. 'Akibah, the illustrious teacher, who suffered martyrdom
Hadrian. To this rabbi the book, no doubt, belongs both in
ce and form.[5] It has gone through numerous editions, the
being of 1562 (Mantua, 4to), and has been translated into
German, and English (New York, 1877).
Othiyyoth de Rabbi 'Akiba is a *quasi*-cabbalistic *Midrash* on
habet, belonging, in essence if not in form, to the aforesaid
and in style. *Ed. prine.*, Constantinople, 1520, 4to.
Massekheth Hekhaloth is an astronomico-cabbalistic *Midrash*
Peraïm. It is ascribed to R. Yishmael the high priest.

valuable edition of this treatise (in Hebrew and English) has
blished by Dr C. Taylor, Cambridge, 1878.
these we may add, for the sake of convenience, although they
strictly speaking, belong to the canonical *Mishnah*, the *Perak*
lor and the Aggadic parts of the *Massekhtoth Ketannoth*.
collections of Talmudic *Aggadoth* were made early in the 16th

(1) *Haggadath Hattalmud*, Constantinople, 1511, folio, of
pparently only five copies are in existence, the finest of these
being in the University Library of Cambridge, and (2) *Ein*
Ya'akob, of which numerous and cheap editions exist,
prin. being that of Salonika, 1516-22.
must at once be stated that the latest critics have said concerning the age of
our *Midrash Rabboth* and *Midrashim* will have to be unsaid. Not
merely are these statements difficult of proof; in this case the reverse
is demonstrable. We shall only give two examples. The statement
Yerushalmi Bikkurim cannot be early, as Rashi did not know of it,
nowhere mentioned it," is doubly incorrect: Rashi *does* quote
on Hagigah 14 *a*. On the statement "We must not omit to
that no early Jewish commentator—Rashi, Ibn Ezra, &c.—
s the Targum either to Proverbs or to Job and Psalms, Nathan
hiel (12th century) is the first who quotes it," contains a *re-*
ad absurdum. For Nathan b. Yehiel was, as is well
a somewhat older contemporary of Rashi (*ob.* 1105), and lived
undred years before the Ein Ya'akob.

T. B., *Sanhedrin*, 65*b* and 67*a*. In the former place it distinctly
of the *Sepher Yezirah* (ספר יצירה), and, although in the
ter it speaks of the *Hilekhoth Yetsirah* (הלכות יצירה), there
be a doubt that *Sepher* (ספר) and *Hilekhoth* (הלכות) are
entical. Moreover, *Mishnayyoth* and *Halakhoth* are, in a cer-
n e, convertible terms (see MISHNAH); and our book (as
ed above) consists of *Mishnayyoth*.

Judging from internal evidence on the one hand, and from
known of R. Yishma'el in the *Talmudim* and *Midrashim*
Berakhoth, 7*a* and elsewhere) on the other hand, there see
no valid reason for doubting that he is the author of this s
sublime book. This *Midrash* is printed in the collectio
Lebanon (Venice, 1601, 4to) under the title of "*Pirkê Hek*
and "*Massekheth Hekhaloth*," and a MS. of it is preserve
University Library of Cambridge (Dd. 10. 11. 7. 2). Th
however, called "The Greater and the Lesser *Hekhaloth*,"
Peraïm, printed in this century, somewhere in Poland, c
besides the ancient literature, a good deal of matter whi
much later date.

(5) *Seder 'Olam* (the Greater and the Lesser) are two h
Midrashim, the former of which belongs to the 2d century
the latter (which is a mere extract of the former) belongs
age indeed (the Gaonaic). They have been repeatedly
always together, the *ed. prine.* being Mantua, 1513, 4to.

(6) *Haggadah shel Pesah* is a liturgical *Midrash* of the m
the 2d century, as far as its main portions go. It exists
three principal and several minor recensions in accordance
various rituals (see MAHZOR), and is recited at the domesti
of the first two Passover evenings. The editions are too n
to be mentioned, the *ed. prine.* being Constantinople, 1505

(7) *Megillath Antiokhos* treats ostensibly, as its name i
of the sufferings of the Jews under Antiochus Epiphanes, a
deliverance from his tyranny, but in reality of their sufferin
Hadrian and their deliverance under Antoninus Pius. The
text, with the exception of a few interpolations, belongs to th
of the 2d century. This little "roll" was for the first time p
by Filipowsky (London, 1851, 32mo). A MS. copy of the
is preserved in the University Library of Cambridge (Dd.

(8) *Zohar* (*Midrash Hazzohar*, *Midrasho shel Rabbi Sh*
Yohai, *Midrash Yehi 'Or*, &c.) is a cabbalistic *Midrash* on
Pentateuch, Canticles, Ruth, and part of Lamentations. It is v
ascribed to the famous R. Shim'eon (disciple of R. 'Akibah,
to R. Moshch b. Shemtob of Leon (a second-rate cabbalis
time of Nahmanides and Ibn Addereth). The *Zohar*
strictly speaking, to neither of these, whilst, in a certai
it belongs to both. The fact is: the nucleus of the bo
Mishnic times, and R. Shim'eon b. Yohai was the autho
Zohar in the same sense that R. Yohanan was the autho
Palestinian Talmud, *i.e.*, he gave the first impulse to the
tion of the book. But R. Moshch of Leon,[6] on the other ha
the first not only to copy and disseminate the *Zohar* in
but also to disfigure it by sundry explanatory interpolation
more details see Lumby, "Introduction to the Epistle of J
the *Speaker's Commentary*, vol. iv. p. 388. The first two
of the *Zohar*[7] on the Pentateuch came out simultaneously (
1558-60, 4to, and Cremona, 1558, folio), and the *ed. pr*
Canticles, Ruth, and part of Lamentations came out at
(1597, 4to). The best, though by no means critical, edition
Pentateuch is that of Brody, 1873, 8vo. Of translations,
they are, there exist those of Knorr v. Rosenroth, *Kabbala d*
(vol. i., Sulzbach, 1677, and vol. ii., Frankfort, 1684, 4
Tholuck, *Wichtige Stellen*, &c. (Berlin, 1824, 8vo), &c.[8]

(9) *Pesikotho*[9] (commonly, but by mistake, called
derab Kohana is a homiletic *Midrash* consisting of th
Peskhoth for the principal festivals and fasts, and the hist
noted sabbaths and other days. It is of the end of the 3
beginning of the 4th century. Having been but rarely
since the 12th century, so that most scholars knew of

[6] R. Moshch of Leon is a fair sample of the mediocrity of
in cabbalistic lore, and combined, as is usual, with his medio
illimitable vanity; see MS. Dd. 11. 22 (Cambridge University L
leaf 2*a*: "And I adjure every one who should deeply study th
or who should copy it, or read it, that he do not blot out n
from my property (inheritance), for I have composed it. . . .
statement alone would suffice to prove that R. Moshch of Le
never have ascribed a book composed by himself to anybody el

[7] The *Zohar*, cleared of the main works by which it is surr
and of the interpolations by which it has been disfigured bot
first European copyist and by others down even to our own d
begun in Palestine late in the 2d or early in the 3d centu
finished, at the latest, in the 6th or 7th century. It is im
that it should have been composed after that time and be
Renaissance, as both language and contents clearly show.

[8] Whilst the principal editions of the many textual extrac
from the *Zohar* (as the *Iddroth*, &c.) need not be specified he
of the following supplementary and kindred works ought to
tioned:—(1) *Tikkune Hazzohar* (*ed. prine.* Mantua, 1557, 4
(2) *Zohar Hadash* (*ed. prine.* Cracow, 1603). Nor should the
mesephet Hazzohar, *Hibbure Tinyono* (by the otherwise very
Yitshak b. Moshch of Satanow) be passed over. It is a mere i
of the *Zohar*,—an imposition of a kind which is a disgrace to li

[9] For the three *Midrashim*—*Mekhilto*, *Siphro*, and *Siph*
under MISHNAH.

ly, it was long considered lost, till, in 1868, Salomon Buber berg, a man of learning, wealth, and love for the ancient re of his nation, edited it from four MSS., one of which y in possession of Carmoly) is now preserved in the Uni- Library of Cambridge (Add. 1497). The printed edition d at Lyck, 8vo.

Pesikta Rabbathi, consisting in the latest edition of eighty- *koth*, is a *Midrash* of the same nature, and, in its main part, of the same date, as (9). Both drew from the same sources. *idrash* has been edited five times,—the latest, best, and edition being that of Friedmann (Vienna, 1880, 8vo).

Yenna debe Eliyyahu consists of two parts, the Greater and the Lesser (Zutto),—the former in thirty-one and the twenty-five *Perakim*. It is an exegetical *Midrash*, the which is already known to the *Bereshith Rabbah* (c. lxv.) Babylonian Talmud (*Kethuboth*, 106*a*). It is only un criticism that can declare it a Gaonaic work, although, like r old books of the Jews, it is not without later additions. ue., Venice, 1598, 4to. There are modern and cheap Polish

Midrash Rabbah (רבה) or *Rabboth* (רבות) is chiefly an al and homiletical *Midrash* on the Pentateuch and the Rolls" (*Hamesh Megilloth*, *i.e.*, Canticles, Ruth, Lamenta- Ecclesiastes, and Esther). It is called *Rabbah* either from d (the first distinctive) word of its beginning (רבי הויצי) or from its being the most voluminous- *rash*; hence bbo (רבא). The *Midrash* on Canticles (a nd then also called *Midrash Hazitha* (from rd of the beginning חזית). These ten *Mi* , of various styles and ages; yet no of the excepted, later than the beginning of kable that, although the *Megilloth* the arly l to the Pentateuch (since they were to the 10th and still are, read through the synagogal yea l is the Pentateuch itself), the *Rabbath* hac *inceps*[3]—that on the Pentateuch appearing for the first tim

Rabbah on Genesis has 100 *Parshaioth*, that on Exodu Leviticus 37, that on Numbers 23, and that on Deutero se five *Midrashim* are quoted according to their chapter . The n Canticles accommodates itself to the sacred text, and i cordingly. Ruth has 8 *Parshaioth*, and i oted Lamentations has 1 chapter consisting of introductions *tho Dehakkime*), accommodating itself, for the rest, to the xt. Ecclesiastes has 3 *Sedarim*, and Esther h *Parshaioth*, ous times various modes of quotin *idrashim* are —the most common and most expedient, how er, being that g them according to the verses of the Bible. might with advantage be mentioned some pie of literature e kindred in nature, although some of the are of much ate, whilst others are much later, than the *Midrashim* tioned:—(1) *Agadath Bereshith* on Genesis, ighty-three —edited for the first time by R. Menal. Lonsano in hi *adoth*, Venice, 1618, 4to; (2) *Midrash Vayyosa'u* on Ge in one chapter,—to be found in Jellinek's *Bet ha-Midrasch*, 1855, 8vo; (3) amplifications of chap lxx. of *Mi* on Genesis xxviii. 22, by the incorporation of the v hon *Tobit* in Aramaic, &c. (see *The Book of Tobit*, 1878, 8vo); (4) *Midrash Vayyosha'* on Exodus xiv. 30, printed at Constantinople, 1519, 4to; a MS. of this *Midrash* ved in the University Library, Cambridge (Add. 854); (5) *'Asereth Haddibberoth* on Exodus xx.,—printed in Jellinek's *Midrasch*, Leipsic, 1853, 8vo; (6) *Midrash Petirath Aharon* ers xx. 23-29; (7) *Midrash Petirath Mosheh* on Deuteronomy 8) *Midrash Abbo Gorion* on Esther; the last three are to be the before-mentioned *Bet ha-Midrasch*; (9) *Midrash Shemuel*, d, from its beginning, *'Eth la'asoth Ladonai*, Constantinople, io; (10) *Midrash Yonah*, Prague, 1595, 4to; (11) *Midrash Tehillim*), 1512; (12) *Midrash Mishele*, 1517, the last two ed at Constantinople, and in folio; (13) *Sepher Hayyashar* a good many old traditions are preserved, although it is , not the one mentioned in various books of the Bible), 1625, 4to; (14) *Dibere Hayyamim shel Mosheh*, Constanti- 516, 4to; a fragment of this is to be found in MS. Add. the University Library of Cambridge; (15) *Yosephon* (or), various works of Flavius Josephus worked up rather freely, 1480, folio,—translated into Latin (German and Spanish) imes; (16) *Zerubbabel*, Constantinople, 1519, 8vo; (17) *Elleh* on the "Ten Martyrs." For several other smaller *Midrashim* ek's *Bet ha-Midrasch*, i. and ii., 1853, iii., 1855, iv., 1857, ipsic; v., 1873, and vi., 1877, both at Vienna; and comp. rowitz, *Sammlung Kleiner Midraschim*, i., ii., Frankfort. The *Midrashim* on Isaiah and on Job seem now irretriev

f to compensate for this drawback, the well-known Cornelio d brought out at Venice, in 1545, two editions of the *Rabboth* entateuch and *Megilloth*, the one at Bombergi's house and the

in 1512 (Constantinople, folio), and that on the *Megilloth* in (somewhere in Italy, במדינת איטליאה, also in folio).[4] The and best edition is that of Vilna, 1880, folio. A translatio German is now coming out at Leipsic, by Dr A. Wunsche.

(13) *Pirḳe de-Rabbi Eli'ezer* (also called *Boraitha de- Eli'ezer*) is an astronomico-theosophical *Midrash* consistin fifty-four *Perakim*. It goes through the so-called "eighteen dictions," the signs of the zodiac, &c., but is unfinished. It bel no doubt, to the 5th century. The fact that the name "Fat occurs in it is no proof whatever that the book is post Mohamme as that name must have been already known to the idolatrous A *Ed. prin.*, Constantinople, 1514, and with a Latin transla Leyden, 1644, both editions being in 4to. There are also to be found cheap editions (Lemberg, Warsaw).

(14) *Tanḥuma* is an exegetical and homiletical *Midrash* o whole Pentateuch. It is quoted according to the *Parshaioth* the week. Although originally of the end of the 5th or beginning of the 6th century, it has now two principal addit which form part of the book: (1) several of the *Shaelloth* of Aha'i Gaon (of the 8th century), and (2) several pieces of *Yesod* of R. Mosheh Haddarshan, of Narbonne (of the 11th cent On its relation to the "*Yelammedenu*" (often quoted in the century, but supposed to be lost) light will soon be thrown by before-mentioned Salomon Buber, who is now preparing a cr edition of it. The *ed. prine.* of the *Tanḥuma* is Constantin 1522, folio; and a very valuable MS. copy of it is in the bridge University Library (Add. 1212).

(15) *Bahir* is a small cabbalistic *Midrash* ascribed to the Mishnic teacher, R. Nehunyah b. Hakkanah,—no doubt its beginning with the words רבי נחוניה בן הקנה Nahmanide- (*ob.* 1268) quotes the book often in his commen on the Pentateuch, under the names of *Sepher Habbahir*, *Midrasho shel Rabbi Nehunyah b. Hakkanah*. Some have nounced this work a late fabrication, but others, who thoroughly studied it, justly describe it as "old in substan not in form." *1st prin.*, Amsterdam, 1651, 4to. A cheaper appeared at Lemberg (1865, 8vo), and a MS. of this work is served in the University Library of Cambridge (Dd. 10. 11. 4).

(16) *Yalḳut* is the only existing systematic (not exhau collection of the *Aggadoth* on the whole Bible. Its author drew only from most of the *Midrashim* named in this article, but from the *Boraithoth* (see Mishnah), both *Talmudim*, and Midrashic works now lost (as the *Abkhir*, *Hasshakhem Hashkem*, &c.).[5] This fact constitutes one of the principal p of its value. The author was R. Shim'eon, brother (and not of R. Hello, and father of the distinguished grammarian, critic divine R. Yoseph Kara. He lived somewhere in the north of F in the 11th century. The *ed. prine.* of the *Yalḳut* on Nehemiah, and the books of Chronicles came out at Venice, folio (in the first Rabbinic Bible), that on the Prophets Hagiographa in 1521, and that on the Pentateuch in 1526-27, at Salonika, and in folio. An English translation of the w work has been undertaken by a band of Rabbinic scholar Cambridge. The first instalment, "The Yalkut on Zechari by E. G. King, B.D., Hebrew lecturer of Sidney Sussex Col appeared in 1882. This specimen, besides giving a correct t lation, contains many valuable notes.

(17) *Leḳaḥ Tob* is a *Midrash* on the Pentateuch and the *Megilloth*, by R. Tobiyyahu b. Eli'ezer of Greece, who lived du the crusade of 1096. This work draws, certainly, upon the old well-known *Midrashim*, and as such it would have thorou deserved the censure passed upon it by the witty but some irreverent Abraham Ibn Ezra (in his preface to his commen on the Pentateuch). But the *Leḳaḥ Tob* has also most valu explanations both by the collector himself and by his fathe Eli'ezer), a fact passed over by Ibn 'Ezra in silence. The *L Tob* on Leviticus, Numbers, and Deuteronomy came out the first time at Venice, in 1546, folio, under the title of *Pe Zuttarto* (see leaf 93*b* in the postscript by the editor, פקיקתא זוטרתא, which explains the somewhat vague title on the page פסיקתא זוטרתא או רבתא). In 1753-54 it was re printed at Venice, with a Latin translation, by Blasius Ugo in his *Thesaurus Antiquitatum Sacrarum* (xv.-xvi.) under name of *Pesikta*. The *Leḳaḥ Tob* on Genesis and Exodus

other at Gustiniani's. These two editions differ in nothing b the title pages, &c., and the vignettes of the various books. former edition is in possession of Dr W. Aldis Wright, and the in that of Dr C. Taylor. The fact of these editions having app simultaneously is, apparently, unknown to the bibliographers.

[4] It is noteworthy that in this edition *Ahasherosh*, *i.e.*, Es stands between Lamentations and Ecclesiastes, with which latte *Midrash* on the *Megilloth* ends.

[5] We may mention here the *ed. prine.* of three cabbalistic-Midr collections which go under the name of *Yalḳut*:—(1) *Yalḳut Ha* Lublin, 1648, 4to; (2) *Yalḳut Reubeni Hakkatan*, Prague, 4to; and (3) *Yalḳut Reubeni Haggadol* Wilhermsdorf, 1681, fo

ed, with a critical commentary, at Vilna, by Salomon Buber
8vo), where also simultaneously a third edition of this
on the last three books of Moses, with a short commentary
ame out by Aharon Moshch Padova, of Carlin. The *Lekah*
the five *Megilloth* is as yet unpublished, there exist, how-
veral good MSS. of it, both in public and private libraries,
st copy in every respect being that preserved in the Un-
Library, Cambridge (Add. 398).

Menorath Hamaor is a valuable though incomplete,
n of the principal *Lekahs* of the *Talmudim* and
rim, by R. Yizhak Abohab the elder, flourished 13th century.
tions with and without translations, are very numerous,
rim being Constantinople 1511, folio. There are transla-
n Spanish, Judæo-German and German, but not in English.
ppend two specimens of *Midrashim*, the first from
a, leaf 12*a* and the second from *Midrash Shemoth Rabbah*,

[illegible] the Holy One (blessed be He!) sent to the Prophets to cover
our wedding-day?
ent Hosea to comfort her and said, The Holy One (blessed be He!) sent
to comfort thee. She said to him, What hast thou in thine hand to comfort
Prophet said (Hos. ii. 19), I will betroth thee unto Me for ever.' But
said to him, Only yesterday thou foldest me (Hos. ii. 16), 'Ephraim is
he is joined to idols: let him alone: they shall have no fruit: yea, though they bring
well I slay even the beloved fruit of their womb:' and now thou
to me thus. Which shall we believe, the first or the second prophecy?
ent Moses to comfort her and said, The Holy One (blessed be He!) sent
to comfort thee. She said to him, What hast thou in thine hand to
The Prophet said (Isa. xxvi. 19), 'Thy dead men shall live, my dead bodies
shall they arise.' But Jerusalem said to him, Only yesterday thou foldest me
that I fallen.' But Jerusalem said to him, Only yesterday thou
(Amos v. 2), 'The Virgin of Israel is fallen; she shall no more rise:' and
speakest to me thus. Which shall we believe, the first or the second
ent Micah to comfort her and said, The Holy One (blessed be He!)
thee to comfort thee. She said to him, What hast thou in thine hand to
one. The Prophet said (Isa. l. 1), 'Where is the bill of your mother's
iniquity and put away by the transgression of the covenant of Her
But Jerusalem said to him, Only yesterday thou foldest me (Isa. l. 1),
transgression of Jacob: for all this, and for the sins of the house of Israel
now thou speakest to me thus. Which shall we believe, the first or
prophecy?
ent Nahum to comfort her and said, The Holy One (blessed be He!)
thee to comfort thee. She said to him, What hast thou in thine hand
me? The Prophet said (Nah. i. 15), 'For the wicked shall no more
through thee:' But Jerusalem said to him, Only yesterday thou foldest
'There is one come out of thee that imagineth evil against the Lord,
counsellor:' and now thou speakest to me thus. Which shall we
first or the second prophecy?
ent Habakkuk to comfort her and said, The Holy One (blessed be He!)
thee to comfort thee. She said to him, What hast thou in thine hand
me? The Prophet said (Hab. i. 1), 'Thou wentest forth for the salvation
ple even for the salvation with Thine Anointed One:' But Jerusalem
Only yesterday thou foldest me (Hab. i. 2), 'O Lord, how long shall I cry
will not hear, even cry out unto Thee of violence and Thou wilt not
I now thou speakest to me thus. Which shall we believe, the first or
prophecy?
ent Zephaniah to comfort her and said, The Holy One (blessed be He!)
thee to comfort thee. She said to him, What hast thou in thine hand
me? The Prophet said (Zeph. iii. 14), 'Sing, O daughter of Zion; shout,
Israel; be glad and rejoice with all the heart, O daughter of Jerusalem.'
search Jerusalem with lights:' But Jerusalem said to him, Only
thou foldest me (Lam. i. 1), 'A city of darkness and gloominess:' and now
to me thus. Which shall we believe, the first or the second
ent Haggai to comfort her and said, The Holy One (blessed be He!)
thee to comfort thee. She said to him, What hast thou in thine hand
me? The Prophet said (Hag. ii. 19), 'Is the seed yet in the barn? Yea as
and the fig-tree and the pomegranate and the olive-tree hath not
from this day will I bless you.' But Jerusalem said to him,
thou foldest me (Hag. ii. 20), 'Ye have sown much and bring in little,
speakest to me thus. Which shall we believe, the first or
prophecy?
ent Zechariah to comfort her and said, The Holy One (blessed be He!)
thee to comfort thee. She said to him, What hast thou in thine hand
me? The Prophet said (Zech. ii. 10), 'And I am very sore displeased with
but a little displeased and they helped
for evil.' But Jerusalem said to him, Only yesterday thou foldest
displeased with your father:' and now thou
me thus. Which shall we believe, the first or the last prophecy?
ent Malachi to comfort her and said, The Holy One (blessed be He!)
thee to comfort thee. She said to him, What hast thou in thine hand
me? The Prophet said (Mal. iii. 12), 'And all nations shall call you
for ye shall be a delightsome land:' But Jerusalem said to him, Only
thou foldest me (Mal. ii. 17), 'I have no delight in you:' and now thou
to me thus. Which shall we believe, the first or the last prophecy?
ent all the Prophets [illegible] Holy One (blessed be He!) saying to Him,
the Universe, Seek ye the welfare of Jerusalem, and pray before Me
supplication at our hands. Then
One (blessed be He!) said
[illegible] 'Depart ye, depart ye, go ye out from there, touch no unclean
and this is why it is said, 'Depart ye, depart ye, go ye out from there, touch no unclean
comfort her with My words of comfort.' Comfort her, ye
ones.' Comfort her, ye
ones.' Comfort her, ye
[illegible] comfort her, ye dead ones!
[illegible] comfort her.

Pesikta Rabbathi, ed. Friedmann, leaf 142*a*.
Pesikta Rabbathi (ed. Friedmann, leaf 150*a*), where it says (before the
on *Nahum*), "Obadyah prophesied for Edom, and Yonah for Nineveh."
true, is a mere gloss; but it is the true reason why these two prophets
at
is a play here upon the meaning of the Hebrew עִמִּי, which may be
'*Immi* ("my people") or '*Immi* ("with me").

SECOND SPECIMEN.—And whom does He try? The righteous one;
(Ps. xi. 5), "The Lord tieth the righteous." And by what does He try
the feeding of sheep. David He tried by sheep and found him a good
for it says (Ps. lxxviii. 70), "And He took him from the 'restraints'
What is the meaning of '*Mimmikhleoth*?' The root is the same as that
kale [*haggeshem*] (Gen. viii. 2), "And the rain was restrained." David
the big sheep in favour of the small ones. He brought out first the yo
so that they should feed on the tender herbs, then he brought out th
that they should feed on the less tender herbs; and, finally, he brough
strong sheep that they should feed on the coarser herbs. Upon this the
(blessed be He!) said, He who understandeth to feed sheep according
strength, let him come and feed My people! And this it is what
(Ps. lxxviii. 71), "From following the ewes great with young He brou
feed Jacob His people!" And the same was the case as regards Mos
the Holy One (blessed be He!) tried by sheep. Our rabbis say, When
teacher (peace be upon him!) was feeding the sheep of Jethro in the w
a kid ran away from him, and Moses ran after it till they came to a
hollow. When it had reached the mountain hollow there was a pool
and the kid stood still in order to drink. When Moses reached the kid
it, I did not know that thou didst run away from me because thou wast t
faint. Thereupon he put it on his shoulders and walked back with
flock. Then said the Holy One (blessed be He!), Thou art compassion
feeding of sheep belonging to mere flesh and blood (man), as thou li
shalt feed My flock, even Israel! Behold, this it is that is written (Ex
"And Moses was feeding the flock, &c."

(S. M

MIEDZYRZEC PODLASKI (Russian, *Mejirye*
district town of Russian Poland, in the governm
Siedlce, 16 miles to the east of the government
on the railway between Warsaw and Brest-Litovsk
is first mentioned in the year 1390 as a feudal do
of King Vaghello. After frequently changing ha
became the property of the Czartoryski, and afte
of the Potocki family, whose palace is still to be s
the town. Its 10,000 inhabitants, half of wh
Greek nonconformists, and half Jews and Poles,
on some trade in bristles, and pursue minor industr

MIERIS, the name of a family of artists who pr
painting at Leyden for three generations in the 17
18th centuries.

I. FRANS VAN MIERIS, the elder, son of Jan van
a goldsmith and diamond setter, was born, accord
Houbraken, at Leyden on the 16th of April 16
died there on the 12th of March 1681. His father
to train him to his own business, but Frans pr
drawing to chasing, and took service with Abraha
envlet, a glazier who kept a school of design. A
happens, the youth's style was influenced by his
surroundings. In his father's shop he became f
with the ways and dress of people of distinction
eye was fascinated in turn by the sheen of jewelle
stained glass; and, though he soon gave up the t
of Torenvliet for that of Gerard Dow and Abraha
den Tempel, he acquired a manner which had more
finish of the exquisites of the Dutch school than
breadth of the disciples of Rembrandt. It sho
borne in mind that he seldom chose panels of wh
size exceeded 12 to 15 inches, and whenever his
attached to a picture above that size we may surely
it to his son Willem or to some other imitator.
Gerard Dow when he first left Rembrandt, or Ja
when he started on an independent career, he nev
tured to design figures as large as life. Character
his art in its minute proportions is a shiny brightn
metallic polish. The subjects which he treated h
those in which he illustrated the habits or actions
wealthier classes; but he sometimes succeeded in
incidents and in portrait, and not unfrequently l
tured on allegory. He repeatedly painted the sati
which Terburg brought into fashion, and he often
Terburg in the faithful rendering of rich and
coloured woven tissues. But he remained below T
and Metzu, because he had not their delicate perce
harmony or their charming mellowness of touch ar
and he fell behind Gerard Dow, because he was ha
had not his feeling for effect by concentrated lig
shade. In the form of his composition, which so
represents the framework of a window enlivene

[4] Who, on reading this, does not think of such passages in the New
as Matt. xviii. 12, xxv. 21, and John x. 14?

y, and adorned with bas-reliefs within which figures
n to the waist, his model is certainly Gerard Dow.
been said that he possessed some of the humour of
een, who was his friend, but the only approach to
r in any of his works is the quaint attitude and
a tinker in a picture at Dresden, who glances know
t a worn copper kettle which a maid asks him to

a question whether Houbraken has truly recorded
aster's birthday. One of his best-known pieces, a
f ladies and gentlemen at an oyster luncheon in
rmitage at St Petersburg, bears the date of 1650.
ated alike for composition and finish, it would
that Mieris had reached his prime at the age of
Another beautiful example, the Doctor Feeling
r's Pulse in the gallery of Vienna, is dated 1656;
aagen, in one of his critical essays, justly observes
is a remarkable production for a youth of twenty
In 1657 Mieris was married at Leyden to the pro-
of Jan Potheuck, a painter, and this is the earliest
record of his existence on which we can implicitly
Of the numerous panels known to the writer of
nes, twenty nine at least are dated, the latest
an allegory, long in the Ruhl collection at Cologne,
ting the kindred vices of drinking, smoking, and
in the year 1680.

ris had numerous and distinguished patron He
d valuable commissions from Archduke Leopold, the
palatine, and Cosmo III., grand-duke of Tuscany.
ctice was large and lucrative, but never encumbered
either carelessness or neglect. If there be a differ
etween the painter's earlier and later work, it is that
mer was clearer and more delicate in flesh, whilst the
was often darker and more livid in the shadows.
he died his clients naturally went over to his son
, who in turn bequeathed his painting room to his
ans. But neither Willem nor Frans the younger
d Frans the elder.

WILLEM VAN MIERIS (1662-1747), son of Frans.
orks are extremely numerous, being partly imita
of the paternal subjects, or mythological episodes,
Frans habitually avoided. In no case did he come
he excellence of his sire.

FRANS VAN MIERIS the younger (1689-1763) also
n the traditions of his grandfather's painting room.
ictures of all the generations of the Mieris family were suc-
y imitated by A. D. Snaphaan, who lived at Lapsie and
ronized by the court of Anhalt Dessau. To those who would
is deceptive form of art a visit to the collection of Woltz
ssau may afford instruction.

GNARD, PIERRE (1610–1695), called to distinguish
om his brother Nicholas Le Romain, was the chief
portrait-painter of the 17th century. He was born
yes in 1610, and came of a family of painters. In
he left the studio of Simon Vouet for Italy, where
nt twenty-two years, and made a reputation which
t him a summons to Paris. Successful with his
t of the king, and in favour with the court, Mignard
himself against Le Brun, declined to enter the
ny of which he was the head, and made himself the
of opposition to its authority. The history of this
le is most important, because it was identical, as
as it lasted, with that between the old guilds of
and the new body which Colbert, for political
s, was determined to support. Shut out, in spite of
served success of his decorations of the cupola of
Grace (1664), from any great share in those public
the control of which was the attribute of the new
ny, Mignard was chiefly active in portraiture.
ne, Bossuet, Maintenon (Louvre), La Vallière, Sévigné,
span, Descartes (Castle Howard), all the beauties
and celebrities of his day, sat to him. His readiness
skill, his happy instinct for grace of arrangement, a
for want of originality and real power. With the de
Le Brun (1690) the situation changed; Mignard de
his allies, and succeeded to all the posts held b
opponent. These late honours he did not long enj
1695 he died whilst about to commence work on the c
of the Invalides. His best compositions have be
graved by Audran, Edelinck, Masson, Pollly, and oth

MIGNONETTE, or MIGNONNETTE (*fr.*, "little
ling"), the name given to a popular garden flowe
Reseda odorata of botanists, a "fragrant weed," as C
calls it, highly esteemed for its delicate but delicious per
The mignonette is generally regarded as being of a
duration, and is a plant of diffuse decumbent twiggy
scarcely reaching a foot in height, clothed with bl
lanceolate entire or three-lobed leaves, and bearing l
spikes (technically racemes) of rather insignificant f
at the ends of the numerous branches and bran
The plant thus naturally assumes the form of a low
mass of soft green foliage studded over freely wit
racemes of flowers, the latter unobtrusive and likely
overlooked until their diffused fragrance compels atte
The native country of the original or typical mign
has sometimes been considered doubtful, but accord
the best and latest authorities it has been gathered w
the North African coast near Algiers, in Egypt, a
Syria. As to its introduction, a MS note in the
of Sir Joseph Banks records that it was sent to E
from Paris in 1742; and ten years later it appears t
been sent from Leyden to Philip Miller at Chelsea. T
originally a slender and rather straggling plant, the
now some improved garden varieties in which the g
is more compact and vigorous, and the inflorescence l
though the odour is perhaps less penetrating. The
six petalled flowers are somewhat curious in structur
two upper petals are larger, concave, and furnished
back with a tuft of club-shaped filaments, which
them the appearance of being deeply incised, while t
lowest petals are much smaller and undivided; th
conspicuous part consists of the anthers, whic
numerous and of a brownish red, giving the tone of
to the inflorescence. In a new variety named
Queen the anthers have a decided tint of orange
which imparts a brighter golden hue to the plant
in blossom. A hand-some proliferous or double fl
variety has also been obtained, which is likely to be
useful decorative plant, though only to be propaga
cuttings, the double white flowers grow in large
panicles (proliferous racemes), and are equally fr
with those of the ordinary forms.

What is called tree mignonette in gardens is due to the
the cultivator. Though practically a British annual, as
noted, since it flowers abundantly the first season, and is
destroyed by the autumnal frosts, and though recorded a
annual in its native habitat by Desfontaines in the *Flora A*
the mignonette, like many other plants treated in Eng
annuals, will continue to grow on if kept in a suitable temp
Moreover, the life of certain plants of this semiannual
may be prolonged into a second season if their flowering and
are judiciously prevented. In applying these facts to
duction of tree mignonette, the gardener grows on the
plants under glass, and prevents their flowering by nippin
blooming tips of the shoots, so that they continue their ve
growth into the second season. The young plants are at f
ported in an erect position, the laterals being removed
secure clean upright stems, and then at the height of one
feet or more, as may be desired, a head of branches is en
to develop itself. In this way very large plants can be pro

For ordinary purposes, however, other plans are adopted.
open borders of the flower garden mignonette is usually
spring, and in great part takes care of itself, but, being a f
either for window or balcony culture, and on account of its f
a welcome inmate of town conservatories, it is also very ex

s a pot plant, and for market purposes with this object it is pots in the autumn, and thinned out to give the plants e space, since it does not transplant well, and it is thereafter y grown in pits protected from frosts, and marketed when iving at the blooming stage. In this way hundreds of ds, probably, of pot of blooming mignonette are raised and l of year by year.

sself, nor the colours given out by plants Rimmel ranks the ette in the class of which he makes the violet the type; and pts the same process of giving it to his class of "bosmonds" th the violet and lily-of-the-valley.

mer scientific but it would appear less correctly, written ette. The genus *Reseda* contains some other interesting ful species, among them the *Reseda Luteola*, which is ly called dyer's weed and weld, and yields a valuable lye.

EL, MARIA EVARISTE (1802–1866), usually known MIGUEL, whose name is chiefly associated with his ion to the throne of Portugal, was the third son of ohn VI. of Portugal, and of Carlotta Joachima, one Spanish Bourbons; he was born at Lisbon on 26, 1802. In 1807 he accompanied his parents flight to Brazil, where he was permitted to grow oted child and a worthless youth; in 1821, on his to Europe, it is said that he had not yet learned l. In 1822 his father swore fidelity to the new ese constitution which had been proclaimed in his , and this led Carlotta Joachima, who was an st of the extremest Bourbon type, and otherwise er husband, to resolve to seek his dethronement in of Miguel her favourite son. The insurrections ensued (see PORTUGAL) resulted in her relegation to le of Queluz and the exile of Miguel (1824), who short time in Paris and afterwards lived in Vienna, e came under the teaching of Metternich. On the death of John VI. in May 1826, Pedro of Brazil, est son, renounced the crown in favour of his a Maria da Gloria, on the understanding that she become the wife of Miguel. The latter nominally swore allegiance to Pedro, to Maria, and to stitution which Pedro had introduced, and on the was appointed regent in July 1827. He arrived on in February 1828, and, regardless of his s, dissolved the new Cortes in March; having ogether the old Cortes, with the support of the ary party of which his mother was the ruling e got himself proclaimed sole legitimate king of d in July. The power which he now enjoyed he in the most tyrannical manner for the repression liberalism, and his private life was characterized wildest excesses. The public opinion of Europe more and more actively hostile to his reign, and occupation of Oporto by Don Pedro in 1832, the tion of Miguel's fleet by Captain (afterwards Sir) Napier off Cape St Vincent in 1833, and the ion of Santarem in 1834, Queen Christina recognized the legitimate sovereignty of Maria, the act followed by France and England. Don capitulated at Evora on May 29, 1834, renouncing ter ion to the Portuguese throne, and solemnly to never thereafter to meddle in Peninsular He lived for some time at Rome, where he was papal court, afterwards retired to Brompton Bodley, where he died on November 14, 1866.

ULINSKAYA, a village (*stanitsa*) of Russia, government of the Don Cossacks, and in the district Medyeditsa, 70 miles west of that town, on bank of the Don. It is one of the largest and est *stanitsas* of the government, and has 20,600 ants, who are engaged in agriculture and stock-ng, and in the export of agricultural produce.

ALLOVSKAYA, a Cossack village (*stanitsa*) of , in the government of the Don Cossacks, and in the district of Khopersk, 14 miles to the north-we Uryupino, on the low left bank of the Khoper, whi inundated when the river is full. It has an impo fair, where Tartars from Astrakhan exchange furs cottons for manufactured and grocery wares imported central Russia; the inhabitants of the district als corn, cattle, and plain woollen stuffs. Population, 18

MILAN (the Latin *Mediolanum*, Italian *Milano*, German *Mailand*), a city of Italy, situated near the m of the Lombard plain, on the small river Olona, in 45° 35″ N. lat. and 9° 5′ 45″ E. long. It is 390 feet a the sea level, and lies 25 miles south of the Alps at C 30 miles north of the Apennines, 20 miles east o Ticino, and 15 miles west of the Adda.

The plain around Milan is extremely fertile, owi once to the richness of the alluvial soil deposited b Po, Ticino, Olona, and Adda, and to the excellent sy of irrigation. Seen from the top of the cathedral plain presents the appearance of a vast garden di into square plots by rows of mulberry or poplar To the east this plain stretches in an unbroken as far as the eye can follow it, towards Venice an Adriatic, on the southern side the line of the Apen from Bologna to Genoa closes the view; to the west the Maritime, Cottian, and Graian Alps, with Monte as their central point; while northward are the Pe Helvetic, and Rhætian Alps, of which Monte Rosa Saasgrat, and Monte Leone are the most conspi features. In the plain itself lie many small vill and here and there a larger town like Monza or Sar or a great building as the Certosa of Pavia, makes a point upon the greenery.

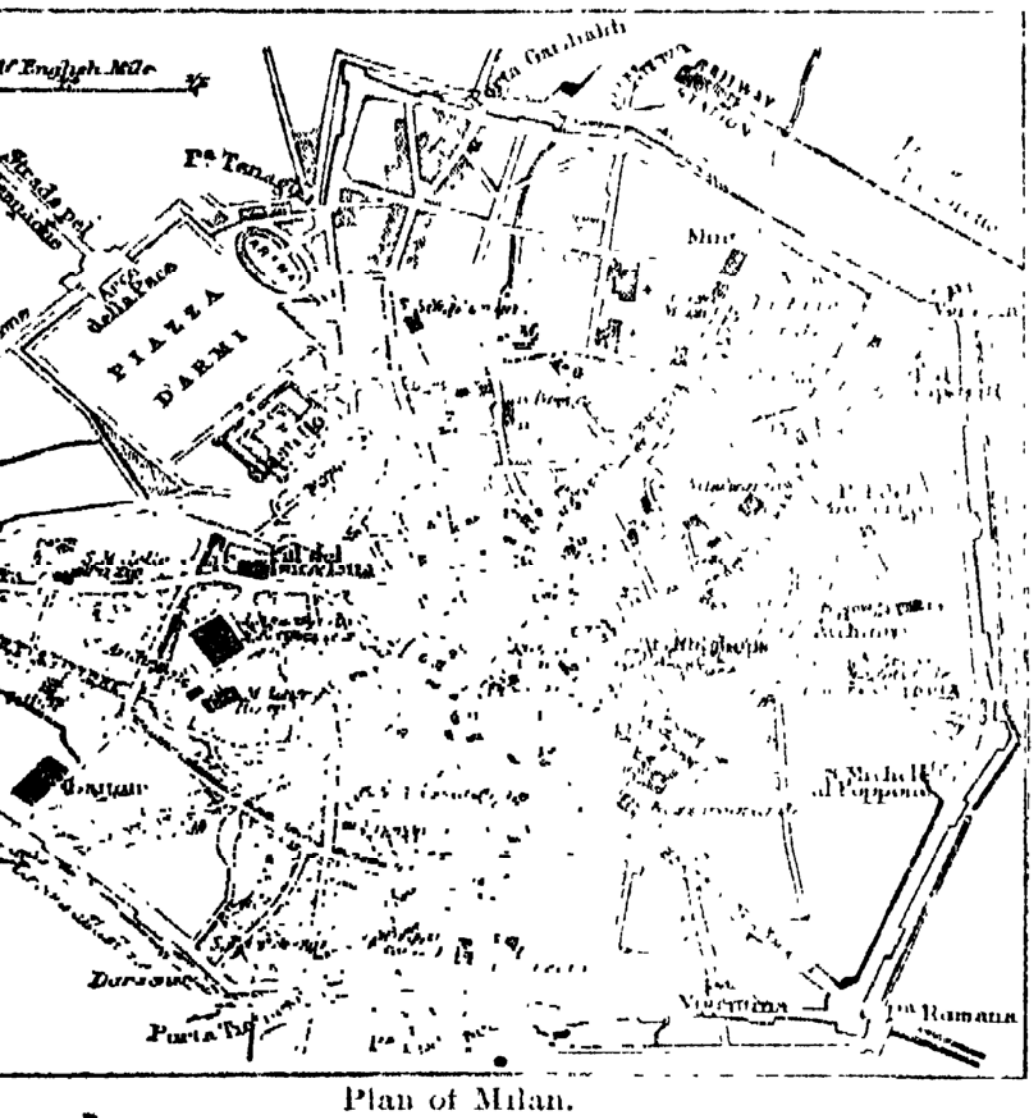
The commune of Milan consists since 1873 of th within the walls (area 1513 acres) and the so-called Santi[1] without the walls (area 15,415 acres). The lation of the whole area increased from 134,528 in to 242,157 in 1861, 261,985 in 1871, and 321,8 1881,—the city within the walls contributing 110,8 1801, 196,109 in 1861, 199,009 in 1871, and 21 in 1881. The climate is very variable; there is a diffe of 41° Fahr. between the extreme summer heat and v cold. The average number of wet days is 72, a snowy days 10 per annum.

Milan is built in a circle, the cathedral being the c point. The city is surrounded by a wall 7 mil circumference, and immediately outside the wall a broad thoroughfare makes the circuit of the city. streets inside are for the most part narrow and croo the main streets are the Corso Vittorio Emanuel Strada S. Margherita, the Via Manzoni, the Corso Ticinese, and the Corso Porta Romana. There are piazzas of any size; the largest is the Piazza del Du which has recently been extended, and the houses a n modernized. To the west of the city is the open of the Foro Bonaparte and the Piazza d'Armi, wit square keep of the Visconti castle, flanked by two gr towers, between them. The castle was partly dest in 1447 by the Ambrosian republic, rebuilt by Fra Sforza, enlarged by the Spanish governors, and take Napoleon in 1800, when the outer fortifications were the second, and the walls left as they now are. of the Piazza d'Armi is the modern cemetery, with a s building and apparatus for cremation, erected in 187

Among the buildings of Milan the most important cathedral, begun under Gian Galeazzo Visconti, in It is built of brick cased in marble from the quarries Visconti gave in perpetuity to the cathedral chapter.

[1] The name Corpi Santi (of doubtful origin) is also applied extra-mural portions of Cremona and Pavia.

of the original architect is not known, but it is
n that many German master masons were called to
to assist the Italian builders. After St Peter's at
and the cathedral of Seville the Duomo of Milan is
argest church in Europe. It is 477 feet in length
83 in width; the nave is 155 feet high, the cupola
feet, and the tower 360 feet. The work was con
d through many centuries, and after the designs of
masters, notably of Amadeo, who carried out the
on cupola, and of Tibaldi, who ornamented the
and windows of the façade in the 16th century. The
was finished, under Napoleon, in 1805. The style
thic, though its purity is destroyed by the introduc
f Romanesque windows and portals on the façade.
orm of the church is that of a cross. Inside there
uble aisles, and aisles in the transepts. The roof is


Piazza del Duomo
Via Cavour
Via Manzoni
Via Gio. Durini
Via Gio. Battista Morgagni
Via Alessandro Manzoni
Via Gio. Battista Vico
Via Gio. Battista Niccolini
Via Gio. Battista Piazzetta
Via Gio. Battista Pergolesi
Via Gio. Battista Pergolesi
Via Gio. Battista Pergolesi

is not so rich in MSS. as the celebrated Ambrosian
y, for which see LIBRARIES, vol. xiv. p. 531.

Features The district of Milan is renowned for its excellent
ture. It may be divided into two regions where different
s of farming are pursued and different crops produced. The
gion lies on the lower slopes of the Alps, where they sink
e plain. This is called the *alta Milanese*, for it is watered
nts only, which have worn themselves too deep a bed to
t irrigation, and the peasants are obliged to collect the rain
in large underground tanks (called *peppe*). The soil is for
t part thin and light, and frequently washed down the
into the plain, where it is only kept in its place by
all terraced walls. The farm-houses here are smaller than
lower plain, and the system of tenure is a compromise
the metayer system, but more akin to the latter, and
lease. The rent is paid partly in money, partly in kind or in a money equivalent,
nented by a certain number of the finest cheeses. In cases where
a fruit trees are scarce, the landlord supplies and maintains
till they come into bearing. The landlord carries out all
ements, and the tenant holds the land at his pleasure.
tation of copper coin for three years. The value of these
s is greatly appreciated by the peasants, who use them
ornaments. The latter produce more cereal wheat in abund
a little flax and millet, apples, and wine. The good
ural district that which lies in the plain, and is called the
me, from the abundance of irrigation which makes
adows yield a constant succession of crops. The plain is
d by numerous canals at various levels, crossing one
on bridges, or by culverts, so that the country is flooded
l at any moment. The system is said to date from the 12th
, but was improved by Leonardo da Vinci, and is now the
erfect network of irrigation in Europe. The rents vary in
from 1500 to 1500 per hectare. They are let upon leases for
selves, or fifteen years, at rents ranging from £5 to £12 10s
per hectare, while those near a city may bring from £15 to £20
The rotation of crops is over five years. The meadow yields
good grass in the year, the first three the second crop, the
, and the fourth the third cut, the fourth is ploughed up.
the ground is perfectly flat no water can be kept on it, nor is
this crop is continued for four years in succession, then
l is rested with cereals and corn. The other crops are
nd wheat. But the chief occupation is the supply of dairy
The cows are bred chiefly in the Swiss cantons of Uri, Zug,
, and Schwyz, the best animals being the smallest. The
alled Parmesan comes from the Milanese, and is made
made of an hammered mill, known as Stracchino
lly at the village of Gorgonzola, 12 miles east
The industry of the district
since the union of Italy a chief
ent centre
nd the M
ning the w
nd the ch
d is surrounded from th
in the year. Soo
ture, but the Mi
n on the production
manufactured at S
Certain coins of Parmesan and
excellent workmanship in Milan is of
Belovesus, king of the Celts, who crossed Alps
against Pisa was Lucius Bono, is fi
the capital of
the Romans in 222
to mention in magnificence
the seat of the imperial court
Western
in the 4th century, Milan, to
description of the Notitia, must
and public buildings. Theodoric died
palace at the Incoronata of St Ambrose, for
ighter of St
Ambrose
of the Milanese church and the
which is still in use throughout
period of invasions begins; and
felt the power of
under Attila (452) of the
ander Odoacer (47
of the Goths under Theodoric
When Belisarius
Justinian to recover Italy,
the archbishop of Milan
him, and the Goths were
from the city. But
Vitiges the Gothic
subsequently assaulted and
the town, after a brave
Totila destroyed the whole of Milan in 539; and hence
this city, once so important a centre of Roman civilization,
so few remains of antiquity. Narses, in his campaigns
the Goths, had invited other barbarians, the Lombards, to
They came in a body under Alboin, their king, in 568,
and were soon masters of North Italy, and entered Milan the year following. Alboin established his capital at Pavia, and Milan remained the centre of Italian opposition to the foreign conquest.

The Lombards were Arians, and the archbishops of Milan from the days of Ambrose had been always orthodox. Though the struggle was unequal, their attitude of resolute opposition to the Lombards gained for them great weight among the people, who felt that their archbishop was a power around whom they might gather for the defence of their liberty and religion. All the innate hatred of the foreigner went to strengthen the hands of the archbishops, who slowly acquired, in addition to their spiritual authority, powers military, executive, and judicial. These powers they came to administer through their delegates, called viscounts. When the Lombard kingdom fell before the Franks under Charles the Great in 774, the archbishops of Milan were still further strengthened by the close alliance between Charles and the church, which gave a sort of confirmation to their temporal authority, and also by Charles's policy of breaking up the great Lombard fiefs and dukedoms, for which he substituted the smaller counties. Under the centralized government of Charles's immediate successors the archbishop was the only real power in Milan. But there were two classes of difficulties in the situation, ecclesiastical and political; and their presence had a marked effect on the development of the people and the growth of the commune, which was the next stage in the history of Milan. On the one hand the archbishop was obliged to contend against heretics or against fanatical reformers who found a following among the people; and on the other, since the archbishops were the real power in the city, the emperor, the nobles, and the people each deemed that he should be of their party; and to which ever party he did belong he was certain to find himself violently opposed by the other two. From these causes it sometimes happened that there were two archbishops, and therefore no central control or no archbishop at all, or else an archbishop in exile. The chief result of these difficulties was that a spirit of independence and a capacity of judging and acting for themselves was developed in the people of Milan. The terror of the Hungarian invasion, in 899, further assisted the people in their progress toward freedom, for it compelled them to take arms and to fortify their city, rendering Milan more than ever independent of the feudal lord who lived in their castles in the country. The tyranny of these nobles drove the peasantry and smaller vassals to seek the protection for life and property, the equality of taxation and of justice, which could be found only inside the walled city and under the rule of the archbishop. Thus Milan grew populous, and learned to govern itself. Its inhabitants became for the first time Milanese, attached to the standard of St Ambrose,—no longer subjects of a foreign conqueror, but a distinct people, with a municipal life and prospects of their own. For the further growth of the commune, the action of the great archbishop Heribert, the establishment of the carroccio, the development of Milanese supremacy in Lombardy, the destruction of Lodi, Como, Pavia and other neighbouring cities, the exhibition of free spirit and power in the Lombard league, and the battle of Legnano, see the article ITALY. See also LOMBARDS.

After the battle of Legnano, in 1174, although the Lombard cities failed to reap the fruit of their united action, and fell to mutual jealousies once more, Milan internally began to grow in material prosperity. After the peace of Constance (1183) the city walls were extended, the arts flourished, each in its own quarter, under a guide who watched the interests of the trade. The manufacture of linen was the most important industry. During the struggles with the emperor Barbarossa, when freedom seemed on the point of being destroyed, many Milanese vowed themselves, their goods, and their families to the Virgin should their city come safely out of her troubles. Hence arose the powerful fraternity of the Umiliati, who established their headquarters at the Brera, and began to develop the wool trade, and subsequently gave the first impetus to the production of silk. From this period also date the irrigation works which render the Lombard plain a fertile garden.

The government of the city consisted of (A) a parlamento or concione, including all who possessed bread and wine of their own, which soon found to be unmanageable owing to its size, was reduced first to 2000, then to 1500, and finally to 800 members, (B) a credenza or committee of twelve members, elected in the great council, for the despatch of urgent or secret business: (C) the consuls, the executive, elected for one year, and compelled to report to the great council at the term of their office. The way in which the burghers used their liberty and powers, secured by the peace of Constance, in attacking the feudal nobility; how they compelled the nobles to come into the city and to abandon their castles for a certain portion of the year; how the war between the two classes was continued inside the city, resulting in the establishment of the podestà; and the nature and limits of this office,—all this has been explained in the article ITALY.

This bitter and well-balanced rivalry between the nobles and the people, and the endless danger to which it exposed the city owing to the fact that the nobles were always ready to claim the protec-

heir feudal chief, the emperor, brought t the front two milies as protagonists of the contending factions,—the of Valsassina, and the Visconti, who derived their name office they had held under the archbishops. After the Cortenova, in 1237, where Frederick II. defeated the Guelf he Milanese and captured their carroccio, Pagano della Torre nd saved the remnants of the Milanese. This act recom him to popular favour, and he was called to the government ty,—but only for the distinct purpose of establishing the ," a property tax which should fall with equal incidence on izen. This was a democratic measure which marked the which the Torriani belonged and rendered them hateful obility. Pagano died in 1241. His nephew Martino bl podestà in 1256, and in 1259 as signore of Milan, the e such a title was heard in Italy. The nobles, who had round the Visconti, and who threatened to bring Ezzelino ano, the Ghibelline tyrant of Padua, into the city, were by Martino, and nine hundred of their number were . Martino was followed by two other Torriani, Filippo ier (1263–65) and Napoleone his cousin (1265–77), as lords n. Napoleone obtained the title of imperial vicar from of Hapsburg. But the nobles under the Visconti had been gathering strength, and Napoleone was defeated at Desio. He ended his life in a wooden cage at Castel Baradello omo.

Visconti, archbishop of Milan (1262), the victor of Desio, lord of Milan, and founded the house of Visconti, who ruled except from 1302 to 1310 till 1447, giving twelve lords. Otho (1277–95), Matteo (1310–22), Galeazzo (1322–28), 328–39), Luchino (1339–49), and Giovanni (1349–54) fol- succession. Giovanni left the lordship to three nephews Galeazzo, and Bernabò. Matteo was killed (1355) by bre , who divided the Milanese, Bernabò residing in Milan 5) and Galeazzo in Pavia (1354–78). Galeazzo left a son, leazzo, who became sole lord of Milan by seizing and im- g his uncle Bernabò. For an account of this most powerful ITALY. It was under him that the cathedral of Milan Certosa of Pavia were begun. He was the first duke of having obtained that title from the emperor Wenceslaus. Giovanni Maria, who reigned at Milan (1402–1412), and Maria, who reigned at Pavia (1402–1447), succeeded him. , on his brother's death, Filippo united the whole duchy sole rule, and attempted to carry out his father's policy ndizement, but without success.

o was the last male of the Visconti house. At his death a was proclaimed, which lasted only three years. In 1450 eral Francesco Sforza, who had married Filippo's only child Visconti, became duke of Milan by right of conquest it by ht. Under this duke the canal of the Martesana, which s Milan with the Adda, and the Great Hospital were carried rancesco was followed by five of the Sforza family. His son o Maria (1466–76) left a son, Gian Galeazzo, a minor, whose and uncle Lodovico usurped the duchy (1479–1500). Lodo s captured in 1500 by Louis XII. of France, and Milan d for twelve years under the French crown. In the partial nt which followed the battle of Ravenna, Massimiliano protégé of the emperor, was restored to the throne of Milan, d it by the help of the Swiss till 1515, when Francis I. e reconquered the Milanese by the battle of Marignano, ssimiliano resigned the sovereignty for a revenue from France rangement did not continue. Charles V. succeeded the Maximilian, and at once disputed the possession of the with Francis. In 1522 the imperialists entered Milan and ed Francesco Sforza (son of Lodovico). France re-entered nd with him ended the house of Sforza. From this date till of the Spanish succession (1714) Milan was a dependency of anish crown. At the close of that war it was handed over ria; and under Austria it remained till the Napoleonic gn of 1796. For the results of that campaign, and for the of Italian progress towards independence, in which Milan a prominent part by opening the revolution of 1848, the s referred to the article ITALY. The Lombard campaign of ith the battles of Solferino and Magenta, finally made Milan f the kingdom of Italy.

ture.—Pietro Verri, *Storia di Milano*, Corio, *Storia di Milano*; Cantù, *one Grande del Lombardo Veneto*; the Milanese chroniclers in Muratori, *Ital. Scriptores*; Sismondi, *Italian Republics*; Leclerc, *Histoire littéraire d'Italie*, *Famiglie celebri italiane*, "Fortiguerra," "Visconti," "Sforza," and "Trivulzio," *Annali d'Italia*; Hallam, *History of the Middle Ages*; and *Mediæval Europe*, 881. Bonvicino da Riva gives a contemporary account of Milan in the my. (J. T. B.)

LAZZO, a city of Italy in the province of Messina dy, 20½ miles west of Messina, is built on the eastern of the Bay of Milazzo, partly on the isthmus of the ntory, Capo Milazzo, which divides it from the Bay vieri. It consists of an old or upper town protected ong bastioned walls, and a lower or modern town outside of the enceinte. The fine old castle is now as a prison. Besides a certain amount of foreign merce (37 vessels with a burden of 6707 tons entered 1881, 93 with 13,496 in 1863), Milazzo carries on coasting trade (194,366 tons in 1881, 40,138 in and is one of the seats of the tunny fishery. The nnual population increased from 10,193 in 1861 to in 1881, and that of the city was 7127 in 1871.

Milazzo is the ancient Mylæ, a seaport and fortress founded the Zanclean (Messanian), which gave its name to the the Mylæan plain in which the Mamertines were defeated by n 270 B.C. In 1123 it was the scene of an unsuccessful con to transfer Sicily to the French. Captured by the Germans it was besieged by the Spaniards, but relieved by a Neapoli English force. In July 1860 the defeat of the Neapolitan vicinity and the capture of the fortress forced direct the ne act of Garibaldi's victorious campaign. The Bay of Mila been the scene of the defeat of the Carthaginian navy by (260 B.C.), of Pompeius by Octavian's general Agrippa (36 B. of the French and Mussulman galleys by the Pisans (1718).

MILDEW (explained as "meal-dew" or, with probability, as "honey-dew") is a popular name to various minute fungi from their appearance, and the sudden, dew-like manner of their occurrence. many other popular names of plants, it is used to different species which possess very small bo affinity. The term is applied, not only to spec longing to various systematic groups, but also t as follow different modes of life. The corn r the hop-mildew, and the vine-mildew are, for ex parasitic upon living plants, and the mildews of dam and of paper are saprophytes, that is, they subs matter which is already dead. It is generally pos draw a distinct line between parasitic and sapr fungi; a species which attacks the living body of does not grow on dead matter, and *vice versâ*. This so far as is known of perhaps all the higher fungi *Saprolegnia ferax* (Gruith.), a parasite of fres fishes (especially of the salmon), which also grows on their dead bodies and on those of flies, &c. As mildews in general, the conditions of life and grow mainly suitable nutrition and dampness accompanie high temperature. The life-history of the same spe mildew frequently covers two or more generation these are often passed on host of different kind some cases again the same generation continues its to the same kind of host, while in other the same tion grows on various hosts. For information reg fungi generally see FUNGUS, vol. ix. p. 827.

The following examples are of common occurrence

The Corn-Mildew (*Puccinia graminis*, Pers., *Uredinea*).—This disease of our grain crops and of other grass plants is very widely distributed, like it over the earth, and is by far the most important to all mildews. Its life-history is passed in three gene

two of them on the grass plant and one on the ba In early spring the first generation is found on th leaves and leaf-sheaths of grass plants (on wh disease has hibernated), presenting to the naked appearance of thin black streaks. When examined microscope these streaks are seen to consist of a number of minute two-celled and thick-walled telent (reproductive bodies), each situated at the end of (see A in fig. 2, vol. ix. p. 831). These have burst t the epidermis of the plant from their origin on among the tissues beneath. When they have b contact with excessive moisture for a few hours, the spore-cells germinates by emitting a fine tube promycelium, on which there are borne small rou walled sporidia (reproductive bodies). The spori easily detached and carried from place to place wind, and on alighting on the leaves of a barberry

erminate by pushing out a small tube which per-
the epidermis and thus gains access to the interior
caf, where it branches copiously, and forms a mass
ul like tissue called mycelium. The germ tubes of
are unable to enter the grass plants.
six to ten day. thus n ne to flask
bodies called pycnidia (vol. ix. p. 831, fig. 2
immediately under the surface of the leaf (usually
er one), but breaking through it at the neck of the
out of which there protrudes a bunch of hair
the flasks are formed at the end of stalks many
ngly small oval bodies called spermatia, which escape
the neck. The spermatia of these bodies have not yet
inately made out, but they bear a very strik
emblance to the male sexual organs of other fungi
an be no doubt. In the same leaves and on the same
m there arise several days later numerous ba
bodies containing erect stalks, bearing at the apex
ber of round zoöthecospores (reproductive bodies) in
ecidia (vol. ix. p. 831, fig. 2 B, a). These con
the second generation. On their escape they
ate by emitting a tube which, if the host on which
ll be a grass plant, enters the leaf through one of
mata in the epidermis, and there by branching forms
mycelium. On this there soon appears, but ting
the epidermis, a new generation consisting of round
uredo pores produced at the end of stalks (vol. ix.
fig. 2 C). The uredospores constantly reproduce
neration, and in such abundance that the grain crops
massively ravaged by it attack. It is in this sense
at the term mildew is popularly given to the fungus.
In autumn on the same mycelium the two-celled
spores appear, and these after hibernating renew in
the life history. This very remarkable cycle of
ions was first traced by Professor de Bary.

Hop Mildew (Sphærotheca Castagnei Lev., Order *Pyre*
a parasite the spores of the hop thrown off often to in
many other plant, such as *Potentilla, Lysimachia, Lychnis*,
cucumbis, cranesbill. The disease fir
n appears on the young and leaves of the hop as
pot and limit mate. Pyc
n bear many minute, round conceptacles (perithecia) which
ir supporting threads or hyphæ coloured. Within each
numerous found a somewhat oval body termed an ascus, con
ght ascospores (reproductive bodies).

Vine Mildew (Uncinula Prolacis Berk., Order *Perisporiacei*)
only in one generation called the oidium stage soon dis
ring of the vine the attack takes place on the young leaves,
ich the thin white mycelium spreads rapidly to the other
d twigs which it does not appear to affect. Its presence is
f damage is done to the grapes while they are in a very
condition. The mycelium which travels over the surface
own at intervals into the tissues short irregular protuber
ted haustoria, which perform for it the function of root
rise from the mycelium short stalk bearing each a single
s. The disease spreads on the same plant not
the extension of the mycelium but by the simultaneous
tion of the points. Here no perithecia are known.

Rose Mildew (Sphærotheca humuli var. hortorum, Berk., Order *Perisporiacei*)
a parasitic fungus, the oidium stage of which is saprophytic in its mode of
on dead leaves, and bears a large filamentous mycelium on
upon which the spores occur. Finally a round brown peri-
is formed upon the threads which appear as radiating
With both the oidium and numerous linear asci contain-
a row of dark-coloured spores.

Wheat Erysiphe ix. p. 833

LETUS, an ancient city on the southern shore of
tmic Gulf opposite the mouth of the Maeander.
the Ionic migration it was inhabited by the Carians
ii. 876; Herod. i. 146) other authorities call the
l people Leleges, who are always hard to distinguish
Carians. The Greek settlers from Pylus under
massacred all the men in the city, and built for
lves a new city on the coast. It occupied a very
ble situation at the mouth of the rich valley of
eander, and was the natural outlet for the trade
of southern Phrygia (Hipponax, *Fr.* 15); it had
harbours, one of considerable size. Its power exte
inland for some distance up the valley of the Mæa
and along the coast to the south, where it founded the
of Iasus. The trade with the Black Sea, however,
the greatest source of wealth to the Ionian cities. Mi
like the rest turned its attention chiefly to the north
after a time it succeeded in almost monopolizing the t
Along the Hellespont, the Propontis, and the Black
coasts it founded more than sixty cities—among
Abydus, Cyzicus, Sinope, Dioscurias, Panticapæum,
Olbia. All these cities were founded before the mid
the 7th century, and before 500 B.C. Miletus was deci
the greatest Greek city. During the time when the
prise and energy of the seafaring population, the *dare*
raised Miletus to such power and wealth, nothing is k
of its internal history. The analogy of all Greek
and some general statements in later writers, suggest
that bloody struggles took place between the oligar
and the democracy, and that tyrants sometimes r
themselves to supreme power in the city; but no d
are known. Miletus was equally distinguished at this
time as a seat of literature. The Ionian epic and
poetry indeed had its home farther north; philosophy
history were more akin to the practical race of Mi
and Thales, Anaximander, Anaximenes, Hecataeus
belonged to this city. The three Ionian cities of Ca
Miletus, Myus, and Priene spoke a peculiar dialec
Ionic.[1]

When the Mermnad kings raised Lydia to be a
military kingdom, Miletus was their strongest adve
War was carried on for many years, till Alyattes conc
a peace with Thrasybulus, tyrant of Miletus; the Mil
afterwards seem to have peaceably acknowledged the r
Croesus. On the Persian conquest Miletus passed un
new master; it headed the revolt of 500 B.C., and
taken by storm after the battle of Lade. Darius t
it with peculiar severity, massacred most of the inhabi
transported the rest to Ampe at the mouth of the T
and gave up the city to the Carians. Henceforth
history of Miletus has no special interest; it revived i
when the Persians were expelled from the coast in 47
and was a town of commercial importance throughou
Græco-Roman period, when it shared in the general fo
of the Ionian cities under the rule of Athenians, Per
Macedonians, Pergamenians, and Romans in succe
Its harbours, once protected by Lade and the
Trogilian islands, were gradually silted up by
Maeander, and Lade is now a hill some miles from the
Ephesus took its place as the great Ionian harbour
Hellenistic and Roman times. It was the seat
Christian bishopric, but its decay was sure, and its
now a marsh.

See Strabo, *Commentt. de Reb. Miles.*; Soldan, *Rer.*
Chron., Revue *Milet et le Golfe Latmique*; Head, "Early
Coins," in *Numism. Chron.*, vol. xvi.

MILFORD, a seaport, market-town, and contrib
parliamentary borough (one of the Pembroke di
of Pembrokeshire, South Wales, is finely situate
the north side of Milford Haven, about 8 miles
north-west of Pembroke. The land-locked estua
Milford Haven stretches about 10 miles inland, w

[1] The coinage of Miletus during this early period is an im
ject on account of the wide commercial connexions of th
The early electrum coinage belongs to the Phœnician or Græco-
standard, which was introduced from Phœnicia and spread ove
of the Ionian and Thracian cities through the influence of M
trade. Very archaic coins of Miletus, Ephesus, Cyme, and Sa
known of this standard, and at a somewhat later date of Chios,
Clazomenæ, Lampsacus, Abydus, and Cyzicus. The lion is the
Milesian type, often with a star beside or above him.

of from 1 to 2 miles. In most places it has a f from 15 to 19 fathoms, and, as it is completely d by hills, vessels can ride in it at anchor in all of weather. The royal dockyard, founded at in 1790, was removed in 1811, and from that time as been in a languishing condition. The town es iron-works. The shipping trade is confined to coasting vessels, but with the completion of new capable of receiving vessels of the largest tonnage, posed that a considerable trade may be carried on nerica. The population of the urban sanitary di- 1871 was 3252, and in 1881 it was 3813.

FORD, a post-village of the United State , in ter county, Massachusett , lies 31 miles south-west on, at the junction of the Milford branch of the and Albany Railroad with the Hopkinton Milford, onsocket Railroad. It is one of the principal seats boot manufacture in New England, and also pro- arge quantities of straw goods. The population 10 in 1880.

IC, or MILITSCH, of Kremsier, Moravia, was the nfluential among those preachers and writers in a and Bohemia who during the 14th century paved y for the reforming activity of Hus and through that of Luther. He was born about 1325, was in holy orders in 1350, in 1360 was attached to rt of the emperor Charles IV., whom he accompanied rmany in that year, and about the same time also canonry in the cathedral of Prague along with the of archdeacon. About 1363 he resigned all his ments that he might become a preacher pure and ; he addressed scholars in Latin, and (an innovation) ly in their native Czech, or in German, which he d for the purpose. The success of his labours in ing the fallen made itself apparent in the reforma- a whole quarter of the city of Prague. As he dwelt nd more on ecclesiastical abuses and the corruption clergy, and viewed them in the light of Scripture, viction grew in his mind that the "abomination of ion" was now seen in the temple of God, and that ist had come, and in 1367 he went to Rome (where V. was expected from Avignon) to expound these He affixed to the gate of St Peter's a placard ncing his sermon, but before he could deliver it was into prison by the Inquisition. Urban however, arrival ordered his release, whereupon he returned to , and from 1369 to 1372 preached daily in the Teyn there. In the latter year the clergy of the diocese ined of him to the papal court at Avignon, whither summoned in Lent 1374, and where he died before e was decided. He was the author of a *Libellus de risto*, written in prison at Rome, a series of *Postillæ ectiones Quadragesimales* in Latin, and a similar of *Postils* in Czech.

LITARY FRONTIER (German, *Militärgrenze*; ic, *Granica*), a narrow strip of Austrian Hungarian ry stretching along the borders of Turkey, which centuries a peculiar military organization, and from to 1873 constituted a crown land. As a separate n of the monarchy it owed its existence to the ty of maintaining during the 15th, 16th, and 17th ies a strong line of defence against the invasions of rks, and may be said to have had its origin with ablishment of the captaincy of Zengg by Matthias us and the introduction of Uskoks (fugitives from y) into the Warasdin district by the emperor and I. By the close of the 17th century there were frontier "generalates"—Carlstadt, Warasdin, and ia (the last also called the Banal). After the defeat Turkish power by Prince Eugene it was proposed to abolish the military constitution of the frontier, bu change was successfully resisted by the inhabitants o district; on the other hand, a new Slavonian frontier trict was established in 1702, and Maria Theresa ext the organization to the march lands of Transylvania Szekler frontier in 1764, the Wallachian in 1766).[1]

As a reward for the service it rendered the Gover in the suppression of the Hungarian insurrection in the Military Frontier was erected in 1849 into a crown with a total area of 15,182 square miles, and a popu of 1,220,403. In 1851 the Transylvanian portion (about a third) was incorporated with the rest of Tr while and in 1871 effect was given to the imperial of 1850 by which the districts of the Warasdin regi (St George and the Cross) and the towns of Zengg, Ka Karlstadt, &c., were "provincialized" or incorporated the Croatian-Slavonian crown-land. In 1872 the Hungarian Diet followed suit, and in 1873 the old mi organization was abolished in all the rest of the fr Not till 1881, however, were the Croatian-Sla march lands completely merged in the kingdoms to they naturally belonged.

The social aspect of the military frontier régime is inte A communal system of land tenure natural to the old Sla was artificially kept in existence. The piece or plot of assigned to the original family of settlers remained the prop the family as such, and could not be portioned out among the members. In this way the house-community, all under t of the same house-father and house-mother (who were no sarily man and wife, nor the oldest members of the comm and all living within the same palisade, sometimes came t ber two or three hundred persons. The "family" dined in mon hall, and after dinner discussed and settled matters a the common weal. Every man possessing real property country, and capable of bearing arms, was liable to military from his twentieth year. The house-communities are now ning to avoid the motive of the perpetual partition law stranger are free to come and acquire property in land towers with wooden clappers and the beacons which fir alarm along the whole frontier in a few hours are still fa the landscape.

MILITARY LAW consists of the statutes, rule cedure, royal warrants, and orders and regulations prescribe and enforce the public obligations of the soldiers, and others made subject to its provisions essential purpose is the maintenance of discipline; also includes the administrative government of the f force of the state, more especially in the matter of ment, service, and billeting. The term "martial sometimes applied to it, as regard modern time a misnomer. For martial law, as it is now unde applies not only to military persons but to the civ munity, and may be described generally as the abro of ordinary law and the substitution for it of f force uncontrolled save by what, in the discretion commanding general, may be considered the nece the case.

The military law of England in early times exist the [illegible] in the [illegible] period of [illegible]

[illegible] had come to be the division of the [illegible] the [illegible] Hungarian, Croatian, Slavonian, Transylvanian, German Banat Regiments (Grenz-Infanterie-Regimenter), the Croatian Cordon, the Szekler Grenz-Infanterie-Regiment, the Banal Grenz-Infanterie-Regiment, the Roman Catholic and Greek Oriental Military Clergy, the Military Bishoprics, the Military Boards, the Military Courts, the Military Hospitals, the Military Schools, the Military Archives, the Military Treasury, the Military Post, the Military Telegraph, the Military Railways, the Military Steamboats, the Military Harbours, the Military Quarantine, the Military Sanitary Cordon, the Military Health Service, the Military Veterinary Service, the Military Remount Service, the Military Commissariat, the Military Clothing Service, the Military Pay Service, the Military Accounts, the Military Audit, the Military Pensions, the Military Orphanages, the Military Foundations, the Military Decorations, the Military Uniforms, the Military Flags, the Military Music, the Military Drill, the Military Manœuvres, the Military Rifle Ranges, the Military Riding Schools, the Military Fencing Schools, the Military Gymnastic Schools, the Military Swimming Schools, the Military Dancing Schools, the Military Fencing Masters, the Military Riding Masters, the Military Gymnastic Masters, the Military Swimming Masters, the Military Dancing Masters

were raised for a particular service, and were dis- upon the cessation of hostilities. The crown, of its prerogative, made laws known as Articles of War, government and discipline of the troops while thus ed and service. Except for the punishment of on, which offence was made a felony by statute in gn of Henry VI, the ordinances or Articles of ncerned, lacked the due authority for the enforce- during peace until 1689 when the first Mutiny Act ed and the military force of the crown were t under the direct control of parliament. Even the nentary force of the time of Charles I and Cromwell overned not by an Act of the legislature, but by of war made by those raised by the King and ed by ordinance of the Lords and Commons, e to that of the sovereign prerogative. This d however, by prerogative was, however, held to declare during a state of actual war only, and to exercise at no time of peace were ineffectual to this limitation it existed for considerably more century after the passing of the first Mutiny Act 689 to 1803, although in peace time the Mutiny s occasionally altered to express a statutory power n to the crown to make Articles of War to operate olonies and elsewhere beyond the seas in the same as those made by prerogative operated in time of In 1715, in consequence of the rebellion this power ated in respect of the forces in the kingdom. But nactments were apart from and in no respect affected people acknowledged all this time that the crown of prerogative could make laws for the government army in foreign countries in time of war. The Act of 1803 effected a great constitutional change in respect the power of the crown to make any of War became altogether statutory and the pro- mitted in the Act of Parliament. So matters d till the year 1879, when the last Mutiny Act sed and the last Articles of War were promulgated utiny Act legislated for offences in respect of which a penal servitude could be awarded and the of War, while reserving those provisions of the re-granted the direct authority for dealing with for which unparliamentary punish- as well as with many matters relating to trial and ure. The Act and the Articles were found not to ize in all respect. Their general arrangement was and their language sometimes obscure. In 1869 a mission recommended that both should be recast ple and intelligible shape. In 1878 a committee House of Commons endorsed this view and made mmendations as to the way in which the task i performed. In 1879 the Government submitted and passed into law a measure which, while re- Act of the Mutiny Act and the Articles of War, the introduction in certain important respects of new code called the "Army Discipline and Act." After one or two years' experience which to a large extent were found capable of improvement, ments were provided by the Army Act, 1881, now form the foundation and the main portion military law of England. It contains a proviso the right of the crown to make Articles of War, such a manner as to render the power in effect ty for it enacts that no crime made punishable by shall be otherwise punishable by such Articles. punishment of every commissioned officer is provided the Act, any Article made thereunder can be no than an empty formality having no practical effect. history of English military law up to 1879 may ded into three periods, each having a distinct constitutional aspect:—(1) that prior to 1689, when the a being regarded as so many personal retainers of sovereign rather than servants of the state, was ma governed by the will of the sovereign; (2) that betw 1689 and 1803, when the army, being recognized as a manent force, was governed within the realm by sta and without it by the prerogative of the crown; and that from 1803 to 1879, when it was governed ei directly by statute or by the sovereign under an autho derived from and defined and limited by statute. Altho in 1879 the power of making Articles of War becam effect altogether inoperative, the sovereign was empow to make rules of procedure, having the force of law, w regulate the administration of the Act in many ma formerly dealt with by the Articles of War. These r however, must not be inconsistent with the provisio the Army Act itself, and must be laid before parlia immediately after they are made. Thus in 1879 government and discipline of the army became for the time completely subject either to the direct action or close supervision of parliament.

A further notable change took place at the same t The Mutiny Act had been brought into force on occasion for one year only, in compliance with the constitutional theory that the maintenance of a standing a in time of peace, unless with the consent of parliamen against law. Each session therefore the text of the had to be passed through both Houses clause by clause line by line. The Army Act, on the other hand, is a permanent code. But constitutional traditions are respected by the insertion in it of a section providing it shall come into force only by virtue of an annual A Parliament. This annual Act recites the illegality standing army in time of peace unless with the consen parliament, and the necessity nevertheless of maintaini certain number of land forces (exclusive of those ser in India) and a body of royal marine forces on shore, of keeping them in exact discipline, and it brings into the Army Act for one year.

Military law is thus chiefly to be found in the Army and the rules of procedure made thereunder, the Militia 1882, the Reserve Forces Act, 1882, and the Volun Act, 1863, together with certain Acts relating to yeomanry, and various royal warrants and regulat The Army Act itself is, however, the chief autho Although the complaint has been sometimes made, and without a certain amount of reason, that it does not ac plish much that it might in point of brevity, simpli and clearness of expression, it is a very comprehen piece of legislation, and shows some distinct improven upon the old Mutiny Acts and Articles of War.

The persons subject to military law are the office the active list and the soldiers of the regular forces (inc ing the royal marines), the permanent staff of the auxi (viz. the militia, volunteer, and yeomanry) forces, and officers of the militia. The above persons are amenab at all times except while embarked on h a commissioned ship of the royal navy, when they bec subject to the Naval Discipline Act and certain order council made under its authority. Those who are subje military law in certain circumstances only are—officers while serving in a force raised out of the Un Kingdom and commanded by an officer of the reg forces, pensioners when employed in military se under the command of a regular officer; the non-com sioned officers and men of the militia, during train when attached to the regulars or when permane embodied, the officers of the yeomanry and the volun when in command of or attached to a body of men sub to military law, or when their corps is on actual mili

, or when ordered on duty with their own consent; n of the yeomanry when they or their corps are being , when they are attached to or acting with the forces, when their corps is on actual military service, n serving in aid of the civil power; the men of the ers when they are being trained with or are attached body of troops, or when their corps is on actual y service; the men of the army reserve and the reserve when called out for training or on duty in the civil power; any person who in an official y equivalent to that of an officer accompanies a of troops on active service beyond the sea; any accompanying a force on active service holding a om the general entitling him to be treated on the of an officer. In this last category would of course luded newspaper correspondent, also sutler and rs. In one or two cases persons are subjected tary law to a limited extent and in respect only of offences. Thus a militiaman even when not out ining or not embodied is liable to a military trial nishment for fraudulent enlistment or making a swer on attestation. In the same manner an army man may be tried and punished by court martial glect to appear at the place where he is bound cally to report himself, or for insubordination to his rs on these occasions, or for any fraud in connexion he receipt of his pay. A man of the army reserve militia reserve has the legal status of and in fact s a regular soldier when called out on occasions of l danger or emergency under the sovereign's pro- ion.

n a person subject to military law commits an he is taken into military custody, which means arrest in his own quarters or confinement. He without unnecessary delay be brought before his nding officer, who upon investigating the case may the charge if in his discretion he thinks it ought be proceeded with, or may take steps to bring the r before a court martial. Where the offender is not er he may dispose of the case summarily, the limit power in this respect being seven days' imprison with hard labour, fines not exceeding 10s. for ness, certain deductions from pay, confinement to s for twenty-eight days, this involving severe extra deprivations, and other minor punishments. Where ence is absence without leave for a period exceeding days, the commanding officer may award a day's mment in respect of each day of such absence up nty-one. It is only in the case of the imprisonment ing seven days that the evidence before the com- g officer is taken on oath, and then only in the of the accused so desiring it. The commanding is enjoined by regulation not to punish summarily re serious kind of offences, but his legal jurisdiction s respect is without limit as regards any soldier t before him, and when he has dealt summarily case the accused is free from any other liability in t of the offence thus disposed of. In any instance the commanding officer has summarily awarded onment, fine, or deduction from pay, the accused laim a district court martial instead of submitting award.

inary courts martial are of three kinds, viz.: (1) a ental court martial, usually convened and confirmed e commanding officer of the regiment or detachment, ed over by an officer not under the rank of captain, sed of at least three officers of the regiment or ment with not less than one year's service, and g a maximum power of punishment of forty-two days' onment with hard labour; (2) a district court martial, usually convened by the general of the dis consisting in the United Kingdom, India, Malta, Gibraltar of not less than five and elsewhere of no than three officers, each with two years' service or and having a maximum power of punishment of two y imprisonment with hard labour; (3) a general court ma the only tribunal having authority to try a commiss officer, and with a power of punishment extending to penal servitude, for offences for which these pen are authorized by statute, it consist of not less nine officers in the United Kingdom, India, Malta, Gibraltar and of five elsewhere, each of whom must over three years' service, five being not under the ra captain. There is another kind of tribunal incident service in the field, or where, in the case of an of against the person or property of an inhabitant, an ord court martial cannot be held, namely, a field general martial. This court may consist of three officers only it has the power of sentencing to death. Another ki court, called a summary court martial, may be held w an offence has been committed upon active service an ordinary court cannot be conveniently assembled. I event of three officers not being available it may cons two. When thus constituted it can award only a "sum punishment" or imprisonment; where it consists of officers, however, it can sentence to death. In the ca a field general or a summary court martial many f and precautions prescribed in the case of ordinary c are not necessarily observed, the whole proceeding from the necessity of the case a somewhat rough and means of dealing promptly with crime.

The Army Act prescribes the maximum punishment whic be inflicted in respect of each offence. That of death is m by various acts of treachery or cowardice before the enemy, when on active service interfering with or impeding authority ing without orders a guard or post, or when sentry sleeping o drunk on a post, plundering or committing an offence again person or property of an inhabitant, intentionally causing alarms, or deserting. Whether upon active service or not, s also becomes liable to the punishment of death who mutinies cites to or joins in or connives at a mutiny, who uses or offers v to or defiantly disobeys the lawful command of his superior when in the execution of his office. Penal servitude is the max punishment for various acts and irregularities upon active s not distinctly of a treacherous or wilfully injurious character using or offering violence or insubordinate language to a supe disobeying a lawful command when upon active service. The punishment is applicable when not upon active service to a offence of desertion or fraudulent enlistment (i.e., enlistment one who already belongs to the service), certain embezzlem public property, wilfully releasing without authority a pri wilfully permitting a prisoner to escape, enlisting when pre discharged from the service with disgrace without disclosin circumstances of such discharge, or any other offence which ordinary criminal law of England is punishable with pena vitude. Imprisonment with hard labour for two years maximum punishment for various forms and degrees of those o which if committed upon active service would involve de penal servitude, such as using or offering violence or insubor language to a superior or disobeying a lawful command, and following offences: treasure in escort, breaking out of ba neglect of orders, an offence of desertion or attempted de or aiding or conniving at desertion, or of fraudulent enli absence without leave, failure to appear at parade, going b prescribed bounds, absence from school, malingering or p pretended disease or infirmity, maiming with intent to render a unfit for service, an act of a fraudulent nature, disgraceful conduct of a cruel, indecent or unnatural kind, drunkenness, reb prisoner without proper authority or allowing him to escape, concerned in the unreasonable detention of a person awaiting escaping or attempting to escape from lawful custody, commit combatant exactions, making away with, losing by neglect, or w injuring military clothing or equipment, illegally absenting h in the service, making false or fraudulent representations in documents, making a wilfully false accusation against an off soldier, making a false confession of desertion or fraudulent ment, or a false statement in respect of the prolongation of fu misconduct as a witness before a court martial or contempt court, giving false evidence on oath, any offence specified in r

sing or the impressment of carriages, making a false answer
estion put upon attestation, being concerned in unlawful
ent, using traitorous or disloyal words regarding the
gn, disclosing any circumstance relating to the numbers,
, movements, or other circumstance of any part of her
's forces so as to produce effects injurious to her majesty's
fighting or being concerned in or conniving at a duel,
ting suicide, obstructing the civil authorities in the apprehen-
any officer or soldier accused of an offence, any conduct,
, or neglect to the prejudice of good order and military dis-
any offence which if committed in England would be punish-
the law of England. There is another offence which can be
ted by officers only, namely, "scandalous conduct unbecom-
character of an officer and a gentleman." It necessitates
ce, a punishment which in the case of an officer may be
d as an alternative for imprisonment in several other instances.
ri-social offence peculiar to officers and non-commissioned
that of striking or ill-treating a soldier or unlawfully
g his pay. An offence of cheating as distinguished from
ch must also in the case of an officer involve an incapacity to
e crown a man. An officer may be also sentenced to forfeiture
rity of rank and to reprimand or severe reprimand. A
mmissioned officer may be sentenced to be reduced to a lower
to the rank, and where sentenced to penal servitude or
prisonment is deemed to be reduced to the rank. The com-
in chief at home or the commander in chief in India or in
the presidencies may also cause a non-commissioned officer
fficer to a lower grade or to the ranks. An acting non-
missioned officer may be ordered by his commanding officer for
ce or for inefficiency or otherwise to revert to his per
grade, in other words, to forfeit his acting rank.

It has been observed that persons subject to military law
e to be tried by court martial for offences which if com-
n England would be punishable by the ordinary law, and to
the punishment prescribed by the ordinary criminal
hat authorized for soldiers who commit offences to the
of good order and military discipline. The effect of the
rnative is that for many minor offences for which a civilian
to a short term of imprisonment, or perhaps only to a fine,
may be awarded two years' imprisonment with hard labour.
martial, however, cannot take cognizance of the crimes of
murder, manslaughter, treason felony, or rape if committed
nited Kingdom. If one of these offences be committed in
e within her majesty's dominions other than the United
or Gibraltar, a court martial can deal with it only if it be
d on active service or in a place more than 100 miles from
ourt having jurisdiction to try the offence. With regard to
offences the military law, it is to be understood, is subor
to the ordinary law, and a civilian aggrieved by a soldier
t of a criminal offence against his property or person
forfeit his right to prosecute the soldier as if he were a

nces for which soldiers are most frequently tried are desertion,
without leave, loss of necessaries, violence or insubordina
ngness, drunkenness, and various forms of conduct to the
d discipline. The punishments are generally speaking
s much with regard to the character and antecedents of
der as to the particular offence. For a first offence of an
kind a district court martial would rarely give as a rule fifty-six
prisonment with hard labour for a second or graver crime
ear does. There are not many instances in which the
hoped punishment exceeds six months. Corporal punishment,
has been practically limited to offences committed upon
service, and in 1879 to crimes punishable with death, was
olished in 1881, and a summary punishment substituted
ects punishment includes the liability for a term of three
to be kept in a cell and handcuffs, and while so kept
to be fed on bread and water only, so that the offender may remain in
ion for a period not exceeding two hours in the day for
three consecutive days, and for not
than two such days in the aggregate. The offender may
subjected to the loss of pay and restraint, and may be kept
the time he would otherwise be sentenced to hard-labour imprison
But the corporal punishments are to be inflicted so as
cause injury to health or leave a permanent mark on the
The last instance in which this kind of punishment
icted occurred arose out of the campaign of 1882 in Egypt
ed by the results, the abolition of flogging does not appear
injuriously affected the general conduct of the troops in
aving been exceptionally good. The practice of marking, a
with the letters "D" (deserter) or "BC" (bad character),
to prevent his re-enlistment, was abolished about a dozen
in deference to public opinion which erroneously adopted
that the "marking" was effected by red-hot irons or in
ner involving torture. Military men for the most
ret its abolition, and maintain that if the practice were still
the army would not be tainted by the presence of many bad

characters who find means of eluding the vigilance of the au
and enlisting after previous discharge.

The course of procedure in military trials is as follows.
soldier is remanded by his commanding officer for trial by a
or general court martial, a copy of the charge, together w
statements of the witnesses for the prosecution (called t
mary of evidence), is furnished to him, and he is given prope
tunity of preparing his defence, of communicating with his w
or legal adviser, and of procuring the attendance of his w
Further, if he desires it, a list of the officers appointed to
court shall be given him. Any officer is disqualified to
member who has convened the court, who is the prosecu
witness for the prosecution, who has made the preliminary
into the facts, who is the prisoner's commanding officer, or
a personal interest in the case. The prisoner may also c
any officer on the ground of bias or prejudice similarly as m
might challenge a juror. Except as regards the delay ca
the writing out of the evidence, the procedure at a court
is very much the same as that at an ordinary criminal tri
examination and cross-examination of the witnesses, address
prosecutor and prisoner, and the rules governing the admi
rejection of evidence being nearly identical. At a gener
martial, and sometimes at a district court, a judge advocat
senting the judge advocate general officiates, his functions be
much those of a legal assessor to the court. He advises upon a
of law, and sums up the evidence just as a judge charges
When the prisoner pleads guilty the court finds a verdict
ingly, reads the summary of evidence, hears any state
mitigation of punishment, and takes evidence as to charact
proceeding to pass sentence. The sentence is that of the
of the court, except where death is awarded, when two-thir
members in the case of a general court martial and the
that of a field general court martial must concur. When an
upon all the charges takes place the verdict is announced
court, and the prisoner is released without any further pro
When the finding is "guilty," evidence as to character
and the court deliberates in private upon the sentence,
result is not made known until the proceedings are confir
promulgated. No conviction or sentence has any effect u
thus confirmed by the proper authority. The confirming a
in the case of a regimental court is the commanding officer,
of a district court martial the general officer command
district, and in that of a general court, if held in the
kingdom her majesty, and if abroad in most cases the gener
commanding. The confirming authority may order the reass
of the court in order that any question or irregularity may b
and corrected, but not for the purpose of increasing a senten
may, however, of his own discretion, and without further r
to the court, refuse confirmation to the whole or any portio
finding or sentence, and he may mitigate, commute, or
remit the punishment. In the case of a general court
the proceedings are sent to the judge advocate general, who
to the queen his opinion as to the legality of the trial and s
If they are legal in all respects he sends the proceeding
commander in chief, upon whom rests the duty of advising t
regarding the exercise of clemency. In addition to confi
however, every general or district court martial held out
has another ordeal to go through. It is reviewed and exa
the office of the judge advocate general, and any illegality t
be declared is corrected and the prisoner is relieved of
sequence. To a certain extent a protection against illega
exists in the case of regimental courts martial. A monthl
of those held in each regiment is laid before the general co
ing the district or brigade, by whom any question that migh
not free from doubt or difficulty would be referred to the adjutant genera
judge advocate general for decision. It is to be noted, howe
the judge advocate general, although fulfilling duties whic
their nature judicial, is only an adviser. He is not actually
in the executive sense, and has no authority directly to interf
or correct an illegal conviction. In many cases the law t
vides no remedy for an officer or soldier who may have been
by the finding or sentence of a court martial,—for i
through a verdict not justified by the evidence or throug
observance of the rules and practice prescribed for these t
A person who has suffered injustice may appeal to the Queen
division of the high court of justice. But, speaking genera
full appeal would not interfere with a court martial exerc
jurisdiction within the law as regards the prisoner, the cr
the sentence. In most cases, therefore, the virtual protect
accused person against illegality is the judge advocate
who personally advises the queen and the military authori
the law shall be complied with. As a privy councillor and
of the House of Commons that officer is responsible bot
queen and to parliament for the right and due administ
military law; and, notwithstanding his want of direct e
authority, it is not to be contemplated that any militar
would hesitate to act upon advice given by him with refer

estion connected with a court martial. The department of
ge advocate general consists of the judge advocate general,
a lawyer, a privy councillor, and a member of parliament,
manent deputy judge advocate general who is also a lawyer,
three military officers as deputy judge advocates having
xperience in the working of military law.
rmy Act applies to European officers and soldiers serving in
the same manner as to the rest of the army, but natives
are governed by their own Articles of War, and in the case
offences they are dealt with according to the provisions of
ian penal code. The department of the judge advocate
n India is distinct from and independent of that of the
vocate general of the army, and courts martial held in that
are not subject to the supervision of a professional lawyer
prominent irregularities led to the appointment of a
as judge advocate general in India in 1869, but after a few
at appointment again became filled by a military officer.
of the department is, however, far more numerous in India
ewhere. There are judge advocates general for each of
idencies, and a deputy judge advocate at each of the more
nt military centres.

ics of Crime in the Army.—Commissioned officers are
bjected to trial by court martial. Where an officer com-
self in a military sense, and his misconduct is too serious
ssed over merely with a mark of official displeasure, he is
given and seldom fails to accept the alternative of resigning
mission. In some instances the crown is advised to exercise
gative and remove him from the army on the ground that
sty has no further occasion for his services. In no circum-
an an officer or soldier claim a court martial as a right.
sult, the annual number of trials of officers does not average
n four of late years. Among the non-commissioned officers
iers of the army, however, the trials and summary punish-
y commanding officers are exceedingly numerous, as will
y be seen. In India this observation hardly holds good, for
ountry desertion is physically almost impossible except at
or three seaports where troops are stationed. Absence
leave is for a similar reason of rare occurrence, while the
he troops living in their own cantonments, and being free
ny temptations of life existing in the large towns and garri-
home, places them outside the influence of certain prevalent
f crime. For this reason mainly the proportion of courts
held in 1881 was 107 per 1000 men at home as compared
abroad. Similarly the proportion of minor punishments
was 1449 at home to 1042 abroad. It is also generally
at men engaged upon active service in the field commit
e than those serving in ordinary circumstances. But the
riminal statistics of the army for 1881 show a formidable
of crime and punishment. Upon an average strength of
non-commissioned officers and men there were 16,523 courts
of which 179 were general, 8549 district, and 7795 regi-
ourts. There were also 224,681 minor punishments by com-
officers, including 44,108 fines for drunkenness. These
enerally show an increase of crime as compared with the
s immediately preceding, but these two exhibited a decrease
revious years. Of the offences tried by court martial in
following were the principal: mutiny 7, desertion 1597,
in relation to enlistment (fraudulently enlisting while
belonging to the service or making false answers upon
on) 1190, violence to and disobedience of superiors 1650,
subordination and neglect of orders 1472, quitting or sleep-
ost 681, drunkenness on duty 2661, drunkenness (tried by
artial when the offence has been committed on a fifth
within twelve months) 2147, disgraceful conduct of various
0, absence without leave not amounting to desertion 3293,
away with or losing by neglect equipment or necessaries,
d miscellaneous offences chiefly of an ordinary criminal
r or to the prejudice of discipline 4181. Upon the 16,523
ere were 349 findings of acquittal. Regarding the punish-
warded, it appears that no soldier was sentenced to death
the year, and the other awards were as follows:—penal
e 101, imprisonment with or without hard labour (almost
ly the former) 12,125, discharge with ignominy without
nishment 42, stoppages of pay without other punishment
ging (before the abolition of that punishment by the Act of
5, and the new summary punishment (authorized as a sub-
for flogging) 3. Of the non-commissioned officers 3228
nished by reduction to a lower grade or to the ranks, while
re suffered imprisonment in addition to loss of grade, the
number being in the proportion of about 12 and the latter
cent. to strength. Of the men tried 305 were pardoned.

ary Law of other Countries.—The administration of military
other countries having large armies harmonizes in many
nt respects with that of England. In some indeed it is a
whether their systems are not superior and in advance.
ave a considerable body of "auditors" or military lawyers
pound the law and do much to secure a uniform and exact
administration of justice. Thus in Austria there are abou
hundred of these auditors, one being attached to each regimen
the same country there are also courts of appeal from the cou
first instance, these latter consisting of eight persons includi
auditor. Where the prisoner is a non-commissioned officer
private, that rank is represented on the court. Here als
confirmation of superior authority is required. In the G
army there are general and regimental courts. An auditor
is a lawyer is attached to each division, and it is his du
expound the law, collect the evidence, and read it to the
in the presence of the prisoner, who is asked if he has any th
say. The court consists of eleven members, of whom upon th
of a private soldier or non-commissioned officer three are
rank of the accused. The power of commanding officers in
to disciplinary punishments is greater than in the British
especially in relation to officers, who may be placed in arr
fourteen days. The non-commissioned officers and privates are
to extra guards, drills, fatigues, and different degrees of arrest
of a very severe character. Dismissal from the army, which
garded as a most severe punishment, involving civil disqu
often awarded. In Russia there are three kinds of military co
namely, the regimental court martial, the tribunals of m
districts, and the supreme tribunal at St Petersburg. The
permanent courts are attended by legal persons, and in c
instances have jurisdiction over the civil population as well
army. There is a judge advocate general at St Petersburg,
the supreme tribunal consists of general officers and high wa
functionaries who have studied military law or possess a
experience of it working. In Italy there are permanent m
tribunals for the trial of non-commissioned officers, and so
while special tribunals are appointed to try officers. The co
the absolute judges of the facts, but regarding legal ir
irregularities an appeal lies to the supreme war tribunal, whic
sists of four civilian judges and three general officers. The I
code corresponds in many respects with those of the other
Continental armies, but it tends rather to give individual c
large powers of imprisonment graduated according to them
The chief distinctive feature of the French system is the insti
of regiments of discipline for refractory characters. Whe
general officer's power of imprisonment (two months) is exh
the offender may be sent before a court of discipline and by
drafted into a *compagnie de discipline*; and cases of habitual m
duct are thus dealt with, the man being struck off the stren
his original corps and transferred to one in Algeria. The m
law of the United States is founded upon and proceeds much
the same lines as that of England. (J. C. C.)

MILITARY TACTICS. See WAR.

MILITIA. The militia of the United Kin
consists of a number of officers and men maintaine
the purpose of augmenting the military strength o
country in case of imminent national danger or
emergency. In such a contingency the whole or any
of the militia is liable, by proclamation of the sove
to be embodied, that is to say, placed on active mi
service within the confines of the United Kingdom
occasion for issuing the proclamation must be first
municated by message to parliament if it be then in se
if it be not sitting, parliament must be called tog
within ten days. For the purpose of keeping the fo
a condition of military efficiency, the officers and me
subjected to one preliminary training for a period
exceeding six (usually about two) months, and furth
an annual training not exceeding fifty six (usually tw
eight) days. The force is composed of corps of art
engineers, and infantry. Infantry militiamen are fo
into battalions constituting part of the territorial re
of the locality of which the regular forces are the
battalions. The officers and men when called out are
to duty with the regulars and in all respects as r
soldiers within the United Kingdom. Of late year
men have been raised exclusively by voluntary enlist
but where a sufficient number for any county or place
thus raised a ballot may be resorted to in order to com
the quota fixed by the queen in council for that coun
place. Each man is enlisted as a militiaman for the c
to serve in the territorial regiment or corps of the di
The period of engagement is not to exceed six year
during the last of these years a militiaman may
engaged for a further period also not exceeding six

ho illegally absent themselves are liable, in addition ishment for the offence, to make up for the time of bsence by a corresponding extension of their service. ficers are appointed and promoted by the crown, but ppointments are given to persons recommended by d lieutenant of the county who may be approved lling the prescribed conditions in respect of age, ditions and educational examinations. Since 1877 ers have been permanently subject to military law. neral body of the non-commissioned officers and men subject only when called out for training or embodi At other periods they have simply the legal status ilian, except as to their liability to trial and ment for offences in connexion with enlistment or litary offences committed while called out. Each tachment has a permanent staff, consisting of an t and a small body of non-commissioned officers and ers, to conduct the recruiting drills and ordinary of the corps, and the members of the permanent re always subject to military law. They mostly of non-commissioned officers who belong to or erved in the regular portion of the territorial rt. Many of the militia corps have their head s at the brigade depot or local establishment of the ial regiment, and all are under the general supervision (regular) colonel commanding the brigade depot. ea of service does not extend beyond the United om, but those who voluntarily offer to serve in the el Islands, the Isle of Man, Malta, or Gibraltar may loyed there. The uniform of the officers and men militia is precisely the same as that of the regular rth which they are associated, or rather of which m part, except that in addition to the regimental nishing mark they bear the letter "M" upon their nents, to denote that they belong to the militia of the corp

bove stated, the ranks of the militia are usually y voluntary enlistment; but by a statute which, temporarily suspended, can be put in force provi e made to filling up any deficiency in the allotted n any county, city, or riding by ballot of the male nts at within certain limits of age. The enactment s as follows:

cretary of state is to declare the number of militiamen to- whereupon the lord lieutenant is to cause meetings to be he lieutenancy for each subdivision. To these meetings the fficers of each parish are to send returns of all male persons the age of eighteen and thirty dwelling in their respective Before the ballot, however, the parish may supply volun ent up the quota, every volunteer so provided and approved y as if he were a balloted person. If a deficiency still e persons on the lists shall be balloted for, and deficiencies of those required to supply the deficiency shall be drawn ns present when drawn may claim exemption or and the deputy lieutenants settle the question of his liability Provided that those who are of the requisite (the age of 18½ to 21) be enrolled in the order in which ey are drawn until the quota is completed. If the list ntlemen to be balloted require another ballot in the same manner f their age, who become liable to serve may, provided they be within the requisite physical qualifi and be duly approved, offer to serve.

nder the general liability of the militia is contained s having an additional and important obligation in atter of service. It is called the "militia reserve," formed of men who voluntarily undertake a liability the regular force and serve in any place to which ay be ordered in case of the proclamation of a state ment national danger or great emergency. In this they are in fact upon the same footing as the army and on the occasion of the mobilization of 1878 an 20,000 of these men became part of the regular The present strength of the militia reserve is a little under 29,000 men, and judging by past exper may be computed that about 25,000 could be added to the ranks of an army in the field in the e national danger or emergency. It is to be observe ever, that every man thus added to the regulars w taken away from the effective strength of the militi

There is no statutory provision for the number to be maintained, that number being what from t time may be voted by parliament. The latest infor available respecting the actual condition of the mi Great Britain relates to the year 1881, and that of to 1880, the militia of the latter country for political reasons not having been called out for trai 1881 or 1882. Taking the militia of the United K in 1881, we find that the establishment provided 139,501, of whom 18,618 were artillery, 1317 en and 119,566 infantry. Divided into ranks, this es ment was made up of 3534 sergeants and 1260 drum the permanent staff and of the general body 3909 2520 sergeants, 5040 corporals, and 123,238 p The number actually enrolled was 127,868 of all leaving 11,633 wanting to complete. Of the enrolled 84,864 belonged to English, 14,138 to Scot 28,866 to Irish regiments, the numbers wanting to c being for England 7420, for Scotland 162, and for 1051. As the Irish regiments were not called o information regarding the actual effective condition force as shown at the annual training does not Ireland. With regard to the English regiments, were present out of an enrolled strength of 84,86 the absentees 3144 were with and 6775 without In the Scotch regiments, 12,101 appeared at the t and of the absentees 616 were with leave and 112 out. Of the total establishment (106,584) for Britain, 99,002 were enrolled, and of those enrolled presented themselves and 3760 were absent with le 7896 actual defaulters. Of the English regimen sixths and of the Scotch regiments two-thirds were the county to which their regiments respectively be Of 92,677 men (for Great Britain) whose occu are disclosed, 17,665 were artisans, 22,221 me labourers, 26,927 agricultural labourers, and 26,56 trades. Speaking approximately, more than one the men were between twenty and thirty years about 1 per cent. between seventeen and eighteen 9 per cent. between eighteen and nineteen, and a per cent. between nineteen and twenty, while some cent were over thirty years of age. More than the chest measurements inspected in 1881 were between 5 feet 5 inc 5 feet 7 inches in height, about 20 per cent. were feet 5 inches, while only 589 out of a total of 92,67 6 feet and upwards. At the date of inspection the 296 men in military confinement and 465 in the of the civil power. On the last occasion (1880) on the Irish militia were called out, upon an establi of 32,813 and an enrolled strength of 30,515 the present at the training was 26,399, leaving 706 abse and 2264 without leave. Regiments numbering aggregate 1146 men were not trained.

As distinguished from the regular forces or standing a militia has been described as the constitutional military for country, and its history justifies the description, at least recent period when it lost its distinctive character and bec great extent merged in the regular army. It is the old Britain possesses, and in fact represents the train bands English history. Its origin is to be found in the obligati freemen between certain ages to arm themselves for the pres of the peace within their respective counties, and generally protection of the kingdom from invasion. This obligation, in the first instance upon the individuals themselves, becam to the owners of land, who were compelled to keep up their tion of horses and armour for the national defence. The for

ıdor the lieutenant of the county, empowered in this respect mission from the crown. This prerogative of the sovereign, ad been in some instances a matter of controversy, was by statute shortly after the Restoration By the same he militia of each county was placed under the lieutenant, vested with the appointment of officers, but with a reserva he crown in the way of commissioning and dismissal. The the annual training for fourteen days fell upon the local y. Offences against discipline were dealt with by the civil ates, but with a power to the officers of fining and of ning in default. Upon this footing the militia of England d for nearly a century, with the general approval of the nity. It was recognized as an instrument for defence and preservation of internal order, while it was especially from the circumstance that from its constitution and ation the crown could not use it as a means of violating the tion or abridging the liberty of the subject It was con and regulated in the county; it was officered by the land and then relatives, its ranks were filled by men not depend- their subsistence or advancement upon the favour of the its numbers and maintenance were beyond the royal control, rnment was by statute While the supreme command was ly vested in the crown, every practical security was thu gainst its use by the crown for any object not constitutional nate. It was regarded as, and was, in fact, the army of the distinguished from the standing army, which was very much y of the king personally. The latter consisted of hired , and was more than once recruited by a conscription con owever, to persons of the vagrant class not having a lawful ment, while the former was mainly composed of those having abode and status The militia thus enjoyed for many years pared with the regular forces a moral as well as a concr l superiority. About the middle of the 18th century the was reconstituted, with certain modifications, not involving e of the principle of its local government, but strengthening at the supervising influence of the crown. Thus the king appointed the permanent staff, and was given a veto upon ointment and promotion of the officers, who were to have a y qualification. A quota was fixed for each county, to be y ballot of those between the ages of eighteen and forty-five rish having the option of supplying volunteers at its own d each man balloted being permitted in lieu of serving to to provide a substitute When called out for service the s to be the same as that of the regulars, and while embodied rbled for annual training the officers and men were placed he Mutiny Act and Articles of War, with, however, a proviso time of training no punishment was to extend to death or The crown was given the power to call out the militia in apprehended invasion or of rebellion, and associated with ular army, but only upon the condition of previously in parliament if then sitting, and if it were not sitting of parliament together for the purpose A further and im- security was established to prevent an unconstitutional use militia by the crown, the estimate for its training was framed ear, not by an executive minister of the sovereign, but by use of Commons itself. Upon the initiative of a committee House, an Act was passed providing for the pay and clothing militia for the year. Upon this footing substantially the of England remained for many years, the Irish and Scotch being meantime brought under the same conditions by enactments. The force was embodied on several occasions the last and in the early years of the present century, and ributed largely to the army engaged in the Peninsula From 1813 just 100,000 men, or two fifths of those raised for the came from the militia. In this way, however, it lost its tive character as a defensive force During the peace which d the final fall of Napoleon the militia was suffered to fall ay; and up to 1852 it had only a nominal existence in the of an effete permanent staff with no duties to perform In he militia was revived just in time to enable it to fulfil most e functions. In the war with Russia it was embodied and rrison duty not only in the United Kingdom but in the rranean garrisons, thus enabling the authorities to send most available regular troops to the scene of hostilities It further outed many officers and some 30,000 men to the line It yes annually about 8000 recruits to the regulars. During dian mutiny it filled scarcely less useful functions when called out. It has since then been regularly assembled for training; and when it is brigaded with the regular forces at hot and other camps of instruction its military aptitude and ney have generally elicited the surprised admiration of pro- al soldiers. In 1871 an important constitutional change was It was part of the new army system inaugurated in that at the control of the militia should be removed from the lord ant of the county and vested wholly in the crown. It has rtually ceased to exist as a distinct body, and is a part of gular forces with a limitation as to the time and area and other conditions of service. There is no longer a regim militia. The body that would formerly be thus described is collection of militiamen of a regiment largely composed of re The votes for the maintenance of the militia are now part army estimates The officers of the militia and the line are for duty with either force, and may sit upon courts martia ccasionately This practical amalgamation of the old constit force with the standing army may appear theoretically open objection that it is thereby placed under the direct control sovereign But the day has passed when such an objection have any value. The fact of the whole army being place ct, under the direct control of a minister responsible t to the crown but to parliament is enough to dissipate any e the [illegible] the head [illegible] onal militia that forms an effective force i Canada, which is organized as an efficient local army Government of the Dominion include a minister of milit defence The force is placed under the command of a officer, assisted by an adjutant general, belonging to the army and appointed by the go The training of the of matter of peculiar care, there being a military college at Ki several of the governing body and professors of which ar of the Royal Artillery and Royal Engineers, as well as sch gunnery and military For military purposes the Dom mapped out in twelve districts The militia is divided i active and the [illegible] ves, and the total inhabitants between t [illegible] eighteen and sixty, with the usual exceptions are li military service, the extent [illegible] vary with the age man, the largest amount of [illegible] ng upon the youth of active militia comprises 12 [illegible] of cavalry, 17 field garrison batteries of artille [illegible] a mountain battery, panies of engineers, 9 mounted [illegible] orps, 94 battalions of to 10 companies each and 16 independent companies of ri The uniforms is for the most part like that of the regular and the organization and general efficiency of the whole ha been very favourably reported upon Although the obliga the Canadian militia are purely local, a large number of occasion offered themselves for general service, and in th of a war on a large scale, it is believed that the force wou tribute a valuable addition to the fighting strength of the army [illegible] of C

MILK is the fluid secreted by the mammary gla the division of vertebrate animals called *Mammalia*. glands are in a rudimentary form in the Monotreme *Ornithorhynchus* there is no nipple, but the mou tongue are closely applied over the area on which th open, and the fluid is withdrawn by suction on the the young and compression of the gland by the In *Echidna* the ducts of the gland open into a small foreshadowing the larger pouches of marsupial Marsupials the glands are more compact, and have a number of lobules They are found behind the ma depressions or those of the pouch they are not few two on each side not more than thirteen six on ea and one midway. The duct, long and tender during tion, open on a nipple which is covered by a refle the skin at the back of the pouch, thus forming a h hood or sheath. The nipple is protruded beyond th during lactation, and is much elongated. The num these nipples bears a relation to the number of you birth; thus the kangaroo, with one at a birth, ha nipples (two, generally the anterior pair, being i whilst the Virginian opossum, which produces six at a birth, has thirteen nipples. Rodents show a sponding provision for the nourishment of the young number of nipples. A seeming exception is the g guinea pig, which frequently has eight, ten, or twelve at intervals of two or three months, and yet the has only two teats to serve them, turn and turn the original stock of the domestic species breeds, ha only once annually, and has but one to two young, domestic variety is a curious anomaly due to the a circumstances of its life In the porcupine there nipples, one midway between the fore and hind leg, a other midway between this and the base of the t In the coypu, a creature often carrying its young back, whilst it swims across rivers, the teats project the flanks near the shoulders, and are of considerable

the young readily reach them. The *Insectivora* s a rule, more nipples than are found in any other Thus in the tenrec (*Centetes*) there are as many as two, and they are rarely fewer than fourteen, out in pairs from the pectoral to the inguinal . There are ten teat in the common hedgehog, six in moles and shrews, two in both and armadillos. there are two long, narrow, flat glands lying the dermal and abdominal muscles, with the sub one blubber separates them from the skin. The ity of the arrangement in these animals, where is performed under water, is the large size of the duct, which acts as a kind of reservoir, so that the may obtain a considerable supply in a very short It would appear also that when suckling takes place of the young above the surface of the water. Ruminants, in the elephant the glands and teats are the fore legs, in the rhinoceros they are inguinal; mare and ass the glands are two in number, and are between the thighs, about 9 inches in front of the the tapir has two inguinal nipples, the peccary trial and two inguinal, the wild sow eight nipples, the domestic breeds there are at least ten, extend the pectoral to the inguinal regions. Ruminants glands aggregated into a round mass in the region, pendulous in full function, divisible into ds, each of which has a large reservoir. When in teats, one pair or two pairs being the number, in on with the reservoirs become so large as to receive al name of "udder." All the deer tribe, camels, affe, and all kinds of cows have four teats; most s and the gazelles have two teats, whilst a few s have four. As to *Carnivora*, the felines have six nipples; the wolf, jackal, fox, dog have usually the seals and the walrus have four, the otters e weasels six, the bears six; and in the kinkajou *ota*) the number is reduced to two. Amongst *mata*, the aye-aye (*Chiromys*) has only one pair of about an inch and a half in front of the vulva; emurs have in addition to these a pectoral pair, in platyrhine and catarhine *Quadrumana* there is only of glands, restricted to the pectoral region. Here are between the fore legs, and the young cling to her breast in human fashion, but there is no protu the breast as in the human being. (For further see Owen's *Anatomy of Vertebrates*, vol. iii. p. 769.) e human race the glands are two in number, form ne with the skin and fat, two rounded eminences, ach side, on the front of the thorax. They extend e third to the sixth or seventh rib, and from the the sternum to the axilla. In the centre projects conical body, the *nipple*. Around the nipple is a circle, or *areola*, which is darker during pregnancy, women who have borne children than in the state. The surface of the nipple is wrinkled, and a magnifying glass is seen to be covered wi . It is perforated by numerous openings, the mouths milk ducts. The tissue of the nipple contains ous minute blood vessels, and it has at the base ar fibres arranged in concentric circles and in er bands. It has much of the character of erectile as in the *corpora cavernosa* of the penis, becoming firm, and prominent from excitement. The base gland lies on the pectoral muscle, a thin layer of intervening. The surface is covered with fat, which the smooth rounded outline. It is amply supplied ood by the long thoracic artery, some other minute s of the axillary artery, the internal intercostal and the subjacent intercostals. The nerves come e anterior and middle intercostal cutaneous branches, and the nipple is especially sensitive. The gland is posed of numerous lobes bound together by connective adipose tissue, and each lobe is formed of smaller lob Each lobe has an excretory duct, and these ducts, fifteen to twenty in number, converge towards the ar beneath which they are dilated so as to form sinuses $\frac{1}{6}$th to $\frac{1}{4}$th of an inch in calibre. From these sinuses the ducts which open on the surface of the nipple. general structure will be understood by referring to accompanying figures, along with the description.

FIG. 1.—Half diagrammatic view of a section through a lobule of the mammary gland, after Kölliker (*Atlas of Histology*, plate xl. fig 1), magnified 60 diameters. *a*, duct dividing into two branches; *b*, *b*, *b*, connective tissue passing between the ultimate pouches of the gland; *c*, *c*, pouches or alveoli of the gland, the dots representing the cells lining the

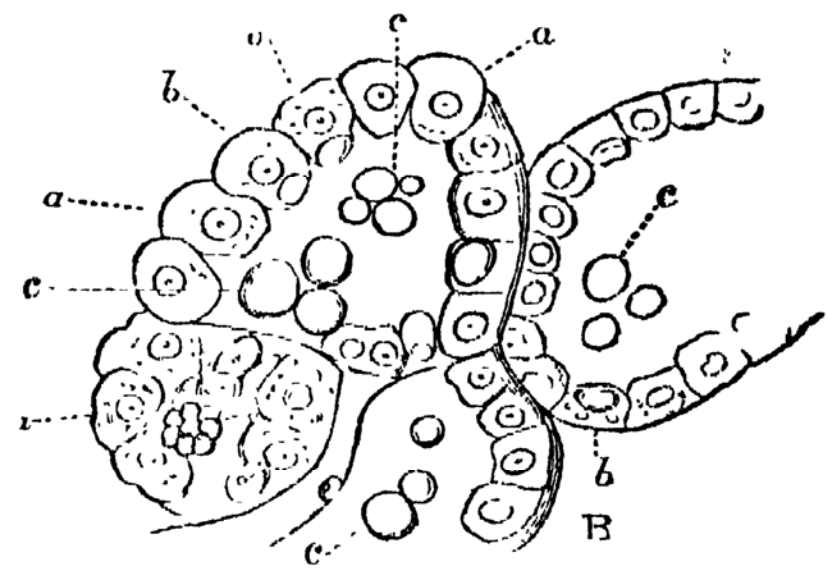


FIG. 2.—A portion of the same gland, magnified about 400 diameters, showi complete and i omplete alveoli. *a*, *a*, *a*, short, columnar, epithelial lining the alveo ch having an oval or rounded nucleus; *b*, *b*, *b*, epit cells; *c*, *c*, the interior of the alveolus, *a* milk globule; *c*, *c*, *c*, globules which have been set free from epithelial cells.

When a duct is traced into the gland, it is found to divide into smaller ducts, and these into still smaller, the smallest ductlet is reached, round the end of whic clustered several *alveoli* or pouches. Each alveolus a wall, lined with epithelium cells. In the wall of alveolus there are capillary blood-vessels which brin blood near the cells. By this blood the cells are nouri There is a minute cavity in the centre of each alveolus which cells or their products can accumulate. There be no doubt that the formation of the milk globule place in these cells. Whilst milk is not being forme cells have a granular appearance, and the lumen or ce cavity of the alveolus is small; but during secretio cavity is enlarged and shows a few milk globules, v one or more milk globules can be seen in the interi the cell. If the milk globule in the cell be very large nucleus of the cell is pressed outwards and the protop of the cell is reduced to a thin covering, over the glo at this stage presenting a striking resemblance to cell containing an oil globule. Thus each milk glob formed in the protoplasm of the epithelium cell, and at an early stage each milk globule consists of a m drop of fat or oil surrounded by a thin albuminous env It has not been clearly ascertained whether epithelial after having secreted milk globules, degenerate and off, or whether they have the power of ejecting the globules. The fluid constituents of milk (water, ho

in solution) may be separated from the blood by a
of filtration under blood pressure, as is the case in
secretory processes. The origin of the sugar of milk
f the casein is unknown. (For a description of the
e structure of the
gland, see Klein's
of Histology, p.
and references.)
he beginning of
ion the milk is
large irregularly-
decorpuscles (fig. 3,
) called *colostrum*
scles. These are
actile bodies, slow-
anging their form
squeezing out the
articles. At first
are the only bodi
nt, but they are soon replaced by the ordinary milk

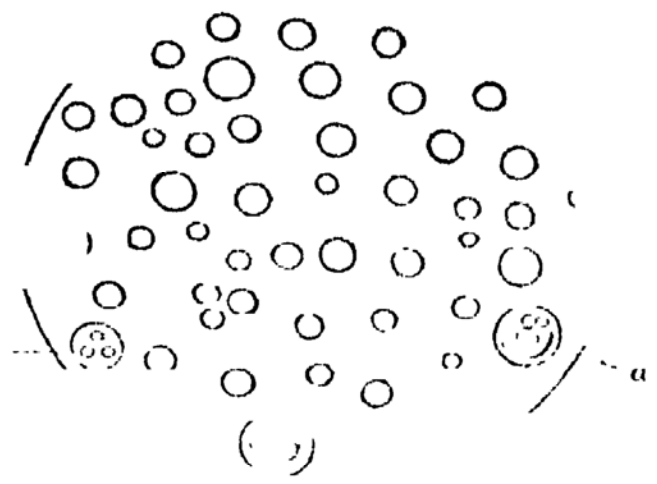


Fig. —A drop of milk

les. Such globules have bright refractive edges,
urface is smooth, they vary in size from $\frac{1}{1000}$th to
,
of fatty matter surrounded by a layer of albumen
herson's membrane").
secretion of milk takes place in newly born children,
the fourth to the eighth day, and also in rare cases
n (Hermann's *Physiology*, p. 158). During
human being the mammary glands increase in
diately after the birth of the child active secretion
ences; and usually it is on the stoppage of the secre
ten months afterwards, that the process of menstrua-
which has been arrested by impregnation, again is
blished.
secretion of milk is undoubtedly affected by the
us system, as is shown by fear or mental distress
ing or injuring the quality of the secretion, and by the
" or feeling of fulness in the breast experienced by
other when the child's mouth touches the nipple, or
when she sees her offspring. The nervous mechanism,
ver, is unknown, as it has been observed that secretion
continue even after section of all the nerves known to
to the gland. The nature of the diet has a marked
nce on the quality of the secretion. Thus the
nt of casein and of fat is greater during an animal
during a vegetable diet. Fatty foods do not seem to
se the amount of fat or butter; an ample supply of
-hydrates (starches and sugars) increases the amount
gar. These facts indicate that most if not all of the
ituents of milk are formed from changes in the pro-
sm of the epithelial cells. In some women the milk
ficient in fat and casein, and consequently is less
tious. Prolonged lactation diminishes the amount of
d sugar without materially affecting the amount of
ninous matter; but the milk is less nutritious and is
for the child. The occurrence of menstruation during
ion also deteriorates the milk. (J. C. M.)

Milk as Food.

e milk of various domesticated animals is more or less
by man for food. The milk of the cow, which may
ken as typical of all others, and is indeed by far the
important and valuable of all, is, when newly drawn,
aque white fluid, with a yellowish tinge, soft, bland,
weetish to the taste, and possessed of a faintly animal
r. This odour, according to Schreiner, is due to the
nce of sulphuretted hydrogen, and disappears after a
exposure. The specific gravity of milk ordinarily
s from 1·029 to 1·033, very seldom reaching 1·035 or
g so low as 1·027. In chemical constitution it con-
sists of an emulsion of fatty globules (cream) in a
alkaline solution of casein, and a variety of sugar, p
to milk, called lactose. The fat (which when separa
know as butter) and the lactose constitute the carbon
portion of the milk regarded as food. The casein,
forms the principal constituent of cheese, and a
proportion of albumen which is present, form the
genous, while the complex saline substances and
are the mineral constituents. These various substan
present in the proportions which render milk a perfe
typical food suitable to the wants of the young
various animals for whom it is provided by nature
milk of all animals, so far as is known, contains
although they are present in somewhat different
tions. It is probable that the milk of ruminants p
certain physical and physiological distinctions from
non-ruminant animals, which will account for the
attributed to the milk of the ass and mare. The fol
table exhibits the chemical constitution of the ki
milk most frequently used by man:

	Ass					
Water	86·57	87·00	84·44	83·70	90·310	91·65
Fat	3·50	1·00	6·11	4·45	1·955	0·11
Casein and albumin	1·75	1·10	3·94	5·16	1·953	1·82
Sugar	4·00	4·08	4·68	5·73	6·285	6·08
Ash			0·79	0·96	0·369	0·34

In addition to these constituents milk contains sm
portions of the gases carbonic acid, sulphuretted hy
nitrogen, and oxygen, and minute quantities of oth
ciples, the constant presence and essential condi
which have not been determined. These consist of g
and lactochrome, substances peculiar to milk, disc
by Winter Blyth, with certain animal principles s
leucin, pepton, kreatin, tyrosin, &c. The salts i
consist, according to the average of numerous anal
Fleischmann, of the following constituents:—

Phosphoric acid	28·31	Potash	
Chlorine	16·34	Magnesia	
Lime	27·00	Ferric oxide	
Soda	10·00		

Milk thus is not to be regarded as a definite c
compound nor even as a mixture of bodies in fix
invariable proportions. Not only does the milk of d
races and breed of cow vary within comparatively
limits, the milk of the same animal is subject to ex
fluctuation. The principal causes of variation
individual are age, period of lactation, nature and
of food, state of health, and treatment, such as fre
of milking, &c. The following table indicates the
of normal variation —

Water	90·00 to 8
Fat	2·80 ,,
Casein and albumin	3·30 ,,
Sugar	3·00 ,,
Ash	0·70 ,,

The average quantity of milk yielded by cows
highly variable, both in individuals and breed
rule the smaller breeds of cows yield a small am
milk rich in cream (butter fat), while the yield
larger breed is greater in quantity, but compa
deficient in cream. A good milch cow should
a milk-giving period of from eight to nine month

[1] Ewe's milk is exceedingly variable, especially in its perc
fat. The above analysis is one of nine by Dr Voelcker,
the fat was found to range from about 2 to 12¾ per cent.

llons of milk, from which nearly 500 lb of cheese lb of butter would be obtainable.

y Treatment. Cows are commonly milked by hand three times a day. A milking machine of American which was introduced about the year 1862, has been y abandoned. The milk should be drawn from the s in as clean a condition as possible, but notwithg every precaution some amount of hair and nd and other animal debris invariably enters the ilk. It has therefore to be immediately strained h a sieve with fine wire cloth or hair strainer. As peculiarly susceptible of taint, and absorb odours lked with great avidity, it is of the utmost con e that all vessels in which it is placed or kept be so made as to be easily purified and that ould be kept scrupulously clean. In Switzerland strained with most beneficial effect through sprigs ed fir tops, which inserted loosely and uprightly e hole of a funnel arrest all hair, skin, clots, and matter on the acicular leaves. The milk drains n in a clean condition with a fresh slightly ized flavour favourable to its keeping. A fresh n used on each occasion of straining milk, so that freedom from the risk of taint which arises through of imperfectly cleaned wire gauze. The milk must oved from the cow house as quickly as possible; intended for use as new milk and for sale in the rthood of the dairy, it may at once be put up for . But if it has to travel a distance, or if it is to for creaming or cheese making, it should be rapidly lown, and kept in a cool airy milk room if practi surrounded with fresh cold water.

ordinary method of separating cream either for se or for butter making is by allowing it to form surface and skimming it off with a broad flat spoon; enous adaptations of centrifugal machines of Laval's separator is one of the best known, have troduced for the purpose of effecting the rapid and e separation of the cream. The centrifugal force machines throws the denser portions of the fluid s the side of a rapidly revolving cylinder, collecting am on an inner layer, which is carried off by one while the impoverished milk escapes by another. val separator gives a very rich cream, as will be seen e following analyses by Voelcker:

	Ordinary Cream	Cream by Separator	Skimmed Milk by Usual Separator	Ordinary Skimmed Milk
	77·30	66·12	90·82	90·55
ter	15·45	27·69	0·31	1·12
	3·40	2·69	3·31	3·09
ein	3·15	3·03	4·77	5·16
d matter	0·70	0·47	0·79	0·08

e being kept some time, depending principally on perature at which it is maintained, milk begins to sour owing to the formation of lactic acid, by a of fermentation, at the expense of the lactose or ugar. The acid so developed causes a coagulation casein, and the milk separates into a solid white nd a thin translucent yellow milk serum or whey. hanges can to a certain extent be artificially prehindered, and controlled. The following are the of analyses by Fleischmann.

Constituents of 100 Parts of Sour Milk.

100 cream	23·50	butter
	16·50	buttermilk.
100 skimmed milk	71·40	curd
	0·32	whey.
100 loss	0·30	loss.

Relative Composition of Milk and its Products.

	Water	Fat.	Casein	Albumin.	Milk Sugar
Whole milk	87·60	3·98	3·02	0·40	4·30
Cream	77·30	15·45	3·20	0·20	3·15
Skim-milk	90·34	1·00	2·87	0·45	4·63
Butter	14·89	82·02	1·97	0·28	0·28
Buttermilk	91·00	0·80	3·50	0·20	3·80
Curd	59·30	6·43	24·22	3·53	5·01
Whey	94·00	0·35	0·40	0·40	4·55

The simplest and most advantageous form in milk can be disposed of as a commercial product is sale as sweet or new milk, and it is in this mann the greater proportion of the milk produced with reach of large centres of population is disposed of. milk, cream, and skimmed milk are the only primary in which milk is sent into the market. CHEE BUTTER have been dealt with in separate articles Whey, the yellow liquid remaining after the separa the curd in cheese making, is a source of milk employed to a limited extent in pharmacy; but it equally used for feeding pigs. The buttermilk wh mains after separating butter is a most wholeson nutritious article of food.

Preservation of Milk. The numerous methods which ha proposed for the preservation of milk in a condition fit for a lengthened period resolve themselves into (1) chemical tr with alkaline salts and antiseptic bodies, (2) physical tre such as cooling or prolonged boiling, and aeration, and (3) combi with or without the addition of a preservative agent. All of preservation, however, are subject to serious disadvantag from their serving their purpose for too limited a time, interfering with the natural constitution and properties milk. Of all preservatives cold is the most efficient a objectionable. It has been shown by Soxhlet (*Dingler's Journal*, ccxxiii. 329) that milk cooled by ice-water remai and unaltered for fourteen days, but after that time ac tained taste. After twenty-eight days it coagulates on owing to the presence of acids resulting from the oxidation cream, and in thirty four days it coagulates even in the ic It is also found that milk which has undergone aerati atmospheric air has its keeping properties much improve aeration is effected by allowing the milk to fall from som in a state of fine division by passing it through the mes sieve. By another method air cooled by passing over ice through the milk.

Milk keeps sweet for a longer time when boiled, but th ties, and other properties are affected, partly owing to th of gases mixed with it when fresh. The unpleasant flavo communicated by boiling can be avoided if the action takes p closed vessel and the milk is immediately cooled dow refrigerator connected therewith. In the case of any susp taint in milk either from disease in the cow, contaminat milk by persons, or the use of infected water in cleaning boiling is also strongly to be recommended, as it eff destroys the germs of disease, in the carrying and spre which milk is a most active agent. It is with the utmost that boiled milk can be coagulated by means of rennet; treatment with acid it coagulates more rapidly and freely unboiled.

Of the various chemical compounds which have been su and more or less used for preserving milk, the most su butter has been salicylic acid, which has the advantage tasteless and inodorous. By briskly stirring in rather less grains to a pint of milk, it can be kept liquid and sweet in perature of from 60 to 65° Fahr. for twelve hours, and at 5 for a whole day. If 4 grains be used to a pint, coagulatio higher temperature is delayed from two or three days, an lower temperature the milk may be kept good from three to fi Boracic acid and borax are also employed by dairymen, th being known as giraldine salt. The presence of any chemi septic in milk is, however, at best a matter of doubtful adv

Condensation.—Milk is now treated on a large scale by a of concentration, the product of which comes into the m two forms, as "plain condensed milk" and as "preserve The credit of originating the industry is due to Mr Gail B White Plains, New York, who began his experiments abo In 1851 he introduced his plain condensed milk, which i milk from which between three-fourths and four-fifths of th has been removed, and in 1861 he rendered important ser the army in the field by supplying preserved milk which

milk similarly concentrated, with a proportion of sugar and hermetically sealed in tin cans. The manufacture was anted to Switzerland in 1865, after which condensing es were established in England, Ireland, Denmark, Bavaria, y, and elsewhere. With the introduction of the condensing here has also been associated the factory system of dealing ary products, by which the milk of many dairies is carried centre and dealt with either for condensing or for cheese or making. The following epitome of the process of condens ilk is from a paper by Mr Willard of Cornell university, ork (*Journ. Roy. Agric. Soc.*, 2d series, vol. viii., 1872) nilk when received at the factory is first passed, he says, ugh a strainer to the receiving vat; from this it is conducted ing through another strainer into the heating cans, each g about 20 gallons; these cans are set in hot water, and the held in them till it reaches a temperature of 150° to 170° it then goes through another strainer into a large vat, at ttom of which is a coil of copper pipe, through which steam duced, and here the milk is heated up to the boiling point the best quality of white granulated sugar is added, in the tion of 1½ lb of sugar to the gallon of milk, when it is drawn e vacuum pan having a capacity of condensing 3000 quarts e at a time. The milk remains in the vacuum tel n for about three hours, during which time al pr bulk in water is removed, when it is drawn n g 40 quarts each. The cans are only partially filled, and are et in a large vat containing cold water, the water being of a equal to that of the milk in the can. Here it is stirred he temperature of the condensed fluid is reduced to a little 70°, it is then turned into large drawing-cans with faucets, r to facilitate the filling of the small cans, holding ch, which are immediately soldered to exclude the air."

he case of plain condensed milk the concentration is usual l farther than is practised in preparing the preserved milk, it evaporated down to between one-fourth and one fifth of the l bulk. It is not put up in sealed tins, being intended for diate use, and keeps sweet only for a few days, varying with ate of the weather, whereas the sugared milk will keep for years. The large amount, however, of cane-sugar added served milk seriously disturbs its balance of proportions as a food, and renders it unfit to be used alone in a dilute state ubstitute for mother's milk by infants, a purpose for which it ely employed. It should also be observed that the relative rtion of fat is small, the milk being partially skimmed before erated on, so that the statement that preserved milk diluted a small proportion of water is equal to cream is not to be on. Preserved milk, rich in cream, has always a more or ened only taste, and cannot be obtained so sweet and even in r as that largely deprived of fat. According to a German of E. Klebs in Prague, plain condensed milk may be ved by adding to every 100 litres of the original milk a on of 50 grains of benzoate of magnesium in one litre of

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lteration. Practically the invariable mode of sophisticating for sale consists in the addition of water and in the subtraction of cream, in other words, passing off skimmed or partly ed as new milk. Now and again there are found certain refinements on these simple frauds, such as adding a quantity gar to correct the specific gravity, flour or starch to increase y, and a touch of colouring matter to cover the bluish tinge would betray skimmed milk. In the United Kingdom no l standard of what constitutes pure milk has been promul but the so-called Somerset House standard has been ally recognized in law courts. According to this, new milk l contain as a minimum of solids not fat 8·5 per cent. and of 5 per cent., and of water a maximum of 88·9 per cent. The satisfactory manner of discovering the probable genuineness ample of milk is by chemical analysis carried sufficiently far termine the amount of fat and of other solids present. erous attempts have been made to place in the hands of dairy-dealers, and consumers of milk a trustworthy method of ting the condition and value of the article by simple itive tests for cream or fat—at once the most valuable con nt and one the presence of which in average proportion is ative of the quality of the whole. The simplest but at the time the least trustworthy and efficient method is by means e so-called "creammeter," which consists merely of a ated glass tube in which a measured amount of milk is placed he amount of cream it throws up is read off by means of the

Specific gravity determinations have by themselves no icance, seeing milk deprived of its cream can by dilution with be brought to correspond exactly with the original milk. by a combination of two methods,—first taking the specific ty, next observing the yield of cream by the "creammeter," finally taking the specific gravity of the milk deprived of , regard being had to the temperature of the milk in these vations, an approximately accurate idea of the value of a sample may be obtained. Among so-called "lactoscopic operations of which are based on the fact that milk rich is a much more opaque fluid than that from which cream taken or to which water is added, that invented by Feser of Munich is one of the simplest and most useful. sists of a glass tube open at the upper end and attenuated lower extremity. Into this narrower portion is fused cylindrical rod of opaque milk glass on which black marked. These lines are invisible when the lower portion tube is filled with a measured quantity of milk, but on add water they become visible. When the black lines become ual admixture of water perfectly distinct, the richness k in cream globules is indicated by the height to which mixture of milk and water has risen in the wide portion tube, which has engraved on it a scale showing on one amount of water added and on the other the proportion equivalent to the transparency resulting from such addition

Statistics. In the year 1878 it was calculated by Mr J. C that the total yield of milk from the 2,250,000 cows and in milk or in calf in England and Scotland amounted 1,000,000,000 gallons yearly. He assumed that about one that quantity (167,000,000 gallons) went to feed calves, a the daily consumption of the population was 1,000,000 being rather more than a quarter of a pint per head, which for 365,000,000 full leaving 165,000,000 gallons to be butter and cheese making. Two thirds of this quan 318,000,000 gallons Mr Morton assumed was used for cheese- yielding 2,800,000 cwts. of cheese (rather less than 1 lb pe of milk), and the remainder, 150,000,000 gallons of milk de butter-making would yield 350,000 lb of butter, or 1 lb for every 21 pints of milk. In these figures no account is Ireland, whence at that period there were sent to Englan yearly 3,500,000 lb of salted butter. In June 1882 the nu cows and heifers in milk and in calf in Great Britain did greatly from the number on which Mr Morton's estimate was based, being 2,267,175, whilst in Ireland the num 1,398,965, making the total for the United Kingdom 3, If we take approximately Mr Morton's data as the basis dom would yield, at 440 gallons per head, 1,620,219,48 of milk. Further assuming that one sixth of this is by calves, one-third consumed by population, one-third cheese making, and one-sixth used for butter making, we the yield of cheese 4,540,000 cwt. and as the yield 929,000 cwt. As Ireland is much more a butter produci cheese-yielding country, the quantity of cheese made is overestimated in these figures, and the amount of butter correspondingly understated. To bring out the consum dairy products for the year the following imports must be

	cwts	
Cheese	1,692,196	44
Butter (including butter-me)	2,192,178	11,

Thus we find the total supply of cheese to the United in 1882 was 6,538,195 cwt., and of butter the supply was ewts. Estimating the home produce of both articles at value as the imports, the cheese supply cost £18,320, the butter £16,150,000. Adding to the the probable c milk consumed as such (say 350,000,000 gallons at 1s p £7,500,000), we have for the year 1882 in round £42,000,000 expended on dairy produce within the United K

The total number of milch cows at present (1883) in th States is stated at 15,000,000, which, taking the 440 gallo yield annually 6,600,000,000 gallons, or nearly 30,000,000 milk. In America the factory system of treating milk has much greater dimensions than in Europe, and that perf treatment, combined with the cheapness of raising and feed enables the American companies to enter the European with large quantities of cheese and other dairy products of good quality which find a ready and remunerative sale.

Koumiss. Under this name is properly understood a drink prepared from mare's milk by the Tartar tribes of th empire and by the nomad races of the northern part It is made by mixing mare's milk with about one six quantity of water, and adding as a ferment about part of very sour milk or of old koumiss. This mixture in a wooden vessel which is covered over with a thick cl left for about twenty-four hours in a moderately warm During that time a thick coagulum rises to the surface, thoroughly incorporated by churning. After standing fo day, the whole mass is again thoroughly churned and m and in this state it forms new koumiss, having an agreeabl taste. The liquor is mostly stored and preserved by the skin bottles, in which the fermentation continues, develo alcoholic qualities, and mellowing and improving its taste. Tartar koumiss has the following composition:—alcohol 3

·19, sugar 2·10, albuminoids 1·86, fat 1·78, salts 0·509, ic acid 0·177, and water 93·46. A distilled spirit is prepared koumiss, which is drunk among the Tartars under the name ca or arsa. Koumiss has of late years come into prominent as a remedial agent in cases of pulmonary consumption, and lly as a nutritious form of food easily assimilated by delicate ons. It is probable that all its virtues reside in the original om which it is prepared, in which case the koumiss can only ended as valuable principally for the convenient form under the essential properties of the milk can be preserved for use. the name of koumiss a preparation of cow's milk is now very ally s quart of new milk a table-spoonful of sugar or honey and brewer's yeast, allowing mentation to proceed a sufficient length then bottling and es in the case of effervescing cider. Such a preparation con- thout the sour alcohol of genuine koumiss, but alcoholic va formed, made by a process of l fermentation, which continues after bottling develops e amount of carbonic acid and renders the liquor highly sparkling

LL, James (1773–1836), historian and political and al philosopher, was born 6th April 1773, in the village called Northwater Bridge (Bridge of North in the parish of Logie Pert, in the county of Forfar. father, James Mill, was a shoemaker; his mother, l Fenton, belonged to a race of respectable farmers. father was industrious, good natured, and pious, but known as specially intelligent. The mother was of a disposition, and resolved to educate James, her eldest or a superior destiny. He began his education at arish school, and went on to the Montrose Academy, he remained till the unusual age of seventeen and a when he went to the college of Edinburgh (1790). rding to the usage of the time and neighbourhood, he to have been sent about thirteen or fourteen to chal College, Aberdeen. His remaining so long at Montrose Academy, and his going to Edinburgh for niversity course, must be connected with his being up by Sir John and Lady Jane Stuart of Fettercairn, engaged him to be tutor to their only daughter. n for having inspired the affection of Sir Walter , and for being the mother of Principal James David . Sir John and Lady Jane Stuart contracted a attachment for Mill, which lasted throughout their At Edinburgh University Mill was distinguished as eek scholar. But he received his greatest impulse Dugald Stewart, for whom he always expressed unbounded admiration. In October 1798 he was licensed preacher, but seems to have preached very seldom ean, from 1790 to 1802, besides being occupied with ant studies extending into history and moral and cal philosophy, were devoted to various tutorships ding to find a career to his mind in Scotland, in 1802 ent to London in company with Sir John Stuart, member of parliament for Kincardineshire. He soon ted literary occupation, to which he applied himself untiring energy. His first important venture was to a periodical on a new plan, entitled *The Literary al*, which began to appear in January 1803, and nued under his editorship till the end of 1806. It the most comprehensive in its aims of any periodical erto in existence, being a summary view of all the ng departments of human knowledge. Thomas nson, the chemist, took charge of science; and many men of ability co-operated. Mill himself wrote ly in biography, history, political philosophy, political omy, and also in theology, on which his views at the were broad without being sceptical. The publisher e journal was Baldwin, who was also the proprietor e *St James's Chronicle*, a Conservative paper appear- three times a week. For two or three years, from onwards, Mill was editor, but at last gave it up, y on conscientious grounds, although in conducting it he never lent himself to the expression of any ill views, but often made it the vehicle of the opposite.

In 1801 he wrote a pamphlet on the *Corn T* advocating the impolicy of a bounty on the exportat grain. This was the beginning of his career as a po economist. In 1805 he published a translation of Vi work on the *Reformation*, an unsparing exposure vices of the papal system. He added notes and quot by way of confirmation of the author's views. O subject also he continued to hold strong opinions all th life, and often recurred to it in his articles in the re In 1805 he married Harriet Burrow, whose moth widow, kept an establishment for lunatics in Hoxton. then took a house in Rodney Street, Pentonville, whe eldest son, John Stuart, was born in 1806. It was the end of 1806 that he entered upon the composit the *History of India*, which he expected to finish in or four years. He was actually engaged upon it for t giving, however, a considerable portion of his time to writing for the support of his family. The strain up energies for the years was enormous.

He became acquainted with Jeremy Bentham in and was for many years Bentham's chief companio ally. In B Bentham, to have Mill nearer him, him Milton's house, which adjoined his own, and w property. After a few months' trial Mill had to gi this house on account of his wife's health, and went n Newington Green; but in 1814 Bentham leas house No. 1 Queen's Square, now 40 Queen Anne's close to his own garden, and gave it to Mill at a re rent, here he remained till 1831. The intimacy Bentham was rendered still closer. For four years 1811 to 1817, Bentham was at Ford Abbey, near C in Somersetshire, and there Mill and his family domesticated with him nine or ten months each yea which retirement it is probable that Mill was a accelerate the completion of his history.

In the twelve years between 1806 and 1818 he w great many articles for various periodicals. Among were the *Anti-Jacobin Review*, the *British Review*, a *Eclectic Review*, but there is no means of tracing h tributions. In 1808 he began to write for the *Edi Review*, and contributed steadily till 1813, most of his a being known. In the *Annual Review* for 1808 two a of his are traced a "Review of Fox's History," a article on "Bentham's Law Reforms," probably h published notice of Bentham. The first known art the *Edinburgh* was on "Money and Exchange" (C 1808). In 1809 (January and July) he wrote a length on Spanish America and General Miranda whom he was on terms of intimate friendship. In th number he also wrote on China. In 1810 (April) he a severe attack on the East India Company. H wrote on the liberty of the press and on the Chu England in connexion with the Lancasterian schools was an active member of the committee for pro education on Lancaster's plan. In 1811 a periodical the *Philanthropist* was started by William Alle published in quarterly numbers till 1817. Mill co-op with Allen both in the writing and in the manag He contributed largely to every number,—his pr topics being education, freedom of the press, and discipline (under which he expounded Bentham's " ticon"). He made powerful onslaughts on the chu connexion with the Bell and Lancaster controvers 1814 Macvey Napier engaged him to contribute supplement to the fifth edition of the *Encycl Britannica*. Many of the articles became notable list included "Government," "Jurisprudence," "L of the Press." "Prisons and Prison Discipline," "C

of Nations," "Education," "Beggar," "Benefit
es," "Banks for Savings." In "Jurisprudence" and
ns" he was largely indebted to Bentham; in most
others he was either altogether or in great part
l. The article on "Government" will occupy a
ent position in English history.
818 was published the *History of India*, which had
and speedy success. It was the means of changing
hor's future position. The year following he was
ed an official in the India House, in the important
ment of the examiner of Indian correspondence.
dually rose in rank till he was appointed, in 1830,
the office. He introduced his eldest son into the
epartment in 1823.
824 Bentham projected the *Westminster Review*, and
as a principal writer for three years. Some of his
igorous writings are included among those contribu-
The first was an elaborate criticism of the *Edinburgh*
as a whole; it was followed by an onslaught on the
dy. Other articles dealt with English history and
ecclesiastical establishments, which he severely in-
. To a periodical of short duration, *The Par-
tary History and Review*, he contributed an elaborate
l retrospect of the parliament of 1820-26. In
ppeared the *Analysis of the Human Mind*. From
1833 he was largely occupied in the defence of the
dia Company during the controversy attending the
l of its charter, he being in virtue of his office the
man of the court of directors. In 1831 Sir William
orth projected the *London Review*, and Mill con-
d to it during the last two years of his life. His
otable article was one entitled "The Church and its
," which was much too sceptical for the time, and
the *Review*. His last published book was the
ent on Mackintosh, which appeared in 1835. He
the 23d June 1836.

nsiderable space would be required to do justice to Mill's
r—intellectual and moral—as shown both in his writings
his intensely active and influential career. He was an ex-
scholar, in the sense of knowing the Greek and Roman
His other accomplishments included general history, the
hy of politics in the most comprehensive acceptation, logic,
and mental philosophy. The type of his intellect was logi-
the highest degree; he was, above all things, clear and pre-
enemy of every form of looseness of reasoning, and a crusher
iling fallacies. This is the most notable feature in his
throughout. His was also an original mind. Except in a
jects, which had been so well elaborated by Bentham that
content to be little more than an expounder of Bentham's
he gave a fresh turn to whatever topic he took up. At a
en social subjects were subjected almost exclusively to an
al handling, he insisted on bringing first principles to bear
point; in this lay both his strength and his weakness.
greatest literary monument is the *History of India*. The
s for narrating the acquisition by England of its Indian
were put into shape for the first time; a vast body of political
was brought to bear on the delineation of the Hindu civiliza-
nd the conduct of the actors in the successive stages of the
t and administration of India was subjected to a severe
n. The work itself, and the author's official connexion with
or the last seventeen years of his life, effected a complete
in the whole system of governing that country.
played a great part as a politician and political philosopher
ish affairs as well. He was, more than any other man, the
of what was called philosophical radicalism. His writings
rnment and his personal influence among the Liberal party
of his time determined the change of view from the French
tion theories of the rights of man and the absolute equality
to the claiming of securities for good government through
extension of the electoral suffrage. Under this banner it
t the Reform Bill was fought and won.
work on *Political Economy* was intended as a text-book of
ject, and shows all the author's precision and lucidity. It
d up the views of Ricardo, with whom Mill was in habitual
y. It urged strongly the modern application of the prin-
population, and started the doctrine of taxing land for the
d increment of value.
his *Analysis of the Mind* and his *Fragment on Mackintosh* Mill acquired a position in the history of psychology and
Attached to the *a posteriori* school, he vindicated its clai
conspicuous ability. He took up the problems of mind ver
after the fashion of the Scotch school, as then represented b
Stewart, and Brown, but made a new start, due in part to I
and still more to his own independent thinking. He carried
principle of association into the analysis of the complex em
states, as the affections, the aesthetic emotions, and the
sentiment, all which he endeavoured to resolve into pleasura
painful sensations. But the salient merit of the *Analysi*
constant endeavour after precise definition of terms and clea
ment of doctrines. The *Fragment on Mackintosh* is a sev
posure of the flimsiness and misrepresentations of Mack
timon dissertation on ethical philosophy. It discusses, in
thorough way, the foundations of ethics from the author's p
view of utility.

Mill's influence on the young men of his time by his conve
has been especially celebrated. Among those that came un
influence were some of the greatest names in the generati
succeeded him. He had himself a very high ideal of public
which he carried out, at the risk of sacrificing all his cha
worldly advancement, and he impressed this ideal on the
surrounded him, most of all on his own son, who has since c
his father in fame, if not in genius.

See J. S. Mill's *Autobiography*, Bain's *Life of James Mil*
Bower's *Hartley and James Mill*. (A.

MILL, John (*c.* 1645-1707), editor of an histo
important critical edition of the New Testament, wa
about 1645 at Shap in Westmoreland, entered Q
College, Oxford, as a servitor in 1661, and took his m
degree in 1669. Soon afterwards he was chosen
and tutor of his college; in 1676 he became chap
the bishop of Oxford, and in 1681 he obtained the
of Blechingdon, Oxfordshire, and was made chap
Charles II. From 1685 till his death he held the a
ment of principal of St Edmund's Hall; and in 1
was nominated by Queen Anne to a prebendal s
Canterbury. He died on June 23, 1707, just a fo
after the publication of his Greek Testament.

Mill's *Novum Testamentum Græcum, cum lectionibus var
MSS. Exemplarium, Versionum, Editionum SS. Patrum
torum Ecclesiasticorum, et in easdem notas* (Oxford, fol. 17
undertaken by the advice and encouragement of Fell, his pre
in the field of New Testament criticism; it represents the l
thirty years, and is admitted to mark a great advance on
had previously been achieved. The text indeed is tha
Stephanus (1550), but the notes, besides embodying all pr
existing collections of various readings, add a vast number
from his own examination of many new MSS and Oriental
(the latter unfortunately he used only in the Latin trans
He was the first to notice, though only incidentally, the
the concurrence of the Latin evidence with the Codex Alexan
the only representative of an ancient non-Western Greek te
sufficiently known, the hint was not lost on Bentley (see W
and Hort, *Introduction to New Testament*). Mill's various r
numbering about thirty thousand, were attacked by Whitb
Examen as destroying the validity of the text. Antony Col
argued in the same sense, though with a different object. T
called forth a reply from Bentley (*Philelutherus Lipsiensis*)
Kuster reprinted Mill's Testament at Amsterdam with the
of twelve additional MSS.

MILL, John Stuart (1806-1873), son of James
(*q.v.*), was born in London on the 20th May 1806
education was from first to last undertaken by his
and is likely long to remain a standing subject for
and discussion. Much of the wonder is no doubt
his father's monstrous inversion of custom, the bo
set almost as soon as he could speak to work at o
honoured subjects of secondary and higher educatio
was taught the Greek alphabet at the age of three,
of his earliest recollections, as he has recorded in h
biography, was learning lists of common Greek wor
their English meanings, written for him by his fa
cards. By his eighth year he had gone through
original a great many Greek books. "Of gramm
says, "until some years later, I learnt no more t
inflexions of the nouns and verbs, but after a c
vocables proceeded at once to translation; and I

ber going through *Æsop's Fables*, the first Greek which I read. The *Anabasis*, which I remember was the second. I learnt no Latin until my eighth At that time I had read under my father's tuition ber of Greek prose authors, among whom I remember ole of Herodotus and of Xenophon *Cyropædia* and *ials of Socrates*, some of the lives of the philosophers genes Laertius, part of Lucian, and Isocrates *Ad Nicoclem* and *Ad Nicoclea*. I also read, in 1813, the s dialogues (in the common arrangement) of Plato, he *Euthyphron* to the *Theætetus* inclusive." Besides Greek book, he had read a great deal of history h by Robertson, Hume, Gibbon, Watson's *II. and III.* Hooke's *Roman History*, Rollin's *Ancient History*, Langhorne's *Plutarch*, Burnet's *History Own Times*, thirty volumes of the *Annual Register*, *Historical View of the English Government*, ins' *Political and Historical History*, M'Crie's *Knox*, and two s of the Quaker

Mill "knew Greek," and "read Plato" before he ght years old is often repeated, sometimes as an e of amazing precocity, sometimes as an awful e of injudicious parental forcing. The attainment child should have done so much at such an age is ly as little grounded in reason as was Mill's own that any child might have done the same. It is n that many thousands of persons have known before the age of eight without a knowledge of the ables of Greek grammar. In presence of the fact all we never distinguished for great memory or e richness of historical or literary allusion, it is a clusion that the matter of his reading at the age a little service to him matter life as it he had read shelf of boys' own books. This is not to say that cational purposes his early years were wasted as in and his father's opinion they generally are. But otedly the main factor in Mill's education was not nature put into his hands, but his constant inter with the active richly stored mind and tremendous er of his father. If any should be tempted to the method, they should bear in mind that the e cardinal element of it. The tutor was of more nce than the books. The reading of Plato's s would have been only an exercise in torgh ion if the boy had not had a Socrates with him in communion. The child was a constant inmate of her's study, and trotted by his side in his walks, from jottings on slips of paper as good an account ould of what he had read. He thus learnt at an

post, he hints, more serviceable to his intellect than manners. His main reading was still history, but h through all the Latin and Greek authors common in the schools and universities, besides several that commonly read by undergraduates. He was not ta compose either in Latin or in Greek, and he was n exact scholar in the academic sense; it was for the s matter that he was required to read, and by the ten he could read Plato and Demosthenes with ease father's *History of India* was published in 1818; i ately the reader, about the age of twelve, John, un energetic direction, began a thorough study of the sci logic, at the same time reading Aristotle's logical t in the original. In the following year he was intr to political economy. And there, when the pup nearly fourteen, this remarkable education term From that time he worked less immediately und father's eye. It was an inevitable incident of s education that Mill should acquire many of his speculative opinions, and his father's way of def them. But his mind did not receive the impress pa and mechanically. "One of the grand objects of tion," according to the elder Mill, "should be to g a constant and anxious concern about evidence"; laboured with all the energy of his strong will allowing his son to become a parrot of his own o and argument. The duty of collecting and w evidence for himself was at every turn impressed up boy; he was taught to accept no opinion upon aut he was soundly rated if he could not give a reason beliefs. John Stuart Mill was deliberately educate apostle, but it was as an apostle of reasoned t human affairs, not as an apostle of any system of de tenets. It was purposely to prevent any falling o this high moral standard till it should become par being that his father kept the boy so closely with h Much pity has been expressed over the dreary ch existence that the child must have led, cut off fr boyish amusements and companionship, working da day on his father's treadmill; but a childhood and h spent in the daily enlargement of knowledge, w continual satisfaction of difficulties conquered, buo by day dreams of emulating the greatest of benefactors, need not have been an unhappy chi and Mill expressly says that his was not unhapp seems unhappy only when we compare it with the of childhood left more to itself, and when we de imagine its peculiar enjoyments and aspirations complains that his father often required more tha

ally early age by example, precept, and practice the of common application to difficult work. The of Mill was taught thus early to take his chief n of overcoming intellectual difficulties, and to realize mmand of general terms, accounts for the singular ge and unparalleled ease which he acquired in the ent of political and social generalizations, not in abstract way, but in close relation with facts. n the intellectual side, and on the moral side the s almost from the dawn of consciousness instructed rd himself as consecrated to a life of labour for the good; his ambition was kindled to follow in the s of the great men of all ages, and at the same he utmost care was taken to purify that ambition worthy motives.

ontemporary record of Mill's life from eight to is published in Dr Bain's sketch of his life. It that the *Autobiography* rather understates than te the amount of work done. At the age of eight n Latin, Euclid, and algebra, and was appointed aster to the younger children of the family—a reasonably be expected of him, but his tasks were severe as to prevent him from growing up a healthy, and high spirited boy, though he was not constitu robust, and his tastes and pursuits were so differen those of other boys of the same age.

Most of Mill's fifteenth year was spent in France family of Sir Samuel Bentham. Away from his he maintained his laborious habits; the disciplin Copious extracts from a diary kept by him at th are given by Dr Bain, and show how methodical necessarily he read and wrote, studied botany, advanced mathematical problems, made notes on the and the people and customs of the country. On his in 1821 he continued his old studies with the add some new ones. One of the new studies was Rom which he read with John Austin, his father havi decided on the bar as the best profession open Another was psychology. In 1823, when he ha completed his seventeenth year, the notion of the l livelihood was abandoned, and he entered as a clerk examiner's office of the India House. "with the

g that he should be employed from the beginning
aring drafts of despatches, and be thus trained up
cessor to those who then filled the highest depart
f the office."
s work at the India House, which was henceforth
lihood, did not come before the public, and those
ve scouted his political writings as the work of an
t philosopher, entirely unacquainted with affairs,
nored the nature of his duties. From the first he
re than a clerk, and after a short apprenticeship he
omoted, in 1828, to the responsible position of
t examiner. The duty of the so-called examiners
examine the letters of the agents of the Company
a, and to draft instructions in reply. The character
Company's government was almost entirely depend
n their abilities as statesmen. For twenty years,
836 to 1856, Mill had charge of the Company's
s with the native states. In the hundred of
hes that he wrote in this capacity, much, no doubt,
ne in accordance with established routine, but few
en of his generation had a wider experience of the
ible application of principles of government to
emergencies. That he said so little about this work
Autobiography was probably because his main con
ere was to expound the influences that affected his
and mental development. A man of different
ament might have found abundance of dramatic
in watching the personal and political changes in
y distinct states. But Mill makes no reminiscences
kind, nor does he give any clue to the results of
initiative.
eturn to his extra official activity, which received an
se impulse about the time of his entering the India
from what must strike a man of the world as a strange
The reading of Dumont's exposition of Bentham's
es in the *Traité de Législation* was an epoch in
ife. It awoke in him an ambition as enthusiastic
passioned as a young man's first love. The
ge that he uses about it in his autobiography reveals
th of inner life that few people would suspect from
ord of his dry studies. When he laid down the last
, he says, he had become a different being. It
nity to the detached and fragmentary component
f his knowledge and beliefs. "I now had opinions
l, a doctrine, a philosophy in one among the best
of the word, a religion, the inculcation and diffusion
ch could be made the principal outward purpose of
And I had a grand conception laid before me of
s to be effected in the condition of mankind through
octrine." He had been carefully bred to contemplate
or human welfare as the ruling motive of his life:
otive had now received definite direction.
y a youth has entered the world with ambition
y high, but few have felt as Mill felt the first shock
pair, and fewer still have rallied from that despair
uch indomitable resolution. The main secret of the
"crisis" of his youthful life is probably to be found
lofty ardour of the aspirations then conceived and
l. For four years he worked with faith and hope in
ssion, and these were years of incessant propagandism
y. The enthusiast of seventeen, burning to reorganize
affairs so as to secure the greatest happiness of the
st number, set siege to the public mind through
l approaches. He constituted a few of his youthful
s, imbued with the principles of his new creed, into
ety which he called the "Utilitarian" Society, taking
ord, as he tells us, from one of Galt's novels. Two
apers were open to him—the *Traveller*, edited by a
of Bentham's, and the *Chronicle*, edited by his
's friend Black. One of his first efforts was a solid
argument for freedom of discussion, in a series of l
to the *Chronicle* apropos of the prosecution of Ri
Carlile. But he watched all public incidents w
vigilant eye, and seized every passing opportunit
exposing departures from sound principle in parli
and courts of justice. Another outlet was opened
him in 1821 by the starting of the *Westminster R*
and still another in the following year in the *Parliamen*
History and Review. This year also he found a con
occupation in editing Bentham's *Rationale of Ju*
Evidence. Into this he threw himself with zeal. A
the time, his mind full of public questions, he disc
and argued eagerly with the many men of promis
distinction who came to his father's house. He en
in set discussions at a reading society formed at
house in 1825, and in set debates at a Speculative S
formed in the same year.
"A very diligent youth," was Peacock's descr
of young Mill at this period, and this was probabl
the enthusiast struck most of his outside acquaint
But the glow of a great ambition as well as the ene
a piercing intellect might have been felt in his wr
His mission was none the less arduous that he propo
convert the world by reason. Only the fulness of mil
hope could have supported his powers, if he had
frame of iron, under the strain of such incessant l
All of a sudden, a misgiving which he compares t
Methodist's "first conviction of sin" made a rift
wholeness of his faith in his mission. It was
autumn of 1826. I was in a dull state of nerve
as everybody is occasionally liable to; unsusceptib
enjoyment or pleasurable excitement; one of those
when what is pleasure at other times becomes ins
indifferent. . . . In this frame of mind it occu
me to put the question directly to myself, 'Suppos
all your objects in life were realized, that all the ch
in institutions and opinions which you are now l
forward to could be completely effected at this
instant, would this be a great joy and happiness to
And an irrepressible self-consciousness distinctly ans
'No!' At this my heart sank within me: the
foundation on which my life was constructed fell
All my happiness was to have been found in the con
pursuit of this end. The end had ceased to chan
how could there ever again be any interest in the m
I seemed to have nothing left to live for."
The passage in his autobiography in which Mill
an account of this prostrating disenchantment an
gradual release from its benumbing spell is one of th
interesting chapters in personal history. The first b
the gloom came, he tells us, from his reading in Marm
Memoires "the passage which relates his father's
the distressed position of the family, and the
inspiration by which he, then a mere boy, felt and
them feel that he would be everything to them
supply the place of all that they had lost." Mi
moved to tears by the narrative, and his burden
lighter at the thought that all feeling was not dead
him, that he was not a mere intellectual machine;
incident, and the delight that he now began to
Wordsworth's "Poems founded on the Affections,"
clue to one of the secrets of Mill's despondency.
an unsatisfied longing for personal affection, for l
friendship, of which his life hitherto had been
His father seems to have been reserved, and mon
even to the pitch of chilling sternness in his inte
with his family; and among young Mill's contac
tempt of feeling was almost a watchword, because
often associated with mischievous prejudice and
conduct. Himself absorbed in abstract questions a

general philanthropy, he had been careless of or keeping personal attachment. But it was not pair first seized him, as he looked back at the of the results of his work as an apostle, that Mill o feel the void in his affections and the need of sympathy. We must remember how little when oition was formed he knew of the living world him He knew in term that political and social must be slow, he could why per patience to him- l say to himself that he life must be happy because inment of his great object must occupy the whole ut without experience he could not have been l for the actual slowness of the reformer's work, or gainst its terribly oppressive influence. Inevitably erated the solidity and strength of the forces against him Four years seems a long time at that n 1826 Mill could look back to four years of eager What were the results? He had become convinced , comrades in the Utilitarian Society, who never ed more than ten, had not the stuff in them for a aking propaganda; the society itself was dissolved; *Elementary Exercise* was a failure; the *Westminster* pay it expenses; Bentham's *Judicial Evidence* pro- tte effect on the reviewers. His own reception at ulative Debating Society, where he first measured gth in public conflict, was calculated to produce rust. He found himself looked upon with curiosity ocious phenomenon, a "made man," an intellectual set to grind certain tunes. The most clear and easoning failed to sway his audience Great things n expected of this society as a means of bringing for close discussion the leading young men then e life or looking forward to it. Its first session fiasco. The leaders that had been expected stayed With these repulses to his hopes along the whole us activity, Mill must also have suffered from the exhaustion that only the hope and heat of the d kept him from feeling before No wonder that disheartened, began to feel defect in his father's , to question and analyse his own faith, to yearn solace of personal affection, and to reconstitute his of life.

n spite of this rude shock the foundations laid by training remained stable appears from the facts through the period of his gloom he continued as before, and that he considered himself bound, vinced that his old plan of life was sufficient, to p a thoroughly reasoned new plan wherewith to w heart and hope to his work. The new system ch less different from the old than might be sup- on what he says of the struggle that it cost him h it. Regard for the public good was still his the ruling motive that gave unity to his conduct now recognized that this was too vague and ab- an object to be sufficient of itself for the satisfac- human affections. It is a proof of the dominating his father's character that it cost the younger Mill effort to shake off his stern creed about poetry rsonal emotion Like Plato, the elder Mill would t poets and to be ministers of prejudice and s of truth And he often insisted on the wisdom ieting as much as possible the private affections, xpanding as much as possible the public affections. s maxim of "few acquaintances, fewer friends, no ntles" had his cordial approval. These doctrines nger Mill at first took up with boyish enthusiasm dantry, but it was against this part of his father's hat he now felt himself forced in reason to revolt. d too much in awe of his father to make him the t of his difficulties. He wrestled with them in the gloomy solitude of his own mind. He was victorious; he reached firm ground at last; but the struggle left him in several respects changed. He carried out of the struggle as the fruits of victory a more catholic view of the elements of human happiness, a delight in the poetry of nature and the affections as well as the poetry of heroic unselfish character and action, a disposition to study more sympathetically the point of view of opponents, a more courteous style of polemic, a hatred of sectarianism, an ambition no less noble and disinterested but moderated to practical possibilities.

In the course of the next few years Mill wrote comparatively little, but he "carried on," as he says, "a quantity of thinking respecting a host of subjects." It was a period of search, deliberation, germination, and striking root. Coincident if not causally connected with the relief from his spiritual crisis came his first consciousness of power as "an original and independent thinker." In the dialectic conversations with a small band of students at Grote's house, he regained the self-confidence that had been shaken in the larger and rougher arena of the Speculative Debating Society. The beginning of his works on logic and political economy may be traced back to those discussions, and he learnt from them, he tells us, the habit of "never accepting half solutions of difficulties as complete; never abandoning a puzzle, but again and again returning to it until it was cleared up; never allowing obscure corners of a subject to remain unexplored, because they did not appear important; never thinking that he perfectly understood any part of a subject until he understood the whole." He learnt also an important moral lesson from the Speculative Society, besides learning the strong points of other political and social creeds and the weak points of Benthamism from defending it point by point against all comers. With all his despondency, he did not abandon the meetings of the society after the fiasco of the first session. He stood by it firmly, and in a short time had the triumph of seeing its debates famous enough to attract men with whom it was profitable for him to interchange opinions, among others Maurice and Sterling. He ceased to attend the society in 1829, but he carried away from it the strengthening memory of failure overcome by persevering effort, and the important doctrinal conviction that a true system of political philosophy was "something much more complex and many-sided than he had previously had any idea of, and that its office was to supply, not a set of model institutions, but principles from which the institutions suitable to any given circumstances might be deduced."

The first sketch of Mill's political philosophy appeared in a series of contributions to the *Examiner* in the autumn of 1830 on "Prospects in France." He was in Paris soon after the July Revolution, made the acquaintance of the leading spirits among the younger men; and in his discussion of what they were doing and what they should do in making a new constitution we find the germs of many thoughts afterwards more fully developed in his *Representative Government*.

The division of a man's life into periods must always be a rough partition, but we may conveniently and with tolerable accuracy take these letters as marking the close of his period of meditative search, of radication, and his return to hopeful aspiring activity. It was characteristic of the nature of the man that he should be stirred to such delight by the Revolution in France, and should labour so earnestly to make his countrymen understand with what gravity and sobriety it had been effected. Their own Reform Bill came soon after, and it is again characteristic of Mill—at once of his enthusiasm and of his steady determination to do for humanity the work that nobody else

able or willing to do—that we find him in the heat struggle in 1831 writing to the *Examiner* a series ors on "The Spirit of the Age" which drew from the exclamation, "Here is a new mystic!" We ily see now what it was in these remarkable essays scinated Carlyle; it was the pervading opinion that y natural state of society power must be in the of the wisest. This was the condition of stability: power and wisdom ceased to coincide, there was a bance of the equilibrium till this coincidence was effected. But whether Carlyle was right in the "mystic" may be judged from the fact that Mill's ve logic was the direct result of his aspirations after al stability as determined by the dominion of the "Why is it," he asked, "that the multitude accept tly the decisions of the wisest, of the specially , in physical science?" Because in physical science s all but complete agreement in opinion. "And why greement?" Because all accept the same methods estigation, the same tests of truth. Is it possible o obtain unanimity as to the methods of arriving at sions in social and political matters, so as to secure agreement of opinion among the specially skilled, imilar general respect for their authority?" The hought appears in a review of Herschel's *Natural ophy*, written about the same time. Mill remarks he uncertainty hanging over the very elements of and social philosophy proves that the means of g at the truth in those sciences are not yet properly tood. "And whither," he adds, "can mankind so ageously turn, in order to learn the proper means, form their minds to the proper habits, as to that of knowledge in which by universal acknowledg- he greatest number of truths have been ascertained, e greatest possible degree of certainty arrived at?"

1831 Mill's enthusiasm for humanity had been ghly reawakened, and had taken the definite shape spiration to supply an unimpeachable method of for conclusions in moral and social science. From atform on which Carlyle and Mill met in 1831 they ed different roads,—the one to preach the duty of nce to the wisest, the other to search for a means by wisdom might be acquired such as would command t and win the assent of free conviction. No mystic worked with warmer zeal than Mill. But his zeal ntered a check which baffled him for several years, hich left its mark in various inconsistencies and rences in his completed system. He had been bred father in a great veneration for the syllogistic logic antidote against confused thinking. He attributed early discipline in this logic an impatience of vague ge which in all likelihood was really fostered in him study of the Platonic dialogues and of Bentham, for ays had in himself more of Plato's fertile ingenuity vassing the meaning of vague terms than the school rigid consistency in the use of them. Be this as it nthusiastic as he was for a new logic that might ertainty to moral and social conclusions, Mill was no esolute that the new logic should stand in no onism to the old. In his *Westminster* review of ely's *Logic* in 1828 (invaluable to all students of the s of Mill's logic) he appears, curiously enough, as an and brilliant champion of the syllogistic logic against ers such as the Scotch philosophers who talk of rseding" it by "a supposed system of inductive" His inductive logic must "supplement and not sede." It must be concatenated with the syllogistic the two to be incorporated in one system. But for l years he searched in vain for the mean tion.

Meantime, while recurring again and again, as was custom, to this cardinal difficulty, Mill worked indefatig in other directions where he saw his way clear, expatia over a wide range of political, social, economical, philosophical questions. The working of the new ord France, and the personalities of the leading men, had a found interest for him; he wrote on the subject in *Examiner*. He had ceased to write for the *Westmi* in 1828; but during the years 1832 and 1833 he tributed many essays to *Tait's Magazine*, the *Jurist*, the *Monthly Repository*. In 1835 the *London Revie* started, with Mill as editor; it was amalgamated with *Westminster* in 1836, and Mill continued editor till 1 Much of what he wrote then was subsequently incorpo in his systematic works, some of his essays were repr in his first two volumes of *Dissertations and Discus* (1859). The essays on Bentham and Coleridge constit the first manifesto of the new spirit which Mill soug breathe into English Radicalism. But the reprinted pa give no just idea of the immense range of Mill's energ this time. His position in the India Office, where h he did work enough for most men, cut him off entering parliament, but he laboured hard th ineffectually to influence the legislature from withou combating the disposition to rest and be thankful. his *Autobiography* he admits that the attempt to fo Radical party in parliament at that time was chimeri

It was in 1837, on reading Whewell's *Inductive Sc* and re-reading Herschel, that Mill at last saw his clear both to formulating the methods of scientific in gation and joining on the new logic as a supplement t old. Epoch making as his logic undoubtedly was, the multitude of new views opened up, from the ado of a new wing to the rambling old building, and fro inspiring force with which every dusty chamber searched into and illuminated, Mill did not escape a innumerable pitfalls of language that beset the pione such a subject. It is evident from a study of his pur and the books from which he started that his perplexities were due to his determination to ex scientific method as the complement of scholastic In his defence of the syllogism he confounds the syllo forms with deductive reasoning. Every deductive re ing may be thrown into the form of a syllogism, bu every syllogism is deductive. The reasoning in seve the syllogistic forms is not deductive at all in the of involving a movement from general to parti Although he knew Aristotle in the original, Mill di recognize the fact that the syllogistic machinery primarily constructed for the reasoning together of t As regards the word induction, Mill uses it in diff connexions to cover three or four distinguishable mea

induction viewed as the establishment of predic about a general term, induction viewed as inference the known to the unknown, induction viewed as ve tion by experiment, and induction viewed as the pro propositions of causation. The form of his systen really governed by the scholastic notion of induction means of establishing general propositions; the indu part of his system is introduced after the deductive this character, while the greater portion of the subs of what he treats of under the name of induction especially the so-called experimental methods, have no whatever to do with the establishment of general pr tions, in the technical sense of general propositions.

But the permanent value and influence of Mill's indu logic is not to be measured by technical inaccuracie inconsistencies, to which an academic mind may attach undue importance. In the technical history science, Mill's *Logic* may be viewed as an attempt to

ctical tests of truth set forth in Herschel's *Discourse ural Philosophy* with the theoretic views of induc- opounded in Whately's *Logic*. But in the history ght the great importance of the work i due not so o its endeavour to formulate the methods of science y bare the first principles on which they rest as to ematic application of scientific method to what he the *moral sciences*. Mill ha often been criticized had pretended to teach men how to conduct their gation and how to make discoveries in the physical s. His work was rather to evince from the practice of science the principles on which they proceed in and proving their speculations concerning cause ect in the physical world and see whether the same h could not be applied in testing and proving tion concerning cause and effect in the moral What is the effect upon human character and happiness of given social and physical conditions- , an intuition, customs, law ? How can conclusions ich points be proved ? These were the questions h Mill was interested, and the striking novelty of l was its endeavour to show that propositions of nd effect in human affairs must be proved, if they ot proof at all, absolute or approximate, on the rinciples with propositions of cause and effect in tural world

Logic was published in 1843. In 1844 appeared *ssays on Some Unsettled Questions in Political gy*. The e essays were worked out and written ears before, and show Mill in his first stage as a l economist. Four out of the five essays are te and powerful solutions of perplexing technical s—the distribution of the gains of international ree, the influence of consumption on production, the on of productive and unproductive labour, the pro ations between profits and wages. Though Mill here purely as the disciple of Ricardo, striving nore precise statement, and reaching forward to consequences, we can well understand in reading ssays, searching, luminous, large and bold in outline, wrought in detail, how about the time when he first d them he began to be conscious of power as an l and independent thinker

originality and independence became more con , when he reached his second stage as a politica ist, struggling forward towards the standpoint hich his systematic work was written It would at in his fits of despondency one of the thought- upon him like a nightmare and marred his dream- an improvement was the apparently inexorable of economic laws, condemning thousands of s to a cramped and miserable existence, and nd soon to semi-starvation. From the oppressive he found relief in the thought set forth in the of the second book of his *Political Economy* that, the condition of production have the necessity of l law the distribution of what is produced among rious classes of producers is a matter of human ement, dependent upon alterable customs and tions. There can be little doubt that this thought, r or not in the clear shape that it afterwards d, was the germ of all that is most distinctive in tem of political economy It was as far as possible he rigidity of his method of exposition to fall into nfusion of supposing that it was for political y to discuss the equity of different modes of ution, or the value of other objects of human our conflicting with the production of wealth ; but economic inquiries clearly in their proper place as to conclusions that were not always final and bind- ing on the practical statesman, but had to be take other considerations as governing rational human Besides thus putting political economy in its just tion with other parts of social science and conduc widened the scope of economic inquiries by discussi economic consequences of various ideal social arrange and more especially different modes of distributing between landlord, capitalist, and labourer. Mill re redeemed political economy from the reproach of dry science. Nobody with any interest in human im ment can read his work with indifference. And this without in any way disturbing the original con of political economy as the science of cause and e the production of wealth. One of his most e successors, the late Professor Cairnes, thus adm summed up his work as a political economist: " himself used to put it, Ricardo supplied the backb the science, but it is not less certain that the hum joints, the muscular developments all that political economy a complete and organized bo knowledge have been the work of Mill."

While his great systematic works were in pr Mill wrote very little on events or books of the day turned aside for a few months from his *Political E* during the winter of the Irish famine (1846- advocate the creation of peasant-proprietorships remedy for distress and disorder in Ireland. He time also to write elaborate articles on French histo Greek history in the *Edinburgh Review* apropos of M Guizot, and Grote, besides some less elaborate essay

The *Political Economy* was published in 1848 could now feel that the main work he had propo himself was accomplished; but, though he wrote co tively little for some years afterwards, he remai much as ever on the alert for opportunities of influence, and pressed on with hardly dim enthusiasm in his search for useful truth. Amon things, he made a more thorough study of socialist with the result that, though he was not converted of their schemes as being immediately practical began to look upon some more equal distribution produce of labour as a practicability of the remote and to dwell upon the prospect of such changes in character as might render a stable society possible the institution of private property. This he has ca third stage as a political economist, and he says was helped towards it by the lady, Mrs Taylor, who hi- wife in 1851, and with whom he had lived in i friendship for more than twenty years before. generally supposed that he writes with a lover's e rance about this lady's powers when he compares h Shelley and Carlyle But a little reflexion will sho he wrote with his usual accuracy and sobriety w described her influence on him. He expressly sa he owed none of his technical doctrine to her, t influenced only his ideals of life for the individual society, and his language about her is really measure of the importance that he attached to such above any system of reasoned truth. There is ver proportional difference between Mill and his fathe it is obvious from what he says that his inner life very different after he threw off his father's au This new inner life was strengthened and enlarged Taylor. We must remember also that Mill in hi years had been so strictly secluded from comm sentiment that what the general world would c commonplace must have come to him with all the fr of a special revelation.

During the seven years of his married life Mill pu less than in any other period of his career, but four

osely reasoned and characteristic works, the *Liberty*, *litarianism*, the *Thoughts on Parliamentary Reform*, e *Subjection of Women*, besides his posthumously ed essays on *Nature* and on the *Utility of Religion*, ought out and partly written in collaboration with e. In 1856 he became head of the examiner's n the India House, and for two years, till the tion of the Company in 1858, his official work, a light task, kept him fully occupied. It fell to head of the office to write the defence of the ny's government of India when the transfer of its was proposed. Mill was earnestly opposed to the , and the documents in which he substantiated the boast for the Company that "few governments even far more favourable circumstances have attempted h for the good of their subjects or carried so many r attempts to a beneficial issue," and exposed the of the proposed new government, are models of nt and dignified pleading. His prediction that the Secretary's council would serve as a screen and a check was in the opinion of many amply verified ears ago.

he dissolution of the Company, Mill was offered a the new council, but declined. His retirement ficial work was followed almost immediately by his death, and from this calamity he sought relief in literary occupation. Politics, sociology, and psycho vided as before the energies of his active mind. f his first cares was to publish with a touching ion to his wife the treatise on *Liberty*, which they ought out together, principle by principle and e by sentence. This pious duty discharged, he to current politics, and published, in view of the ng Reform Bill, a pamphlet on parliamentary The chief feature in this was an idea concerning he and Mrs Mill often deliberated, the necessity nding checks against uneducated democracy. His suggestion of a plurality of votes, proportioned to tor's degree of education, was avowedly put forward an ideal; he admitted that no authentic test of on could for the present be found. An anonymous vative caught at the scheme in another pamphlet, ng income as a test. Soon after, Mill supported ser's, still with the same object, Mr Hare's scheme representation of minorities. In the autumn of me year he turned to psychology, reviewing Mr works in the *Edinburgh Review*.

his way the indefatigable thinker worked on, throw nself by turns into the various lines along which he spects of fulfilling his mission as an apostle of pro In his *Representative Government* (1860) he systema- pinions already put forward in many casual articles says. His *Utilitarianism* (published in *Fraser's* m was a closely reasoned systematic attempt to answer ons to his ethical theory and remove misconceptions As the inventor of the term Utilitarianism, he was l to define its meaning; and he was especially s to make it clear that he included in utility the es of the imagination and the gratification of the emotions, and to show how powerfully the good of od as a motive appealed to the imagination. His e on the *Subjection of Women*, in its ruling intention est against the abuse of power, was Mill's next work, it was not published till 1869. His *Examination milton's Philosophy*, published in 1865, had engaged share of his time for three years before. When it curred to him that a criticism of the chief of our intuitional psychologists would cause a wholesome d serve enlightenment, he thought only of an article s he wrote about Austin's *Jurisprudence* or Grote's *Plato*. But he soon found that the subject required and a book appeared which certainly answered the of rousing the sleepy realms of philosophy and theo

While mainly occupied in those years with philos studies, Mill did not remit his interest in current He made his voice heard on the contest in Ame 1862, taking the side of the North then very unp in London and using all his strength to explain w since been universally recognized as the issue re stake in the struggle, the abolition of slavery. characteristic of the closeness with which he w current events, and of his zeal in the cause of "hu that, when the *Reader*, an organ of science and imp opinion, fell into difficulties in 1865, Mill joined wit distinguished men of science and letters in an effort t it afloat. He supplied part of the money for carr on, contributed several articles, and assisted the Mr Fraser Rae, with his advice. The effort was though such men as Herbert Spencer, Huxley, T Cairnes, Mark Pattison, F. Harrison, Sir Frederick P and Lecky were among the contributors.

In 1865 a new channel was opened to his infl He was requested to stand for Westminster, and on conditions strictly in accordance with his princi parliamentary election. He would not canvass, n agents to canvass for him, nor would he engage to to the local business of the constituency. He wa difficulty persuaded even to address a meeting electors. The story of this remarkable election ha told by Mr James Beal, one of the most active sup of Mill's candidature. In parliament he adhered lifelong principle of doing only work that needed done, and that nobody else seemed equally able or to do. It may have been a consciousness of th which prompted a remark made by the Speaker that presence in parliament elevated the tone of debate, impression made by him in parliament is in some of being forgotten, because he was not instrumen carrying any great measure that might serve as an memorial. But, although in one of his first sp against the suspension of the Habeas Corpus Act in he was very unfavourably received, Mill thou succeeded in what recalled "gaining the ear of the The only speech made by him during his three y parliament that was listened to with impatience errors-ly enough, his speech in favour of counte democracy by providing for the representation of min His attack on the conduct of General Eyre in J was listened to, but with repugnance by the ma although his action in the matter in and out of parl was far from being ineffectual. He took an active the debate on Mr Disraeli's Reform Bill, and he extort from the Government several useful modifi of the Bill for the Prevention of Corrupt Practices reform of land tenure in Ireland, the representa women, the reduction of the national debt, the re London government, the abrogation of the declara Paris, were among the topics on which he spok marked effect. He took occasion more than o emphasize what he had often advocated in writing, En duty to intervene in Continental politics in support cause of freedom. As a speaker Mill was sor hesitating, pausing occasionally as if to recover the of his argument, but he showed great readiness in parliamentary debate. Viewed as a candidate for min office, he might be regarded as a failure in parliame there can be no doubt that his career there greatly e his influence.

Mill's subscription to the election expenses Bradlaugh, and his attitude towards Governor E

ally regarded a[s] the main cause[s] of his defeat in the
l election of [1]. But, a[s] he suggest himself, his
d advocacy of unfamiliar p[rinci]ples had made
npopular with [the] moderate [party]. When he was
lected on a sudden impul[se] [of] [the] [people], extremely
was known about him by [the] [great] electorate;
s writings about electoral [reform] had pre
nently [brought] [him] [before] the
ctoral politi[cal world]. He
[was] [the] [author] of a pamphlet on questions
[of] [the] [day], entitled
[Thoughts] [on] [Parliamentary] Reform. It
[was] [a] [reply] to
[a] [pamphlet] [by] Mr Lowe, [which] had appeared
[in] [the] [previous] year, [and] had [at once] attracted
[much] [attention]. [The] [pamphlet] [was] [a] [powerful]
[piece] [of] [writing], [and] [the] [author] [was] [at] [once]
[recognized] [as] [a] [man] [of] [mark]. [The] [Parliamentary]
[Reform] [Bill] [of] [1866] [was] [the] [result] [of] [a]
[great] [political] [crisis], [and] [the] [pamphlet] [was]
[a] [contribution] [to] [the] [discussion] [which] [preceded]
[the] [introduction] [of] [the] [measure]. [The] [Reform]
[Bill] [of] [1867] [was] [the] [work] [of] [a] [Conservative]
[ministry], [and] [was] [introduced] [in] [the] [House] [of]
[Lords]. [Mill] [had] [no] [hand] [in] [the] [framing] [of]
[the] [measure], [but] [he] [had] [absorbed] [nearly] [the]
[whole] [of] [its] [principles] [before] [it] [was] [introduced]
[to] [the] [House] [of] [Commons]. [In] [1865] [Mill] [was]
[elected] [Lord] [Rector] [of] [the] [University] [of] [St]
[Andrews]. [His] [rectorial] [address] [was] [a] [powerful]
[and] [eloquent] [plea] [for] [the] [study] [of] [the]
[ancient] [classics], [in] [opposition] [to] [the] [views]
[which] [had] [been] [put] [forward] [by] [Mr] [Lowe] [in]
[the] [second], [to] [annotations], [in]
[Mr] [Buckle's] [History] [of] [Civilization]. [In]
[this] [address] [Mill] [showed] [how] [he] [could] [look] [forward] [to]
[the] [future], [and] [how] [he] [could] [look] [back] [to] [the] [past].
[His] [little] [volume] [on] [Auguste] [Comte] [and] [Positivism]
[was] [published] [in] [1865], [and] [in] [the] [autumn] [of] [that] [year]
[Mill] [and] [his] [wife] [started] [on] [a] [tour] [round]
[the] [Mediterranean]. [This] [tour] [was] [undertaken] [chiefly]
[for] [the] [benefit] [of] [Mrs] [Taylor's] [daughter], [Mrs]
[Hardy], [who] [was] [in] [delicate] [health]. [The] [party]
[visited] [Marseilles], [Genoa], [Pisa], [Rome], [Naples], [Sorrento],
[Amalfi], [Palermo], [Syracuse], [Taormina], [Catania], [Girgenti],
[Corfu], [Athens], [Smyrna], [Constantinople], [Athens] [again],
[Brindisi], [Venice], [Milan], [Turin], [Mont] [Cenis], [Paris],
[Avignon], [Marseilles], [Nice], [Genoa], [Pisa], [Florence],
[Bologna], [Milan], [Como], [Lugano], [Como] [again], [Milan]
[again], [Turin], [Paris], [Boulogne], [Folkestone], [London].
[Mill] [was] [accompanied] [on] [the] [tour] [by] [Mr] [Helps],
[Mr] [Hardy], [Mr] [Taylor], [and] [Mr] [Thornton]. [Mill's]
[companion] [after] [his] [wife's] [death] [was] [Miss] [Helen]
[Taylor], [and] [many] [of] [the] [places] [visited] [on] [the]
[tour] [were] [revisited] [by] [Mill] [in] [company] [with]
[Miss] [Taylor] [and] [Mr] [Thornton] [on] [all] [occasions]
[subsequent] [to] [1865]. [Mill] [carried] [out] [many]
[improvements] [in] [their] [quiet] [home] [for] [the] [philo]
[sophic] [comfort] [of] [Mrs] [Taylor]. "Helen," he wrote to Mr Thornton
[on] [the] [occasion] [of] [a] [long-cherished] [scheme] [at] [last] [carried]
[out], [at] [which] [time] [he] [was] [himself] [in] [his] [fifty-ninth]
[year], "Helen," he wrote to Mr Thornton on the occasion of a long-cherished scheme at last carried out, at which time he was himself in his fifty-ninth year, "Helen will be [in] [her] [element] [when] [she] [has] [got] [you] [and] [me] [to] [herself] [in] [addition] [to] [the] [rest] [of] [her] [family]. [He] [has] [found] [me] [a] [room] [from] [the] [windows] [of] [which] [we] [shall] [see] [the] [sea] [and] [the] [Estaque] [hills] [and] [valleys] [and] [the] [Mont] [Ste] [Victoire] [and] [the] [Alps] [behind] [it]. [Helen] [is] [to] [have] [the] [room] [next] [to] [mine] [and] [the] [sitting-room] [between] [us] [is] [to] [be] [common] [property]. [Helen] [has] [found] [a] [nice] [house] [for] [herself] [and] [Harriet] [close] [to] [us]. [Helen] [is] [to] [have] [the] [carriage] [and] [we] [are] [to] [have] [a] [boat] [between

blished. On the other hand, it must be admitted
is expectation was a prominent feature in the earliest
nation of the gospel, and materially contributed to
ess. If the primitive churches had been under the
ty of framing a "Confession of Faith," it would
ly have embraced those pictures by means of which
ar future was distinctly realized. But then these
s and dreams and hopes were just the theme that
systematized doctrine impossible, it is possible to
ate the mythological ideas, but not the shifting
y of the imagination.

he anticipations of the future prevalent among the
hristians (*c.* 50–150) it is necessary to distinguish
and a fluctuating element. The former include
notion that a last terrible battle with the enemies
was impending; (2) the faith in the speedy return
ist; (3) the conviction that Christ will judge
nd (4) will set up a kingdom of glory on earth.
latter belong views of the Antichrist, of the location
power, of the place, extent, and duration of the
kingdom of Christ, &c. The former made one
tion, they were modified from day to day, partly
of the changing circumstances of the present by
forecasts of the future were regulated, partly because
fications real or supposed of the ancient prophets
admitted of new combination and construction
en here certain positions were agreed on in large
s of Christendom. Among these was the expecta
at the future kingdom of Christ on earth should
fixed duration, according to the most prevalent
, a duration of one thousand years. From the fact
hole ancient Christian eschatology was known in
mes as "chiliasm," a name which is not strictly
e, since the doctrine of the millennium was only one
in its scheme of the future.

his idea that the Messianic kingdom of the future
th should have a definite duration by like the
eschatology of the primitive church roots in the
apocalyptic literature, where it appears at a com
ely late period. At first it was assumed that the
ic kingdom in Palestine would last for ever (so the
ts; *cf.* Jerem. xxiv. 6; Ezek. xxxvii. 25, Joel iv.
aniel vi. 27; Sibyll. iii. 49 *sq.*, 766; Pss. Solom.
; Enoch lxii. 14), and this seems always to have
e most widely accepted view (John xii. 34). But
comparison of prophetic passages of the Old Testa
earned apocalyptic writers came to the conclusion
distinction must be drawn between the earthly
nce of the Messiah and the appearance of God
f amongst His people and in the Gentile world for
l judgment. As a necessary consequence, a limited
had to be assigned to the Messianic kingdom. It
altogether improbable that the mysterious references
sufferings of the Messiah had also an influence on
inds. This, however, is doubtful. It is certain at
nts that the whole conception marks the beginning
dissolution of realistic and sensuous views of the
The age was too advanced to regard the earthly
ic kingdom as the end. There was an effort to
lace among the hopes of the future for those more
l and universal anticipations, according to which
and heavenly blessedness will be the portion of the
, this earth and heaven will pass away, and God
all in all. As to the period to be assigned to the
kingdom, no agreement was ever reached no
n, any more than in the detailed descriptions of its
d pleasures. According to the Apocalypse of Baruch
this kingdom will last "donec finiatur mundus
ionis." In the Book of Enoch (xci. 12) "a week"
fied, in the Apocalypse of Ezra (vii. 28 *sq.*) four
hundred years. This figure, corresponding to the
hundred years of Egyptian bondage, occurs also
Talmud (Sanhedrin 99*a*). But this is the only p
the Talmud has no fixed doctrine on the point
view most frequently expressed there (see Von
Hilgenfeld's Zeitschrift, 1877, p. 527 *sq.*) is th
Messianic kingdom will last for one thousand (so
two thousand) years. "As in six days God created
world, on the seventh He rested. But a day of
equal to a thousand years (Ps. xc. 4). Hence the
will last for six thousand years of toil and labour
will come one thousand years of Sabbath rest for the
of God in the kingdom of the Messiah." This idea
have already been very common in the first century
Christ. The combination of Gen. i., Dan. ix., and
was peculiarly fascinating:

"As the Holy One had spent only one return of
of Man. He returns to judgment. In speaking of
of the glorious kingdom He is to introduce, He ma
of apocalyptic and even (Matt. xxiv. 11, xxvi. 29, Luke
16; Matt. xix. 28), but nowhere in the discourses
Jesus is there a hint of a limited duration of the M
kingdom. The apostolic epistles are equally free
any trace of chiliasm (neither 1 Cor. xv. 23 *sq.* nor
iv. 16 *sq.* points in this direction). In the Apocaly
John, however, it occurs in the following shape (cha
After Christ has appeared from heaven in the guis
warrior, and vanquished the antichristian world
the wisdom of the world, and the devil, those wh
remained steadfast in the time of the last catastrop
have given up their lives for their faith, shall be ra
and shall reign with Christ on the earth as a royal
hood for one thousand years. At the end of this time
is to be let loose again for a short season; he will
a new onslaught but God will miraculously destr
and his hosts. Then will follow the general resu
of the dead, the last judgment, and the creation
heavens and a new earth. That *all* believers will
share in the first resurrection and in the M
kingdom is an idea of which John knows nothing;
earthly kingdom of Christ is reserved for those wh
endured the most terrible tribulation, who have wi
the supreme effort of the world-power, that is, fo
who are actually members of the church of the la
The Jewish expectation is thus considerably curta
the hands of John, and the chief charm of its
attractions—"the rest and holy joy that hath pas
the resurrection, on which the second death hath no
but they shall be priests of God and of Christ, an
reign with Him a thousand years." More than th
does not say. But other ancient Christian autho
not so cautious. Accepting the Jewish apocaly
sacred book of venerable antiquity, they read the m
and transferred the whole content bodily to Christianity
more, the Gentile Christians took possession of
and yet in proportion as they were neglected
Jews who, after the war of Bar Cochba, became
enemies of the Messianic hope and hardened themselv
more and devotion to the law, they were naturalize
Christian communities. The result was that the
became "Christian" documents, it entirely to
not to Jewish tradition that we owe them pre
The Jewish expectations are adopted, for example
Papias, by the writer of the epistle of Barnabas,
Justin. Papias actually confounds expressions of
with verses from the Apocalypse of Baruch, refer
the amazing fertility of the days of the Messianic k
(Papias in Iren. v. 33). Barnabas (*Ep.* 15) gives
Jewish theory (from Gen. i. and Ps. xc. 4) th
present condition of the world is to last six thousan

he creation, that at the beginning of the Sabbath
venth millennium) the Son of God appears, to put
to the time of "the unjust one," to judge the ungodly
new the earth. But he does not scruple, like Papias,
sensuous descriptions of the seventh millennium, to
as at a time of rest, of unbroken joy, and of a holy
It is not the end but the commencement followed by an
day of eternal duration—the beginning of another
So that in the words of Barnabas the Messianic
will be but "a little while" (Justin, *Dial.*, 80)
of which not a single part of complete
ness, almost to be feared Christians who do not
it. He believes with the Jews, in a restoration
tion now of the city of Jerusalem, but a time that
will be the seat of the Messianic kingdom, and
at a future period, that there all believers
rise at once with Enoch and Elijah along with patriarchs
ophets will enjoy perfect felicity for one thousand
In fact he reads the visions into the Apocalypse of
which he understands to mean that before the
resurrection all believers are to rule for a time
Christ on earth. That a philosopher like Justin,
an Jew and Hellenic conviction of the Christian
, should nevertheless have accepted millenarianism
is the strongest proof that these enthusiastic
tions were inseparably bound up with the Christian
own to the middle of the 2d century. And another
found in the fact that even a predominantly Jewish
n like Corinthus not only did not renounce the
n hope, but pictured the future kingdom of Christ
nquets of carnal pleasures, of eating and drinking
arriage (texts cited by *H. P.*, in *Zeitschr. für*
After the middle of the 2d century the Jewish
ons were gradually thrust into the background
would never have died out, however, had not
tances altered and a new mental attitude been
up. The spirit of philosophical and theological
tion and of ethical reflexion, which began to prevail
the churches, did not know what to make of the
es of the future. To a new generation they seemed
earthly, and fantastic, and far-seeing men had good
to regard them as a source of political danger. But
han this, these wild dreams about the glorious Reign
Christ began to disturb the organization which the
s had scarcely set up to introduce. In the interest of
ervation against the world, the State, and the
, the Christian communities had formed themselves
mpact societies with a definite creed and constitu
d they felt that their existence was threatened by
te heat of religious subjectivity. So early as the
70 a church party in Asia Minor (the so-called
) rejected the whole body of apocalyptic writings
ceived of the Apocalypse of John as a book of riddles
ence; powerful was the reaction (in the so-called
n the controversy (c. 160–220) one of the principal
nvolved was the continuance of the chiliastic
ations in the Church. The Montanists of Asia
defended them in their integrity, with one slight
cation they expected that Pepuza, the city of
ns, would be the site of the New Jerusalem and
illennial kingdom. Modifications of this kind,
have often appeared in later times in connexion
he revival of millenarianism, are a striking evidence
tendency of every sect to regard its own little
er hope as the centre of the world and its fortunes as
rned of universal history. After the Montanistic
ersy, chiliastic views were more and more
ted in the Greek Church; they were, in fact,
ized as "Jewish" and consequently "heretical."
the Alexandrian theology that superseded them;
that is to say, Neo-Platonic mysticism triumphed
the early Christian hope of the future, first among
"cultured," and then, when the theology of the "cult
had taken the faith of the "uncultured" under its
tion, amongst the latter also. About the year 2
Egyptian bishop, Nepos, in a treatise called Ἐλεγχος
ἀλληγοριστων, endeavoured to overthrow the Origenistic
theology and vindicate chiliasm by exegetical means.
Several congregations took his part; but ultimately
Dionysius, bishop of Alexandria, succeeded in healing
the schism and asserting the allegorical interpretation
the prophets as the only legitimate exegesis. During
controversy Dionysius became convinced that the
of my great theology over "Jewish" chiliasm would
be overcome so long as the Apocalypse of John passed
an apostolic writing and kept its place among
homologoumena of the canon. He accordingly raised
question of the apostolic origin of the Apocalypse; and
reviving old difficulties, with ingenious arguments
own, he carried his point. At the time of Eusebius
Greek Church was saturated with prejudice against
book and with doubts as to its canonicity. In the
of the 4th century it was removed from the
canon, and thus the trouble-some foundation on
chiliasm might have continued to build was got
The attempt of Methodius of Tyre at the beginning
the 4th century and Apollinarius of Laodicea
360 to defend chiliasm and assail the theology of
had no result. For many centuries the Greek Church
the Johannine Apocalypse out of its canon, and consequently
chiliasm remained in its grave. It was considered
sufficient safeguard against the spiritualizing eschatology
of Origen and his school to have preserved the main dogma
of the creed and the *regula fidei* (the visible advent of
Christ, eternal misery and hell-fire for the wicked).
Anything beyond this was held to be Jewish. Not
only the chronologers and historians of the church,
following Julius Africanus, made use of apocalyptic
numbers in their calculations, while court theologians like
Eusebius entertained the imperial table with discussions
to whether the dining-hall of the emperor the throne of
David and Solomon, the beloved of God—might not be the
New Jerusalem of John's Apocalypse. Eusebius was
the first who dabbled in such speculations. Dionysius of
Alexandria had already referred a Messianic prediction of
the Old Testament to the emperor Gallienus. Such extremism and political servility between them gave the
death-blow to chiliasm in the Greek Church. It has
again obtained a footing there; for, although, late in the
Middle Ages, the Book of Revelation by what means we
cannot tell did recover its authority, the church of
that time so hopelessly trammelled by a magical cultus
to be incapable of such developments. In the Eastern
churches of the East (the Syrian, Arabian, and Æthiopian)
and in that of Armenia, the apocalyptic literature
preserved much longer than in the Greek Church. They
were very conservative of ancient traditions in general,
hence chiliasm survived amongst them to a later date
in Alexandria or Constantinople. It is to these churches
that we are mainly indebted for the extensive remains of
the old apocalyptic literature which we now possess. The
remote churches of the East Europe has recovered in
the last forty years many works of this kind which
enjoyed the highest repute throughout Christendom.

But the Western Church was also more conservative
than the Greek. Her theologians had, to begin with, no
turn for mystical speculation; their tendency was rather
to reduce the gospel to a system of morals. Nay, with
the moralists chiliasm had a special significance as the
distinguishing feature of the gospel, and the only

ve a specifically Christian character to their system. owever, holds good of the Western theologians only ne middle of the 3d century. The earlier fathers, s, Hippolytus, Tertullian, believed in chiliasm because it was a part of the tradition of the church ause Marcion and the Gnostics would have nothing ith it. Irenæus (v. 28, 29) has the same conception millennial kingdom as Barnabas and Papias, and in support of it to the testimony of disciples of the s. Hippolytus, although an opponent of Montanism, verthelss a thorough-going millenarian (see his *De Antichristo*). Tertullian (*cf.* especially *Adv. n.*, 3) aimed at a more spiritual conception of the ial blessings than Papias had, but he still adhered, lly in his Montanistic period, to all the ancient ations. It is the same all through the 3d and 4th es with those Latin theologians who escaped the ce of Greek speculation. Commodian, Victorinus ensis, Lactantius, and Sulpicius Severus were all ined millenarians, holding by the very details of mitive Christian expectations. They still believe

did, in the return of Nero as Antichrist, they peet that after the first resurrection Christ will reign is saints "in the flesh" for a thousand years. Once, ly once (in the Gospel of Nicodemus), the time is d to five hundred years. Victorinus wrote a ntary on the Apocalypse of John, and all the ians, especially Lactantius, were diligent students ancient Sibylline oracles of Jewish and Christian and treated them as divine revelations. As to the nity and apostolic authorship of the Johannine ypse no doubts were ever entertained in the West, an Apocalypse of Peter was still retained in the in the 3d century. That of Ezra, in its Latin tion, must have been all but a canonical book. mbers of extant manuscripts of the so-called 4 Ezra incredibly great, while several of them are found es of the Latin Bible at the beginning of the 16th y. The Apocalypse of Hermas was much read till rough the Middle Ages, and has also kept its place e Bibles. The apocalyptic "Testamenta duodecim charum" was a favourite reading book, and Latin ns of ancient apocalypses are being continually t to light from Western libraries (*e.g.* the *Assumptio* the *Ascensio Jesaiæ*, &c.). All these facts bear igorously the early hopes of the future maintained lves in the West. In the hands of monastic theo

s, like Lactantius, they certainly assume a somewhat ique form, but the fact that they cling to them clearest evidence that in the West millenarianism ill a point of "orthodoxy" in the 4th century. s state of matters, however, gradually disappeared he end of the 4th century. The change was brought by two causes, - first, Greek theology, which reached est chiefly through Jerome, Rufinus, and Ambrose, econd, the new idea of the church wrought out by tine on the basis of the altered political situation of urch. Jerome, the pupil of the Greeks, took him eady emancipated from "opiniones Judaicæ"; he les the old anticipations; and, though he does not e to reject them, he and the other disciples of the s did a great deal to rob them of their vitality. At me time the influence of Greek theology was by no so great in the West that this of itself could have ossed chiliastic views. It was reserved for Augustine a direction to Western theology which carried it of millenarianism. He himself had at one time ed in it; he too had looked forward to the holy th which was to be celebrated by Christ and His on earth. But the signs of the times pointed to a different prospect. Without any miraculous interpo of God, not only was Christianity victorious on ear the church had attained a position of supremacy. old Roman empire was tottering to its fall; the stood fast, ready to step into its inheritance. It w imply that the world power, the enemy of Chris been vanquished, the fact was that it had gra abdicated its political functions in favour of the Under these circumstances Augustine was led, in h troversy with the Donatists and as an apologist, to r the political side of the catholic church, - to gra elaborate the idea that the church is the kingdom of and the city of God. Others before him may have the same view, and he on the other hand never forg true blessedness belongs to the future, but still he w he it who ventured to teach that the catholic church, empirical form, was the kingdom of Christ, th millennial kingdom had commenced with the appear Christ, and was therefore an accomplished fact. I doctrine of Augustine, the old millenarianism, thou completely extirpated, was at least banished from the of dogmatic. For the official theology of the chu very soon became a thing of the past, certain eleme it were even branded as heretical. It still lived on ever, in the lower strata of Christian society, a certain undercurrent of tradition it was transmitte century to century. At various periods in the his the Middle Ages we encounter sudden outbre millenarianism, sometimes at the foot of a mou sometimes as a far-reaching movement. And, since been suppressed, not, as in the East by mystical tion, its mightiest antagonist, but by the political of the hierarchy, we find that wherever chiliasm in the Middle Ages it makes common cause w enemies of the secularized church. It strengthen hands of church democracy, it formed an allianc the pure souls who held up to the church the i apostolic poverty, it united itself for a time eve mystic-m in a common opposition to the supremacy church; nay, it lent the strength of its conviction support of laity and prince in their effort to bre political power of the church. It is sufficient to re well-known name of Joachim of Floris, of all the m Franciscan spiritualists, of the leading sectaries fr 13th to the 16th century who assailed the papa the secularism of the church, above all, the n Occam. In the times the millenarian mood of the church came to life again, and in the revolutionary ments of the 15th and 16th centuries especially Anabaptist movements - it appears with all its old pressing energy. If the church, and not the ta regarded as Babylon, and the pope declared to Antichrist, these were legitimate inferences fro ancient traditions and the actual position of the But, of course, the new church was not in every identical with the old. It could not hold it without admitting certain innovations. The "eve gospel" of Joachim of Floris was a different thin the announcement of Christ's glorious return in the of heaven, the "age of the Spirit" which mystic spiritualists expected contained traits which m characterized as "modern", and the "kingdom Anabaptists in Munster was a Satanic caricatur kingdom in which the Christians of the 2d century to a peaceful Sabbath rest. Only we must not to ideas of the great apocalyptic and chiliastic move the first decades of the 16th century from the ra Munster. There were pure evangelical forces at it; and many Anabaptist need not shun compari the Christians of the apostolic and post-apostolic ag

German and Swiss Reformers also believed that the
the world was near, but they had different aims in
om those of the Anabaptists. It was not from
and apocalyptic-m that they hoped for a reforma-
the church. In contrast to the fanatics, after a
sitation they threw millenarianism overboard,
ng with it all other "Jewish notions." They
p the same ground as the Roman Catholic Church
Catholic Church had since the time of
. How nearly they reached the latter and
th the helped open the way for German and Anabaptist
into the heart of the Reformation, chiefly
the Reformers afterward also in the
an Church, became misunderstood with
, how an essentially
ime, which could be developed from a belief in
ld upon texts of the Bible how fatally new
pure conscience and there with apocalyptic and
perfectism—these are matters which cannot be
ted upon here, but one remark ought to be
n conclusion. A genuine and intense revival of
hopes always arises when the stretch of [illegible]
comes paralyzed to such a degree that tender
ce can no longer feel sure of the truth within
n the one hand all clubs to phenomena in the history
church demand special attention. But when
are made to find room for millenarianism in our
e system, it must always appear in which
d be utterly unrecognizable to the proclamation
ancient church, who, just because they were
arians, despised dogmatics, in the sense of philo-
l theology. The claim of chiliasm rests only
the acknowledgement that in former times it was
ed to all appearance unreasonably associated
he gospel itself. Those who try to reveal it
conserve it "element of truth, put contempt
while they destroy it, for it was in itself, in its
incomprehensible energy of all reason, [illegible]
event alone with the unspeakable wealth of its
hrist ion.

[illegible], *Lehrbuch der Neuen* [illegible]; Cornill, *Briefe des* [illegible]; [illegible] history of chiliasm has not yet appeared. A. HAUCK.

LLER, Hugh (1802–1856), columnist in science and
re, and one of the most remarkable among self-
men of genius, was born at Cromarty, on the north
st of Scotland, on the 10th of October 1802. He
d seafaring and from a skilled seaman who owned a
el by sailing his own boat, perished at sea when
was five years old. His mother looked much to
ort and encouragement of her son, to her two brothers, James and
ew Wright, the one a soldier, the other a seafarer.
h to piety, more religion, unflagging industry,
ittle entertainment were the lessons which these
ors seemed to preach by precept and by example, most readily
be learned. But young Miller had inherited from his
r a strong sense of duty and obstinate force of will
[illegible] to take a line of his own.
chantment of books and freedom the mere sight
of mother-of-pearl shell and by the sea mist
thirteen years old [illegible] and his schoolmaster
t it likely that he would prove a dunce. Nevertheless
truant school-boy was already giving indications of
stination of the poet. It is too early to date
found in his precocious zeal that led him to
of mechanical models. His mother summed up,
mewhat dialect of the district, the impressions derived
er son's boyhood and youth in the words, "he was
ton." But the writing, from the first and increasingly
went on, could be distinguished from the ordinary
productions of boyhood. A continuity of idea, an
finable grace and freshness, marked his perform
They were never bombastic or verbose. At no pe
his life did he suffer from a thrix of words. But, b
man, he had a felicitous knack of fitting words int
right places and avoiding jerkiness and inequalit
verse he lacked the passionate intensity required fo
rhythmic movement, but he had a fine sense of c
and modulation in prose.

It is a curious fact that what determined Hugh
to apprentice himself to a stone mason was his
ry literary composition. Unemployed during the
frost, the lad, as he perceived, could enjoy for
month every year the ecstacy of writing. One re
his decision was that he never learned any langua
English. Another was that fifteen years of the quar
the hewing bed, with stern experiences of over-wo
privation, sowed in his frame the seeds of incurable
Meanwhile the disadvantages of his decision were indisp
Under the discipline of labour the refractory sch
became a thoughtful, sober-minded man. Miller
looked back to his years of hand-labour with a satis
that his sometime neat of eternity and pathos. "
upright, self-relying lad," he exclaims; "who that
thy solid worth and value would be ashamed of th
hand, and thy soiled vestments, and thy obscure ta
thy humble cottage, and hard couch, and homely fa

It cannot be added that his fifteen years of cl
constant intercourse with fellow-workmen inspired hi
much respect for their class. He was most unfor
in his comrades during the two seasons, 1824 and
when he worked at Niddrie in the neighbourh
Edinburgh. Staunch in their enjoyments, meanly
in their class ambitions, and fatuously subject to
charlatan that Niddrie squad of reprobates which
[illegible] in *The Schools and Schoolmasters* stamped
mind of Hugh Miller an indelible conviction of th
poverty and degradation of the hand-workers.

Returning to Cromarty, he worked in happy pati
a stone cutter year after year, sedulously prosecu
the same time the grand object of his ambition, t
good English. He found time to invigorate and em
mind by careful reading, and was habitually and
observant both of man and of nature. His readi
not extensive but well chosen, and embraced Loc
Hume, Goldsmith and Addison were, more tha
others, his masters in style. It was to get time to wr
he had become a stone mason; another of the surpr
his career is that it was in advertising himself as a
that he came before the world as a literary man. M
mason, he mentioned as a poetical contributor to the *E*
Courier, might, he thought, be asked by some
readers to original inscriptions on tombs. He th
forwarded one of his verses to the editor. Thes
to have been consigned to the waste paper basket
had been the fate of an "Ode on Greece" offered
Scotsman when he was at Edinburgh. Piqued
second failure, he now resolved, at all hazards, to s
self in print. In 1829 appeared the small volume o
as *Poems Written in the Leisure Hours of a Jour*
Mason. It presented its author the valuable friend
Mr Robert Carruthers, and was favourably noticed
press. Miller looked at his poems in print, and con
at once and irreversibly, that he would not succe
poet. It was a characteristic and very manly d
proving that there was no fretting vanity in his disp
Doubtless also it was right. His field was prose,
though his poems yielded nothing in the way of f
they were a beginning of fame. The simple nat
Cromarty began to think him a wonder. Some v

nt letters on the herring fishery extended his reputation. d judges in Edinburgh detected in his work the mint k of genius, and Miller's first prose volume, *Scenes and ends of Cromarty*, was published there in 1835. In the rval he had become the accepted lover of Miss Lydia ser, a young lady of great personal attractions, rare intetual gifts, and glowing sympathy with all that was l and brave and bright. Her affection naturally dded him in his resolution to emerge from the hand rking class; the mallet and chisel gradually dropped n his grasp; and when his prose venture appeared he being initiated, in Linlithgow, into the duties of k clerk. On his return to Cromarty he found employnt in the local branch of the Commercial Bank.

He was a married man, and his tenure of a stable fixed Cromarty, when the agitation that preceded the Disup of 1843 made the air of Scotland vibrate. Miller ed his church, and deliberately threw in his lot with the uable institution possessed by the Scottish people. vently as he had sympathized with those who protested ftical representation for Scotland in the Reform Bill he more fervently took part with those who claimed that ttish congregations should have no power to call their own. In the summer of 1839 he wrote his Essays in phlet-letter to Lord Brougham, Dr Chalmers read it h "nothing short of rapture", and the latter end of 0 saw Miller installed in the editorial chair of the *Witness* spaper, published twice a week in Edinburgh to advoe the cause of non intrusion and spiritual independence. continued to edit the *Witness* till his death which took re in the night between the 23d and 24th of December 6. Unremitting brain work had overtaxed a system manently injured by the hard-ships of his early manhood; reason at length gave way, and Miller died by a pistol t fired by his own hand. A *post mortem* examination, sted by four medical men of the highest character, ced the presence of "disease of appreciable magnitude in the in, and he left a few words indicating the form taken the insane delusion which had mastered him.

During the three years preceding the Disruption, chamnship of the church by Miller did more, probably, than other single agency to win for it the sufferance of the ttish people. Months before the day of separation, name "Free Church" was prospectively adopted to party proposing to sever connexion with the state; l, whether Hugh Miller suggested the name or did not, was one of the chief architects of the institution. Nor the sequel shown that his labour was vain.

But long ere now an enthusiasm parallel in intensity h that which he felt for his country and its church, l to which even his old literary enthusiasm had become servient, had taken possession of him. From infancy had been a keenly interested observer of all natural ts and objects, and during his career as apprentice and rneyman mason he had accumulated a vast store of the rticular information belonging to the geologist. But it s not until later that he expressly undertook the study geology. We still find him, when twenty-seven, laying wn charts of study and production without a word about ence. When, however, he had convinced himself that road to the stars was not by poetry, and when the ited success of his prose tales and literary essays in the ume on Cromarty suggested a profound misgiving as the adequacy of his purely literary materials to produce important result, he bethought him of his hoard of ientific knowledge, and addressed himself with the con trated energy of mature manhood to geological reading d geological researches. These, in fact, were not new him, and he was much impressed by the interest excited ong scientific readers by a geological chapter in the *Scenes and Legends*. His chief master was Lyell he reverenced henceforward as one of the greatest o men. The principal scene of his own investigatio the Cromarty district, where he ransacked every of the hill side, and traced every stratum sawn thro the watercourse, and where, on the beach at ebb, in in clay of bluish tint and great tenacity, belonging Old Red Sandstone formation, he discovered and nodules, which, when laid open by a skilful blow hammer, displayed certain organisms that had nev seen by a human eye. He had entered upon correspo with Murchison and Agassiz, and Fellow of the Ge Society and professor of college had been brought h descriptions "to take place the rock of Cromarty with the patriotic and religious enthusiasm, then to burned within him when he went to champion his in Edinburgh, there showed, in the depths of hi not indeed a stronger but a more gentle and pe greater enthusiasm not for that science in which he excelled, he had something of his own to say, somet which the world of culture would be glad to h early as September he [illegible] there began to appear *Witness* a series of articles entitled "The Old Re stone." They attracted immediate and eager att and the month was not at an end when, at the me the British Association, Murchison brought them the notice of the geological section, presided over b Agassiz, already familiar from Miller's correspo with the organisms described, contributed note respecting them, and proposed that one of the remarkable of the fossils should be called *Pt Millerii*. Buckland joined warmly in the encom Murchison and Agassiz vowing that "he would left hand to possess such powers of description mate." The article which met with so enthus reception from the most eminent geologists m formed the nucleus of a book soon after publi entitled *The Old Red Sandstone*. It established reputation not only as an original geologist b practical thinker of great sagacity, and as a fa fascinating writer. He had at last fairly found hi it is impossible to turn from the *Scenes and Legend* new volume without feeling that the spirit of the has become more exultant, his touch at once stron more free.

During his seventeen years of residence in Edinbu he a variety of book[illegible] of [illegible] attention not only to [illegible] arrangement [illegible] appreciated whenever [illegible] moderation of [illegible] observation the [illegible] with the [illegible] and the [illegible] of travels. Apart [illegible] party [illegible] with the [illegible] most [illegible] formed the nucleus of a [illegible] opinion [illegible] [illegible] [illegible]

ichthyologists unanimously me t d on t- being dor-al,
one of the mo t illustrations to be found of an obsc t
faculty, which is son a well a
as al o, in his principal geological books, *The Footsteps of*
tor and *Th Testimony of the Ro k*, a
he regarded as their
and pl ant for Miller
qu tion He would thus
cattle expert He would
many on hi own side;
aining so well as the
of objections But
ow ver reserve The
e ome of hi controversial
th Royal The ad ersary
th mo t eminent repre
the fact, that claim the
ebate line of demarcation
Paleozoic strata He could
being a alterna between
the op" he could dare to
other
ity intervene
ogical process ha
It i becom impo sible to obtain any change like
tion among gentle men as to the priority of
between period and period which however wide
marine of on a ended to "moraine, and
table to be mainta ned in Miller theory
of creati "Ge graphical provinces and
s Prof Huxley "may, how ever, be distinctly
n the Palæozoic epoch a at present, and there commonly
ppearance of new genera and pe which we ascribe
eation may be simply to alt of migration Such is now
ed opinion of ecologi t, and we may be sure that Miller,
r shut his eyes to ascertained fact would accept
ha said in so many word that the Bible d es not te

long an memorable debate on the order of p ri ds he
dv nced, maintaining, against the author of the *Vestiges*,
me of re the creation But which he did o he could
Buckland, Sedgwick, Murchison and Lyell were on his
e a paradox to believe that he was ually at Darwin
If the author of the *Vestiges* was right, Darwin was wrong
of fact the former was very nearly right but, precisely
Darwin applies what is lacking in , the e who
ntly assent to the *Origin of Species* would not be at
ation

e chiefly perhaps in connexion with the sweetness and
ccuration of his style, and the lovely view he gives of
fact that we ought to prize Hugh Miller In an age
of sham, yet abounding also in extravagance hat and
, the well-educated tone men on w
ler tion of Addison. His powerful pre ogative was
to draw just those line , and to lay on just those color
hould dominate the past As his friend Cunningh
he critic of style, observed, "the to d to men
ing pas to live and flourish, to fly, swim or crawl
ed up in vegetative profusion and splendour, as on
wn of creation Such power belongs to rich creative
you and he has treated to the study of nature ten of
his thought to find in geology no more than a cat gue of
ames, tedious by common in fossil stones, but a Science
well as an intelligent understanding of the rocky
the world

Life and Letters of Hugh Miller by Peter Bayne (2 vols. London, 1871). (P. L.)

MILLER, WILLIAM (1781–1849), the founder of an
American religious sect holding peculiar millennarian views,
rn at Pittsfield, Massachusetts, in 1781. He received
mperfect education In the war of 1812 he served
ain of a battalion on the Canadian frontier While
g at Low Hampton, N.Y. he began in 1833 publicly
ure on the subject of the millennium, asserting that
cond coming of Christ would take place in about
ars. His doctrine awakened wide interest among
classes of the community In 1840 a semi-monthly
, *The Signs of the Times*, was started by one of his
rs, and two years later the *Advent Herald* made its
ance About 1843 the second coming of Christ was
ed by as many as 50,000 believers in the doctrines of Miller; and, although the disappointment of their
somewhat diminished their numbers, many continue
adherence to his tenets regarding the nature of the
mium. At present the number of Millerites or Adven
estimated at from 15,000 to 20,000. Miller died a
Hampton, Washington county, N.Y., December 20,

MILLER, WILLIAM (1796–1882), one of the g
of modern line engravers, was born in Edinburgh
28th of May 1796. After studying in London
George Cook, a pupil of Basire's, he returned
native city, where he continued to practise his art
a long interval He executed plates after Thom
Dodding ton Macculloch, D. O. Hill, Sir George L
and other Scottish landscapists, but his most adm
and most voluminous works were his transcript
Turner The first of these was the Clovelly (1824),
Southern Coast, a publication undertaken by his
and his brother William B. Cook, to which Miller al
tributed the Combe Martin and the Portsmouth
was engaged on the illustrations of *England and*
1827–38, of *The Rivers of France*, 1833–35; of
Poems, 1834, and very largely on those of *The Pr*
Poetical Works of Sir Walter Scott, 1834. In *Th*
ental Antiquities and Picturesque Scenery of Sc
1836, he executed a few excellent plates after Th
and Turner Among his larger engravings of T
works may be mentioned The Grand Canal, Venice
Rhine, Osterspey, and Feltzen; The Bell Rock; The
of London and The Shepherd. The art of William
was warmly appreciated by Turner himself, and Mr
has pronounced him to be on the whole the most suc
translator into line of the paintings of the greatest l
landscapist His renderings of complex Turneria
effects are especially delicate and masterly. Towar
end of his life Miller abandoned engraving and occup
himself more in the production of water colours, many of
were exhibited in the Royal Scottish Academy, of
he was an honorary member. He resumed his
however, to produce two final series of vignette
drawings by Birket Foster illustrative of Hood's
published by Moxon in 1871. Miller was a
respected member of the Society of Friends. H
while on a visit to Sheffield, on the 20th of J
1882.

MILLER'S THUMB (*Cottus gobio*), a well-known
fish, abundant in all rivers and lakes of northe
central Europe with clear water and gravelly b
The genus *Cottus*, to which the Miller's Thumb bel
easily recognized by its broad, flat head, rounde
scaleless body, large pectoral and narrow ventral fin
two dorsal fins, the anterior shorter than the pos
the præopercle is armed with a simple or br
spine. The species of the genus *Cottus* are rather nu
and are confined to the north temperate zone of the
the majority being marine, and known by the name of
head." The Miller's Thumb is confined to fresh
and only one other freshwater species is found in
C. poecilopus, from rivers of Hungary, Galicia, a
Pyrenees, some others occur in the fresh waters of n
Asia and North America. The Miller's Thumb is c
all notable localities in Great Britain, but is ex
rare in Ireland, in the Alps it reaches to an
exceeding 7000 feet. Its usual length is from
inches Generally hidden under a stone or in a ho
the bank, it watches for its prey, which consists
aquatic animals, and darts when disturbed with
ordinary rapidity to some other place of refuge
female deposits her ova in a cavity under a stone
the male watches and defends them until the yo
hatched and able to shift for themselves.

MILLET

LLET (French, *millet*; Italian, *miglietto*, diminutive *iglio* — Latin *mille*, a thousand, in allusion to its y) is a name applied with little definiteness to a conble number of often very variable species of cereals ging to distinct genera and even subfamilies of *inæ*. The true millet, however, is generally admitted *Panicum* (*Setaria*) *miliaceum*, L. (German *Hirse*, which *P. miliare*, Lam., is reckoned by some ists). It is indigenous to the East Indies and North dia, but is mentioned by Hippocrates and Theo ns as already cultivated in South Europe in their Some suppose it to be one of the earliest grains used ad making, and ascribe the origin of its name to *pinso*, rather than to the paniculate inflorescence. It l, requires rich but friable soil, grows to about 3 or 4 gh, and is characterized by its bristly, much branched ng panicles. One variety has black grains. It is y cultivated in India, southern Europe, and northern , and ripens as far north as southern Germany, in wherever the climate admits of the production of wine. grain, which is very nutritious, d in the form of groats, and excellent bread when mixed heaten flour. It is also largely for feeding poultry and cage for which purpose mainly it is ted. *P. italicum*, L. (*Setaria* , Beauv.), is of similar origin distribution, and is one of the wholesome and palatable Indian s. It is annual, grows 1 to 5 igh, and requires dry light soil. an Millet (*P. germanicum*, Ger *Kolbenhirse*, *Mohar*) is probably y a less valuable and dwarf y of *P. italicum*, having an compact, and shorter spike grains of both are very small, one half as long as those of on millet, but are exceedingly e. Many stalks arise from a root, and a single spike often 2 oz. of grain, the total yield five times that of wheat. They nported for poultry feeding like rmer species, but are extensively in soups, &c., on the Continent. erous other species belonging to ast genus the largest among grasses, of which

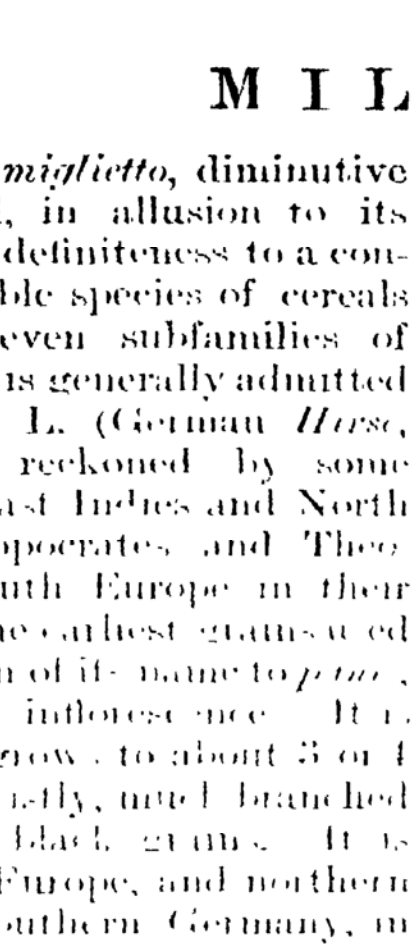


FIG. 1.—*Panicum italicum*.

ring are among the most important are also cultiin tropical or sub-tropical countries for their grain or der grasses, or both, each variety of soil, from swamp sert, having its characteristic forms. They are very y acclimatized wherever the temperature is sufficient, n Australia, and seem destined to rise in agricultural tance.

sh Millet is *P. digitaria*; *P. pennicatacum* Roxb., Shamalo, an grass, is probably a native of tropical Africa; while the ial *P. spicatum*, Roxb., also largely cultivated in tropical ies, is from Sumatra. *P. decompositum* is the Australian , its grains being made into cakes by the aborigines. *P. um*, Jacq., is the Guinea Grass; it is perennial, grows 8 feet and yields abundance of highly nutritious grain. *P. spec.* Nees., is the Coapim of Angola, but has been acclimatized in and other tropical countries. Other grain-bearing species 6 or 7 gh form the field crops on the banks of the Amazon. Of species ging to allied genera, *Pennisetum thyphoideum*, Rich. (*Penia spicata*, Willd.), Bajree, sometimes also called Egyptian , a Guinea corn, is largely cultivated in tropical Asia, Nubia, gypt. *P. distichum* grows south of the Sahara. Species of *lum*, *Eleusine*, and *Milium* are also cultivated as millets.

t the most important dry grain of the tropical countries of Africa and Asia, particularly of India, is *Sorghum* Pers. (*Holcus Sorghum*, L., *Andropogon Sorghum*, Durra, Great Millet, Indian Millet, Turkish Mi Guinea Corn (the French *sorgho*, German *Mohren hirse* or *Kaffernkorn*, Tamil *Cholam*, Bengalese *Jowaree*). It ranges probably as extensively as wheat, being also largely cultivated in southern Europe, the United States, and the West Indies. In Asia Minor, Arabia, Italy, and Spain it may be used to replace oat and barley. It is annual, and may reach 12 feet in height; it is extremely prolific, even rivalling maize, of which it is a great congener. Its flour is very white, but does not easily make good bread, it is largely used in cakes and puddings and for feeding cattle and poultry. The panicles are used for brooms, and the roots for velvet brushes.

FIG. 2.—*Sorghum vulgare*.

S. bicolor, *S. nigrum*, *S. rubrum*, *S. Kaffrorum* (Guinea Corn), *S. saccharatum*, and other species or varieties also of economic importance, the last named (the "Chinese sugar-cane") being much cultivated in the United States as a source of molasses, the juice, which contains much but comparatively little cane sugar, being simply evaporated and concentrated by evaporation. *S. vulgare* is the species referred to by Pliny as millet.

For systematic and economic purposes, see Grisebach, *Med.-Pharm. Botanik*, Leipzig, 1880; Drury, *Useful Plants of India*, London, 1873; F. v. Mueller, *Select Plants, for Naturalization in Victoria*, Melbourne, 1876. For carpology, see *Kulturpflanzen*, &c., Berlin, 1877. On *Sorghum* or "Guinea corn," &c., of western Kansas, see Drummond, "Report," *Patent Office Papers*, No. 2570 (1880).

MILLET, JEAN FRANÇOIS (1814–1875), was a of French peasant life, and it may be questioned whether France has produced in our day any greater original artist. He himself came of a peasant family, was born on the 4th of October 1814 in the hamlet of Gruchy, near Gréville (La Manche) in the picturesque district called Le Hameau. His boyhood passed working in his father's fields; but the sight of engravings in an old illustrated Bible set him drawing, thenceforth, while the other slept, the daily hour was spent by Millet in trying to render the familiar objects around him. From the village priest the lad learnt the Bible and Virgil in Latin, and acquired an interest in one or two other works of a high class which accompanied him to his home. He did not, however, attract attention so much by his attainments as by the stamp of his mind. The whole family seems, indeed, to have worn a cast of antique sanity and dignity, and when Millet's father decided to test the vocation of his son as an artist, it was with a gravity and authority which recall the patriarchal households of Calvinist France. Two drawings were prepared and placed before a painter at Cherbourg, Langlois de Monchel, who at once recognized the boy's gift, and accepted him as a pupil; but shortly after (1835) his father died, and the eldest son, with heroic devotion, took his place at home, nor did he return to his work in

g calls from without were solemnly enforced by the of his own family. He accordingly went back to burg, but after a short time spent there with another (Langlois) started with many misgivings for Paris. municil general of the department had granted him a f 600 francs, and the town council promised an pension of 100, but in spite of friendly help and ction Millet went through great difficulties. The of the Ecole [illegible] was hateful to him, [illegible] vocation that he decided [illegible] de Drouais. The master [illegible] good, he saw his ability, poverty could not longer put the [illegible] to the cabinet pour to the studies, [illegible] ake him take the approved direc- [illegible] Eh, bien, allez à votre guise, [illegible] et mon cher je ne veux rien vous [illegible] Millet when the competition for the Grand Prix [illegible] Delaroche gave Millet to understand that he [illegible] lose the nomination of another, and there- [illegible] Millet withdrew himself, and with his friend Marolle [illegible] a little studio in the Rue de l'Est. He had of the beaten track, but he continued to study [illegible] hilst he sought to procure bread by painting por- at 10 or 15 francs a piece and producing small [illegible] hes" of Watteau and Boucher. These works are [illegible] as those of his "flowery manner," and Millet has [illegible] preached he whose whole life was in fact of con- with having sacrificed his convictions to curry with the public. It is true that he himself has d his aversion to both these masters. "In the ," he said, "I received vivid impressions from ena, complete from Michelangelo, after Michelangelo assin I have remained faithful to the early masters. er was for him an object of "repulsion" and in "I saw," he said, "a little theatrical world which ed me." Thus it was then that Millet naturally I saw, but the strongest genius knows moments of ubt. Later in life Millet was heard to say that not for the small group who believed in him he have lost faith in himself. In earlier years, before certain of his own leadings, he was naturally influ- by the advice of others whose arguments were enforced pressure of dire poverty. Even so from time to he native vein showed strong. In 1840, as soon as de patched a portrait to the Salon, Millet went back ille, where he painted Sailor Mending a Sail and a ner pictures reminiscences of Cherbourg life. His ccess was obtained in 1841 when his Mill woman son in Riding (pastel) attracted notice at the Salon, ndly artists presented themselves at his lodgings- learn that his wife had just died, and that his broth- had appeared. Millet was at Cherbourg, there he ed, but having amassed a few hundred francs he t to Paris and presented his St Jerome at the t time. This picture was rejected and exists no for Millet, short of canvas, painted over it Oedipus nd, a work which during the following year was the of violent criticism. He was, however, no longer Diaz, Théodore Rousseau, and other men supported him by their confidence and friendship, had by his side the brave Catharine Lemaire, his wife, a woman who bore poverty with dignity and courage to bear her and through the cruel trials in he penetrated by a terrible personal experience the secrets of the very poor. To this date belong Golden Age, Bad News, Young Girl and Lamb, athers; but to the Bathers (Louvre) succeeded The r Asking Alms, The Workman's Monday, and The ower. This last work, exhibited in 1848, obtained conspicuous success, but did not sell till Ledru Rol informed of the painter's dire distress, gave him 500 fra for it, and accompanied the purchase with a commissi the money for which enabled Millet to leave Paris Barbizon, a village on the skirts of the forest of Fontai bleau. There he settled in a three-roomed cottage for rest of his life twenty-seven years, in which he wrou out the perfect story of that peasant life of which he al has given a "complete impression." Jules Breton coloured the days of toil with sentiment; others, Courbet, whose eccentric Funeral at Ornans attracted m notice at the Salon of 1850 than Millet's Sowers Binders, have treated similar subjects as a vehicle protest against social misery, Millet alone, a peasant a man table one himself, saw true, neither softening exaggerating what he saw. In a curious letter written M. Sensier at the date (1850) Millet expressed his reso to break once and for all with mythological and undra subject, and the names of the principal works pain subsequently will show how stedfastly this resolution kept. In 1852 he produced Girls Sewing, Man Spread Manure, 1853, The Reapers, 1854, Church at Grév (Luxembourg); 1855 the year of the Internatio Exhibition, at which he received a medal of second class Peasant Grafting a Tree, 1857, The Gleaners; 1859, T Angelus (Louvre, engraved Waltner), The Woodcutter Death; 1860 Sheep Shearing; 1861, Woman Shear Sheep, Woman Feeding Child; 1862, Potato Plant Winter and the Crows; 1863, Man with Hoe, Wom Carding; 1864, Shepherds and Flock, Peasants Bring Home a Calf Born in the Fields; 1869, Knitting Less 1870, Buttermaking; 1871, November- recollection Gruchy. Any one of these works will show how great influence Millet's previous practice in the nude had u his style. The dresses worn by his figures are not cloth but drapery through which the forms and movements of body are strongly felt, and their contour shows a gr breadth of line which strikes the eye at once. Someth of the imposing unity of his work was also, no doubt, to an extraordinary power of memory, which enab Millet to paint (like Horace Vernet) without a model; could recall with precision the smallest details of attitu or gestures which he proposed to represent. Thus he co count on presenting free from after thoughts the vi impressions which he had first received, and Millet's nat was such that the impressions which he received w always of a serious and often of a noble order, to wh the character of his execution responded so perfectly t even a Washerwoman at her Tub will show the gr action of a Medea. The drawing of this subject is rep duced in *Souvenirs de Barbizon*, a pamphlet in which Piedagnel has recorded a visit paid to Millet in 18 His circumstances were then less evil, after struggles severe as those endured in Paris. A contract by wh he bound himself in 1860 to give up all his work three years had placed him in possession of 1000 fra a month. His fame extended, and at the exhibition 1867 he received a medal of the first class, and ribbon of the Legion of Honour, but he was at the sa moment deeply shaken by the death of his faithful fri Pouchon. Though he rallied for a time he never c pletely recovered his health, and on the 20th Janu 1875 he died. He was buried by his friend's side in churchyard of Chailly.

Sensier, *Vie et Œuvre de J. F. Millet*, 1874; Piédag *Souvenirs de Barbizon*, &c. (E. F. S. P

MILLVILLE, a city of the United States, in Cumberl county, New Jersey, at the head of navigation of Mau river, 40 miles by rail from Philadelphia by the Cape M Millville, and Vineland section of the West Jersey Railro

is one of the chief seats of glass-making in the State, d also manufactures cotton, iron pipes for water and gas, rbines, &c. The population was 7660 in 1880.

MILMAN, Henry Hart (1791–1868), dean of St ul's, was born February 10, 1791, and was the third n of Sir Francis Milman, physician to George III. He s educated at Eton and at Brasenose College, Oxford; s university career was brilliant, and among other dis nctions he gained the Newdigate prize with a poem on e Apollo Belvedere. In 1816 he was ordained, and wa on afterwards presented to the living of St Mary's eading. He had already made his appearance as a amatic writer, his tragedy of *Fazio*, founded on a narra e in the *Annual Register* for 1795, having been brought the stage without his knowledge under the title of *The alian Wife*. It was subsequently produced at Covent rden, and obtained great succe s from the acting of iss O'Neill as Bianca. The merit of the play consists iefly in the powerful situation; the diction is florid and nate. The same criticism, by the author's own conte n, applies to his epic, *Samor, the Lord of the Fair ty* (Gloucester), a poem written in early youth. The bject is taken from British legend, and Milman has failed invest it with serious interest. He was more successful his next attempts, where the subject were well adapted an imagination easily kindled by the historical or the oral picturesque. The death struggle of an expiring tion in the *Fall of Jerusalem* (1820), the conflict of new ath and old order, of religious enthusiasm and earthly ection, in the *Martyr of Antioch* (1822), are depicted th great eloquence and real insight into human nature. lman's characters, however, are personified tendencies ther than personages, and in poetical style he was unable free himself from the influence of Byron. *Belshazzar* 822) is in general a pale copy of Byron's *Sardanapalus*, t contains some fine lyrics. Milman's lyrics, indeed, pecially his hymns, have frequently a fine ring and sweep, ough the thought is generally commonplace. His gedy of *Anne Boleyn* (1826) is a poor performance. ith the exception of admirable versions of the Sanskrit isode of Nala and Damayanti, and of the *Agamemnon* d *Bacchæ*, this was Milman's last poetical work.

s elected professor of poetry at Oxford, and in 1827 ivered the Bampton lectures, selecting as his subject the nduct and character of the apostles as an evidence of ristianity. In 1830 his *History of the Jews* appeared in e Family Library. The contracted limits of this series lbade any adequate treatment of the subject; the work nevertheless memorable as the first by an English rgyman which treated the Jews as an Oriental tribe, ognized sheikhs and emirs in the Old Testament, sifted d classified documentary evidence, and evaded or nimized the miraculous. Milman was violently attacked, pecially by Dr Faussett and Bishop Mant, and the odium is occasioned stopped the publication of the Family brary, and long impeded the preferment of the writer. 1835, however, Sir Robert Peel made him rector of St argaret's and canon of Westminster, and in 1849 he came dean of St Paul's. The unpopularity attaching to n had by this time nearly died away; and now, generally ered and beloved, intimate with men of all pursuits, litics, and persuasions, counted among the chief ornaments the most polished society of the metropolis, he occupied singularly dignified and enviable position, which he nstantly employed for the promotion of culture and ightenment, and in particular for the relaxation of bscription to ecclesiastical formularies. His *History of ristianity under the Empire* had appeared in 1840, but d been as completely ignored as if, said Lord Melbourne, clergy had taken a universal oath never to mention it to any one. Widely different was the reception continuation, his great *History of Latin Christi* the death of Pope Nicholas V., which appeared He also edited Gibbon and Horace, and at his 1868 left behind him almost finished a delightful of his own cathedral, which was completed and p by his son.

Milman possessed a large share of the imagination whi nto and calls up the past, and of that which interprets a pprehends opinions by the power of sympathy. In magination he was deficient, a defect which alone preve rom attaining the first rank as an historian. His crowded with splendid names rather than with vivid pe the pomp of action are dwelt with considerable penetra the actor himself is rather heard than seen. There are Exceptions, such as the portrait of Sir Christopher W he possessed a peculiar power of investing mere m ecedence with personality and life. His parallel of Teutonic Christianity, for example, a piece of finished character painting. His power of sympathy rendered him a his natural equal, and he may more than an int nded to his forensic polemic, only less readable perhaps with panthers. It will be long before even work superseded will perhaps be remembered even so as an elaborate the quiet to which the laborious scholar and patient appeared capable of encountering or to reward his amongst historical critics.

MILO, one of the most famous athletes of whose name became proverbial for personal s He lived about the end of the 6th century B.C., times crowned at the Olympic games and six time Pythian for wrestling, and was famous throughc civilized world for his feat of strength, such as an ox on his shoulders through the stadium at C In his native city of Crotona he was much honou he commanded the army which defeated the pe Sybaris in 511 B.C. When Democedes, the phys Darius, deserted the Persian service, he sent a message to the king of Persia informing him marriage to the daughter of Milo. The traditional of his death is often used to point a moral: he tree which some woodcutters had partially split wedge, and attempted to rend it asunder, but th fell out, and the tree closed on his hand, imprisoni till wolves came and devoured him.

MILO was the surname of T. Annius Papianus, the best known of the partisan leaders and ruffian stormy times that preceded the dissolution of the republic. His father was C. Papius Celsus, but adopted by his mother's father T. Annius Luscu joined the Pompeian party, and led the band of mer and gladiators which was required to defend the ca its chief supporter in the public streets. P. Clod leader of the ruffians who professed the democrati was his personal enemy, and their brawls in the stre their mutual accusations in the law courts lasted for years, beginning when Milo was tribune of the c in 57 B.C. In 53 their quarrels came to a heigh Milo was candidate for the consulship and Clodius praetorship, and when the two leaders met by acci the Appian Way at Bovillae, Clodius was murdered (. 20, 52 B.C.). This act of violence strengthened th of Pompey, who was nominated sole consul, and p several stringent laws to restore order in the city was impeached; his guilt was clear, and his enem every means of intimidating his supporters and his Cicero was afraid to deliver the speech he had p *Pro Milone*, and the extant oration is an expanded the unspoken defence. Milo went into exile at M and his property was sold by auction. He joi insurrection of M. Celius in 48 B.C., and was sc near Thurii in Lucania. His wife Fausta was d of the dictator Sulla.

MILTIADES. See Greece, vol. xi. p

M I L T O N

TON, John (1608–1674), was born in Bread Street, ide, London, on the 9th of December 1608. His known as Mr John Milton of Bread Street, scrivener, me of an interesting man. He was a native of shire, having been born there in or about 1563, the a Richard Milton, yeoman, of Stanton-St John's, re there are traces of one of the hardiest adherents old Roman Catholic religion that had been left in his- The son, however, had turned Protestant, and, been cast off on that account had come to London, tly about the year 1580 to push his fortune. ecorded a steadfast man, and having good abilities, ely in merchant business for some time by leadership and patronage. Not till 1599, at all events, he was free of the Company and at liberty to set up on his own account in the profession of a scrivener, till February 1599–1600, when he was about thirty ears of age did he enter the profession as a qualified of the Scrivener's Company. It was then that he s "house and shop" in Bread Street, and began, scriveners, his lawyerly business of drawing up marriage settlements, and the like, with such related s, that of receiving money from clients for invest- and lending it out to the best advantage. It was at me time that he married. Till recently there has e most extraordinary uncertainty as to the maiden of his wife, the mother of the poet. It has been ertained, however, that she was a Sarah Jeffrey, the two orphan daughters of a Paul Jeffrey, of St , London, "citizen and merchant taylor," originally , who had died before 1583. At the date of rriage she was about twenty-eight years of age. lowed mother, Mrs Ellen Jeffrey, came to reside in se in Bread Street, and died there in February 1. Before this death of the maternal grandmother, ildren had been born to the scrivener and his wife, only two survived, the future poet, and an elder alled Anne. Of three more children, born also , only one survived,—Christopher, the youngest of ly, born December 3, 1615.

first sixteen years of Milton's life, coinciding exactly last sixteen of the reign of James I, associate ve with the house in Bread Street, and with the dmg of that house in Old London. His father's permit in business, continued to be known as "mevenose" tastes, and even acquired some di in the London musical world of that time by his occasional contributions to important musical publications was thus a part of the poet's domestic education infancy. Whatever else could be added was without stint. Again and again Milton spoke with deep affection of the ungrudging pains bestowed his father on his early education, "both at the l and also under other masters at home, and ers in one language." He caused me to be The family removed to about the year 1619, Milton was in his tenth year of age. At that time his e tutor was Thomas Young, a Scotsman from Perth and graduate of the University of St Andrews, after a man of learning and distinction among the Puritan clergy. He then became pastor or assistant to some Englishmen in or near Hamburg, and kept out his hood by private teaching. Young's tutorship lasted 22, when he was driven abroad by an offer of the ship or chaplaincy to the congregation of English nts in Hamburg. Already, however, for a year or his tutorship had been only supplementary to the on which the boy was receiving his daily attendance Paul's public school, close to Bread Street. The ster of the school was Mr Alexander Gill, an elderly Oxford divine, of high reputation for scholarship teaching ability. Under him, as usher or second was his son, Alexander Gill the younger, also an graduate of scholarly reputation, but of blustering cha Milton's acquaintanceship with this younger Gill, be St Paul's school, led to subsequent friendship and spondence. Far more affectionate and intimate w friendship formed by Milton at St Paul's with a yonne Charles Diodati, his schoolfellow there, the s naturalized Italian physician, Dr Theodore Diodat had settled in London in good medical practice, an much respected both on his own account, and as bei brother of the famous Protestant divine, Jean or Gi Diodati of Geneva. Young Diodati, who was destin his father's profession, left the school for Oxford Uni early in 1623, but Milton remained till the end of A family incident of that year was the marriage elder sister Anne, with Edward Phillips, a clerk Government office called the Crown Office in Cha Milton had then all but completed his sixteenth ye was as scholarly, as accomplished, and as handso youth as St Paul's school had sent forth. We lear himself that his exercises "in English or other t prosing or versifying, but chiefly this latter," had be attract attention even in his boyhood. Thus impli he must have had a stock of attempts in English and by him of earlier date than 1624. Of these th specimens that now remain are his *Paraphrase on CXIV* and his *Paraphrase on Psalm CXXXVI*.

On February 12, 1624–25, Milton, at the age of years and two months, was entered as a student of C College, Cambridge, in the grade of a "Lesser Pens His matriculation entry in the books of the unive two months later, April 9, 1625. Between these tw James I had died, and had been succeeded by Cha

Cambridge University was then in the full flush prosperity on that old system of university ed which combined Latin and Greek studies with p drill and disputation in the scholastic logic and philo but with little of physical science, and next to no matics. There were sixteen colleges in all, dividing them a total of about 2900 members of the uni Christ's College, to which Milton belonged, ranked third in the university in respect of numbers, c about 260 members on its books. The master Thomas Bainbrigge; and among the thirteen fellow Mr Joseph Meade, still remembered as a comment the Apocalypse, and Mr William Chappell, afterw he is to hear. It was under Chappell's tutorshi Milton was placed when he first entered the colleg least three students who entered Christ's after Milt during his residence, deserve mention. One was Kme a youth of Irish birth and high Irish conn who entered in 1626, at the age of fourteen; anoth John Cleveland, afterwards known as royalist and who entered in 1627, and the third was Henry Mo subsequently famous as the Cambridge Platonist who in 1631, just before Milton left. Milton's own b Christopher joined him in the college in February 31, at the age of fifteen.

Milton's academic course lasted seven years a months, or from February 1624–25 to July 1632, h him from his seventeenth year to his twenty-fourth first four years were his time of undergraduatesh was in the second of these, the year 1626, tha occurred that quarrel between him and his tu Chappell, which Dr Johnson, making the most o tradition from Aubrey, magnified into the supposit Milton may have been one of the last students in e the English universities that suffered the indig

l punishment. The legend deserves no credit; but rtain that Milton, on account of some disagreement appell, leading to the interference of Dr Bainbrigge, lege for a time, and that, when he did return, it was an arrangement which, while securing that he should a term by his absence, transferred him from the ip of Chappell to that of Mr Nathaniel Tovey, of the fellows of Christ's. From a reference to tter in the first of the Latin elegies one infers that se of the quarrel was some outbreak of self-assertion on's part. We learn indeed, from words of his own re, that it was not only Chappell and Bainbrigge had offended by his independent demeanour, but r the first two or three years of his undergraduate e was generally unpopular, for the same reason, the younger men of his college. They had nick him "The Lady," a nickname which the students other colleges took up, converting it into "The Lady s's College"; and, though the allusion was chiefly peculiar grace of his personal appearance, it con also, a sneer at what the rougher men thought his- prudishness, the haughty seclusion in which he and morals. Quite as distinct as the information was for a while unpopular with the majority of his students are the proofs that they all came round him with respect and deference. The change had oc- curred before January 1628–29, when, at the age of , he took his B.A. degree. By that time he had pre-eminence in his college, and indeed among his in the whole university, had come to be acknow-

His reputation for scholarship and literary powers, dinary even then, was more than confirmed during maining three years and a half of his residence in idge. A fellowship in Christ's which fell vacant 0 would undoubtedly have been his had the election posts depended then absolutely on merit. As it e fellowship was conferred, by royal favour and e, on Edward King, his junior in college standing een months. In July 1632 Milton completed his at the university by taking his M.A. degree. His re in the University Register stands at the head of of those who graduated as masters that year from s. Anthony Wood's summary of the facts of his ity career as a whole is that he "performed the ate and academical exercises to the admiration of all, s esteemed to be a virtuous and sober person, yet be ignorant of his own parts." The statement is fect accordance with Milton's own account. He of "a certain niceness of nature, an honest haughti- nd self-esteem of what I was, or what I might be," of his earliest characteristics, and, though intimat- t, even while actually a student at Cambridge, he never greatly admired" the system of the place, he us in no doubt as to the quite exceptional applause hich he had gone through all the prescribed work. regular Latin and Greek of the university he had he tells us, French, Italian, and Hebrew. He had arnt fencing and other gentlemanly exercises of the nd was an expert swordsman.

Milton's skill at Cambridge in what Wood calls "the ate and academical exercises" specimens remain in *olusiones Quædam Oratoriæ*. They consist of seven cal Latin essays, generally in a whimsical vein, ed by him, in his undergraduateship or during his ent bachelorship in arts, either in the hall of 's College or in the public University School. of Milton's Cambridge period are also four of his *Familiar Epistles*; but more important are the l remains. These include the greater number of his ved Latin poems—to wit, (1) the seven pieces which compose his *Elegiarum Liber*, two of the most inte of them addressed to his medical friend, Charles I and one to his former tutor Young in his exile a burg, (2) the five short Gunpowder Plot epigram appended to the *Elegies*, and (3) the first five piece *Sylvarum Liber*, the most important of which are th meter poem "In Quintum Novembris" and the entitled "Naturam non pati senium." Of the poems of the Cambridge period the following is a list: *On the Death of a Fair Infant*, 1625–26, the being the death in that inclement winter of his niece, the first-born child of his sister Mrs Phill *a Vacation Exercise in the College*, 1628; the magn Christmas ode *On the Morning of Christ's Nativity*, the fragment called *The Passion* and the *Song o Marriage*, both probably belonging to 1630; the l *Shakespeare*, certainly belonging to that year; th fectious piece *On the University Carrier*, 1630–3 *Epitaph on the Marchioness of Winchester*, 1631 sonnet *To the Nightingale*, probably of the same ye sonnet *On arriving at the Age of twenty-three*, datin certainly in December 1631.

Just before Milton quitted Cambridge, his father, verging on his seventieth year, had practically from his Bread Street business, leaving the active m ment of it to a partner, named Thomas Bower, a apprentice of his, and had gone to spend his de years at Horton in Buckinghamshire, a small villa Colnbrook, and not far from Windsor. Here, accor in a house close to Horton church, Milton mainly for the next six years, from July 1632 to April 1

Although, when he had gone to Cambridge, it ha with the intention of becoming a clergyman, that in had been abandoned. His reasons were that "t had invaded the church," and that, finding he co honestly subscribe the oaths and obligations requ "thought it better to preserve a blameless silence the sacred office of speaking begun with servitu forswearing." In other words, he was disgusted w system of high prelacy which Laud, who had been of London and minister paramount in ecclesiastical since 1628, was establishing and maintaining in the of England. "Church-outed by the prelates," emphatically expresses it, he seems to have thought time of the law. From that too he recoiled; an ing the legal profession for his brother Christopher, decided that the only life possible for himself was leisurely independence, dedicated wholly to scholars literature. His compunctions on this subject, ex already in his sonnet on arriving at his twenty thi are expressed more at length in an English letter him, shortly after the date of that sonnet, and with of the sonnet included, to some friend who ha remonstrating with him on his "belatedness" a persistence in a life of mere dream and study. were gentle remonstrances also from his excellent Between such a father and such a son, however, t clusion was easy. What it was may be learnt from fine Latin poem *Ad Patrem*. There, in the midst enthusiastic recitation of all that his father had d him hitherto, it is intimated that the agreement b them on their one little matter of difference was complete, and that as the son was bent on a private literature and poetry, it had been decided that he have his own way, and should in fact, so long as he be the master of his father's means and the chief pe the Horton household. For the six years from 16 accordingly, was Milton's position. In perfect lei in a pleasant rural retirement, with Windsor at the of an easy walk, and London only about 17 miles

rough, he tells us, a systematic course of reading Greek and Latin classics, varied by mathematics, nd the kind of physical science we should now call aphy.

an interesting fact that Milton's very first public ce in the world of English authorship was in so le a place as the folio edition of *Shakespeare* His enthusiastic lines on Shakespeare, written was one of the seventeen pieces prefixed to ond folio, above whose of the commendatory hat had appeared in the first folio, one of them on moment to Shakespeare's memory, the poem as now written by Milton at Horton, in all probability after the Latin hexameter *Ad* were to become companion pieces. *L'Allegro* followed, in or about 1633, the *Penseroso*. It was part of a pastoral masque by the young people of the noble family of Egerton at the venerable relative the countess dowager , and performed before that lady at her mansion of l, near Uxbridge, about 10 miles from Horton. lton contributed the words for the entertainment at certain, owing to his friendship with Henry e of the chief court magnates of that time whose nnexion with the Egerton family procured him or obable management of the Horton performance. Next ans to the connection of Horton may be d the three short pieces, *On Shakespeare, May*, *On* nd *Upon the Circumcision*; after which comes the largest and most important of all Milton's es. The name by which that beautiful drama niversally known was not given to it by Milton He entitled it, more simply and vaguely, "A pre ented at Ludlow Castle, 1634 before the Earl water, Lord President of Wales." The existence mask is certainly due to Milton's intimacy with The earl of Bridgewater, the head of the Egerton had been appointed to the high office of the y or viceroyalty of Wales, the official seat of s Ludlow in Shropshire; it had been determined er the festivities on his assumption of the office ould be a great masque in the hall of Ludlow ph Lawes for the stage manager and one of the Milton had been applied to by Lawes for the and, actually, on Michaelmas night, September 29

testimony to her character is that she was a "a most excellent mother and particularly known for her charities through the neighbourhood." The year 1637 was otherwise eventful in his biography. It was in that year that his *Comus*, after lying in manuscript for more than two years, was published by itself, in the form of a small quarto of thirty five pages. The author's name was withheld, and the entire responsibility of the publication was assumed by Henry Lawes. Milton seems to have been in London when the little volume appeared. He was a good deal in London, at all events, during the summer and autumn months immediately following his mother's death. The plague, which had been on one of its periodical visits of ravage through England since early in the preceding year, was then especially severe in the Horton neighbourhood, while London was comparatively free. It was probably in London that Milton heard of the death of young Edward King of Christ College, whom he had left as one of the most popular of the fellows of the college, and one of the clerical hopes of the university. King had sailed from Chester for a vacation visit to his relatives in Ireland, when, on the 10th of August, the ship, in perfectly calm water, struck on a rock and went down, he and nearly all the other passengers going down with her. There is no mention of the sad accident in two otherwise very interesting Latin *Familiar Epistles* of Milton; of September 1637, both addressed to his medical friend Charles Diodati, and both dated from London; but how deeply the death of King had affected him appears from his occupation shortly afterwards. In November 1637, and probably at Horton, whence the plague had by that time vanished, he wrote his matchless pastoral monody of *Lycidas*. It was his contribution to a collection of obituary verses, Greek, Latin, and English, which King's numerous friends, at Cambridge and elsewhere, were getting up in lamentation for his sad fate. The collection did not appear till early in 1638, when it was published in two parts, with black-bordered title-pages, from the Cambridge University press, one consisting of twenty three Latin and Greek pieces, the other of thirteen English pieces, the last of which was Milton's monody, signed only with the initial "J. M." It was therefore early in 1638, when Milton was in his thirtieth year, that copies of his *Lycidas* may have been in circulation among those who had already become acquainted with his *Comus*.

Milton was then on the wing for a foreign tour. He had long set his heart on a visit to Italy, and circumstances now favoured his wish. The vexatious Cotton law suit after hanging on for nearly two years, was at an end, as far as the elder Milton was concerned, with the most absolute and honourable vindication of his character for probity, though with some continuation of the case against the late partner, Bower. Moreover, Milton's younger brother, Christopher, though but twenty-two years of age, and even about to be called to the bar of the Inner Temple, had married a wife, and the young couple had gone to reside at Horton to keep the old man company. There became nothing then to detain Milton, all was arranged for his journey. Before the end of April 1638 he was on his way across the Channel, taking one English servant with him. At the time of his departure the latest news in England was that of the National Scottish Covenant, or solemn oath and band of all ranks and classes of the Scottish people to stand by each other to the death in resisting the ecclesiastical innovations which Laud and Charles had been forcing upon Scotland. To Charles the news of this "damnable Covenant," as he called it, was enraging beyond measure; but to the mass of the English Puritans it was far from unwelcome, promising, as it seemed to do, for England herself, the subversion at last of that system of "Thorough," or despotic

government by the king and his ministers without parliaments, under which the country had been groaning since the contemptuous dissolution of Charles's third parliament ten years before.

Through Paris, where Milton made but a short stay, receiving polite attention from the English ambassador, Lord Scudamore, and having the honour of an introduction to the famous Hugo Grotius, then ambassador for Sweden at the French court, he moved on rapidly to Italy, by way of Nice. After visiting Genoa, Leghorn, and Pisa, he arrived at Florence, August 1638. Enchanted by the city and its society, he remained there two months, frequenting the chief academies or literary clubs, and even taking part in their proceedings. Among the Florentines with whom he became intimate were Jacopo Gaddi, young Carlo Dati, Pietro Frescobaldi, Agostino Coltellini, the accountant Benedetto Buommattei, Valerio Chimentelli, and Antonio Francini. It was in the neighbourhood of Florence also that he "found and visited" the great Galileo, then old and blind, and still nominally a prisoner to the Inquisition for his astronomical heresy. From Florence, by Siena, Milton went to Rome. He reached the Eternal City one time in October, and spent about another two months there, not only going about among the ruins and antiquities and visiting the galleries, but mixing at once in the best society in Florence, with the learned society of the ecclesiastical city. Among those with whom he formed acquaintance at Rome were the German scholar, Lucas Holstenius, librarian of the Vatican, and three native Italian scholars named Cherubini, Salzilli, and Selvaggi. There is record of his having dined once, in company with several other Englishmen, at the hospitable table of the English Jesuit College. The most picturesque incident, however, of his stay in Rome was his presence at a great musical entertainment in the palace of Cardinal Francesco Barberini. Here he had not only the honour of a specially kind reception by the cardinal himself, but also the supreme pleasure of listening to the marvellous Leonora Baroni, the most renowned singer of her age. Late in November he left Rome for Naples. Here he was fortunate. The great man of the place was the now very aged Giovanni Battista Manso, marquis of Villa, the friend and biographer of the great Tasso, and subsequently the friend and patron of the sweet Marino. By a happy accident Milton obtained an introduction to Manso, and nothing could exceed the courtesy of the attentions paid by the aged marquis to the young English stranger. He had hardly been in Naples a month, however, when there came news from England which not only stopped an intention he had formed of extending his tour to Sicily and thence into Greece, but urged his immediate return home. "The sad news of civil war in England," he says, "called me back; for I considered it base that, while my fellow-countrymen were fighting at home for liberty, I should be travelling abroad for intellectual culture." In December 1638, therefore, he set his face northwards again. His return journey, however, probably because he learnt that the news he had first received was exaggerated or premature, was broken into stages. He spent a second two months in Rome, ascertained to have been January and February 1638–39; during which two months, as he tells us, he was in some danger from the papal police, because the English Jesuits in Rome had taken offence at his habit of free speech, wherever he went, on the subject of religion. Though he did not alter his demeanour in the least in this particular, nothing happened: and from Rome he got safely to Florence, welcomed back heartily by his Florentine friends, and renewing his meetings with them privately and in their academies. His second visit to Florence, including an excursion to Lucca, extended over two months; and not till April 1639 did he take leave, and proceed, by Bologna and Ferrara, to Venice. About a month was given to Venice; and thence he shipped for England the books he had collected in Italy, he went on, by Verona and Milan, over the Alps to Geneva. In this Protestant city he spent a week in June, forming interesting acquaintanceships there and having daily conversations with the great Protestant theologian Dr Jean Diodati, the uncle of his friend Charles Diodati. From Geneva he returned to France, so to England. He was home again in August 1639, having been absent in all fifteen or sixteen months.

Milton's Continental tour and especially the Italian portion of it, remained one of the chief pleasures of his memory throughout all his subsequent life. Nor was it without fruits of a literary kind. Besides two of his Latin elegies, *Epistola Familiaris*, one to the Florentine gentleman Buommattei, and the other to Lucas Holstenius, which have to be assigned to Milton's sixteen months' sojourn on the Continent, his three Latin epigrams, *Ad Leonoram Romæ Canentem*, his Latin verses *Ad Salsillum Romanum Lacrymæ*, his fine and valuable piece of Latin hexameters entitled *Mansus*, and his *Ten Sonnets, with a Canzone*, celebrating the charms of an Italian lady he had met in his travels.

One sad and nearer memory did mingle itself with all that was otherwise so delightful in his Italian reminiscences. His bosom friend and companion from boyhood, more than Charles Diodati had been to him a Jonathan to David, and into whose ear he had hoped to pour the whole narrative of what he had seen and done abroad, had died during his absence. He had died, in Pall Mall, London, in August 1638, not four months after Milton had gone away on his tour. The intelligence of it reached Milton till some months afterwards, probably till his second stay in Florence, and, though he may have learnt some of the particulars from others in Geneva, he did not know them fully till his return to England. How profoundly they affected him appears from his *Epitaphium Damonis*, then written in memory of his dead friend. The importance of this poem in Milton's biography cannot be overrated. It is perhaps the finest of all his Latin poems; and, though in the form pastoral, and not a pastoral of the most artificial type, it is unmistakably an outburst of the most passionate personal grief. In this respect *Lycidas*, artificial as it also is, though that poem is, cannot be compared with it, the only fact that *Lycidas* is in English while the *Epitaphium Damonis* is in Latin that has led to the notion that Edward King of Christ's College was personally and profoundly the friend of Milton's youth, not of early manhood.

That Milton, even while in Italy, had been intermittently at work on the achievement in poetry which he had yet attempted only in part, we have known since 1823. What we should not have known for certain but for the incidental proof given by the *Epitaphium Damonis* is that, from the time of his return from Italy, he had resolved on some such literary effort of a new sort. This poem is one in which, after returning to the hope of literary and political careers as suddenly ended by his death, Milton speaks of himself as the story of his own projects in his profession of literature, if may run thus:—

> I have a theme of the Tropic, crossing our course in the Shipmen to sing, and the realm of Imogen along to the Brennus and Arviragus, dukes, and Brennus' lofty harbour Then the Armoric settlers under the law of the Britain Ay, and the womb of Iggrane fatally pregnant with Arthur Uther's son, whom he got disguised in Gorlois' likeness All by Merlin's craft. O then, if life shall be spared me Thou shalt be hung, my pipe, far off on some dying old

forgotten of me; or else your Latian mu
ged to the British war screech! What then? For one to
o all things.
hope all things, it's not. Prize sufficiently ample
and distinction great, unheard of ever thereafter
gh I should be and inglorious all through the world of the
Eternity,
the yellow-haired Ouse shall roll me, the drinker of Alau,
er, which words as it flow and Trent's whole valley of
orchard
s, my own Thame. Dove I met Tamar's western waters,
with ore and where the white waves swinge the fai
ailway

ected procedure the means that Milton was
ring in epic of which King Arthur was to be the
heme, but which should include somehow the
ycle of British and Arthurian legend, and that not
s this epic to be in English, but he had resolved
l be poetry for the future should be in the same

Long after Milton's return the house at Horton
to be the family home. Christopher Milton and
e went to reside at Reading, taking the old
on with them, while Milton himself preferred
He had first taken lodgings in St Bride
yard, at the foot of Fleet Street; but, after a while,
y early in 1640, he removed to a "pretty garden
of his own, at the end of an entry, in the part of
the street which lies immediately on the city side
t is now Mardenhead Court. His sister, whose
husband had died in 1631, had married a Mr Thomas
successor in the Crown Office, and it was arranged
two sons by her first husband should be educated
uncle John Phillips, the youngest of them only
ar old, had boarded with him in the St Bride's
yard lodgings, and, after the removal to Aldersgate
the other brother, Edward Phillips, only a year
became his boarder also. Gradually a few other
he sons of well-to-do personal friends joined the
hillipses, whether as boarders or for daily lessons
the house in Aldersgate Street became a small
school. The drudgery of teaching seems always
been liked by Milton. What meanwhile of the
rthurian epic? That project we find, had been
p, and Milton's mind was roving among many other
, and balancing their capabilities. How he wavered
Biblical subject and heroic subjects from British
and how many of each kind suggested themselves
one learns from a list in his own handwriting among
the MSS at Cambridge. It contains jottings of
rty-three subjects from the Old Testament,
m the Gospels, thirty-three from British and
history before the Conquest, and five from Scottish
It appears that all or most of them are headed
ut as subjects for "tragedies," as if the epic
d now been abandoned for the dramatic. It is
ortunate that all to observe which of the subjects
ted Milton most. Though several of them are
d poetically, they are not one is sketched at such length
particularly as *Paradise Lost*. It is the first subject
list, and there are four separate drafts of a possible
under that title, two of them merely enumerating
mantis personæ, but the last two indicating the plot
division into acts. Date in 1640, twenty-seven
efore *Paradise Lost* was given to the world, he had
wn the name on paper, and had committed himself
hence.

ese poetic dreamings and sketchings there was to
g interruption. The Scottish National Covenant
to extraordinary results. Not only were Charles
nd checkmated in their design of converting the
piscopal system which King James had established
in Scotland into a high Laudian prelacy; but
General Assembly held at Glasgow in the end of
Episcopacy had been utterly abolished in Scotland
the old Presbyterian system of Knox and Melville r
To avenge this, and restore the Scottish bishops,
had marched to the Border with an English army
met there by the Covenanting army under
Alexander Leslie, he had not deemed it prudent to
battle, and had yielded to a negotiation conceding
Scots all their demands. This "First Bishops' W
it came to be called, was begun and concluded
Milton was abroad. About the time of his return
ever, Charles had again broken with the Scots,
had been watching the course of affairs since the
close and career interest. He had seen and partak
the sympathetic stir in favour of the Scots, whi
through the popular and Puritan mind of England
had welcomed the practical proof of this sympathy
in that English parliament of April 1640, called "Th
Parliament," which Charles, in his straits for supplies
the Scots, had reluctantly summoned at last, h
obliged to dismiss unmanageable. Charles had,
therein, with money raised somehow, entered
"Second Bishops' War." This time the resi
momentous indeed. The Scots, not waiting to be a
in their own country, took the aggressive, and i
England. In August 1640, after one small engag
with a portion of Charles's army, they were in pos
of Newcastle and of all the northern English co
The English then had their opportunity. A treat
the Scots was begun, which the English Puritan
regarded their presence in England as the very h
they had been praying for, were in no haste to finish
on the 3d of November 1640, there met that par
which was to be famous in English history, and
history of the world, as "The Long Parliament."

Of the first proceedings of this parliament, includ
trial and execution of Strafford, the impeachme
imprisonment of Laud and others, and the break-
the system of Thorough by miscellaneous reforms
guarantees for parliamentary liberty, Milton was
spectator. It was when the church question e
distinctly as the question paramount, and there ha
divisions on that question among those who ha
practically unanimous in matters of civil reform,
plumbed in an active adviser. There were three
on the church question. There was a high churc
contending for Episcopacy by divine right, and
maintenance of English Episcopacy very much as
there was a middle party, defending Episcopacy on g
of usage and expediency, but desiring to see the po
bishops greatly curtailed, and a limited Episcopac
councils of presbyters round each bishop, substitu
the existing high Episcopacy; and there was the ro
branch party, as it called itself, desiring the entire ab
of Episcopacy and the reconstruction of the
Church on something like the Scottish Presbyterian
Since the opening of the parliament there had been a
of pamphlets crossing one another in the air from
three parties. The chief manifesto of the high
party was a pamphlet by Joseph Hall, bishop of
entitled *Humble Remonstrance to the High Co
Parliament*. In answer to Hall, and in represent
the views of the root-and-branch party, there had
forth, in March 1640–41, five leading Puritan
ministers, the initials of whose names, clubbed toge
the title-page of their joint production, made the
word "Smectymnuus." These were Stephen M
Edmund Calamy, Thomas Young, Matthew New
and William Spurstow. The Thomas Young whos

es in the middle was no other than the Scottish
nas Young who had been Milton's domestic preceptor
Bread Street. Having returned from Hamburg in
, he had been appointed to the vicarage of Stowmarket
ffolk, in which living he had remained ever since,
the reputation of being one of the most solid and
ed Puritans among the English parish clergy. The
us Smectymnuan pamphlet in reply to Hall was
ly Young's. What is more interesting is that his old
Milton was secretly in partnership with him and hi
er Smectymnuans. Milton's hand is discernible in a
on of the original Smectymnuan pamphlet, and he
nued to aid the Smectymnuans in their subsequent
nders to Hall's defences of himself. It was more in
on's way, however, to appear in print independently
in May 1641, while the controversy between Hall and
Smectymnuans was going on, he put forth a pamphlet
is own. It was entitled *Of Reformation touching
ch Discipline in England and the Causes that hav
rto hindered it*, and consisted of a review of English
siastical history, with an appeal to his countrymen to
me that course of reformation which he considered to
been prematurely stopped in the preceding century,
to sweep away the last relics of papacy and prelacy
ng all the root and branch pamphlets of the time a
t out, and stands out still, as the most thoroughgoing
tremendous. It was followed by four others in rapid
ession, to wit, *Of Prelatical Episcopacy and whether
ay be deduced from the Apostolical Times* (June 1641),
*nadversions upon the Remonstrant's Defence against
tymnuus* (July 1641), *The Reason of Church Gover
urged against Prelaty* (February 1641–2), *Apology
nst a Pamphlet called a Modest Confutation of the
nadversions*, &c. (March 1641–2). The first of these
directed chiefly against that middle party which
ated a limited Episcopacy, with especial reply to the
ments of Archbishop Ussher, as the chief exponent of
iews of that party. Two of the others, as the titles
y belong to the Smectymnuan series, and were
gations of Bishop Hall. The greatest of the four, and
most important of all Milton's anti-Episcopal pamphlets
the first, i.e. that entitled *The Reason of Church
rnment*. It is there that Milton takes his readers
his confidence, speaking at length of himself and his
ves in becoming a controversialist. Poetry, he declares,
his real vocation; it was with reluctance that he had
lved to "leave a calm and pleasing solitariness, fed with
rful and confident thoughts, to embark in a troubled
of noises and hoarse disputes"; but duty had left him
option. The great poem or poems he had been meditat
could wait, and meanwhile, though in prose polemics
ad the use only of his "left hand" that hand should
sed with all its might in the cause of his country and
berty.

he parliament had advanced in the root-and-branch
ction so far as to have passed a bill for the exclusion
ishops from the House of Lords, and compelled the
g's assent to that bill, when, in August 1642, the
lder struggle between Charles and his subjects took the
of civil war. All England was then divided into the
alists, supporting the king, and the Parliamentarians,
ering to that majority of the Commons, with a
ority of the Lords, which sat on as the parliament.
ile the first battles of the civil war were being fought
varying success, this parliament, less impeded than
n it had been full, moved on more and more rapidly
he root-and-branch direction, till, by midsummer 1643,
abolition of Episcopacy had been decreed, and the
stion of the future non-prelatic constitution of the
rch of England referred to a synod of divines, to meet
at Westminster under parliamentary authority. Of M
life through those first months of the civil war l
known. He remained in his house in Aldersgate
teaching his nephews and other pupils; and the
scrap that came from his pen was the semi-jocose
bearing the title *When the Assault was intended to th*
In the summer of 1643, however, there was a great
in the Aldersgate Street household. About the end o
as his nephew Edward Phillips remembered, Milto
away on a country journey, without saying whither
what purpose, and, when he returned, about a
afterwards, it was with a young wife, and with
her sisters and other relative in her company. H
in fact been in the very headquarters of the King a
Royalist army in and round Oxford, and the la
brought back with him was a Mary Powell, the
daughter of Richard Powell, Esq., of Forest Hil
Oxford. She was the third of a family of eleven so
daughters, of good standing but in rather embar
rcumstances, and was seventeen years and four
old while Milton was in his thirty-fifth year. He
the marriage came about, it was a most unfortunate
The Powell family were strongly Royalist, and th
herself seems to have been frivolous, not unlikely
stupid. Hardly were the honeymoon festivities
Aldersgate Street when her sisters and other re
having returned to Forest Hill and left her alone w
husband, she pined for home again and begged
allowed to go back on a visit. Milton consented,
understanding that the visit was to be a brief one
seems to have been in July 1643. Soon, howev
intimation from Forest Hill was that he need ne
ever to have his wife in his house again. The re
seems to have been mainly the girl's own aborted
mother, but, as the king's cause was then prospe
the field, it is a fair conjecture that the whole
Powell family had repented of their adherence
so prominent a Parliamentarian and a subject of the
of England as Milton. While his wife was away,
father, who had been residing for three years w
younger and lawyer son at Reading, came to take
quarters in Aldersgate Street.

Milton's conduct under the insult of his wife's de
was most characteristic. Always frank and pro
he converted his own case into a public protest against
existing law and theory of marriage. *The Doctr
Discipline of Divorce. Restored to the good of both Se*
the title of a pamphlet put forth by him in Augu
without his name, but with no effort at concealment,
ning the notion of sacramental sanctity in the m
relation to be a clerically invented superstition, and a
that inherent incompatibility of character, or con
of mind, between two married persons, is a perfec
reason for divorce. There was no reference to h
case, except by implication; but the boldness
speculation roused attention and sent a shock t
London. It was a time when the authors of her
this sort, or of any sort, ran considerable risk
famous Westminster Assembly of Divines, called
Long Parliament, had met on the appointed day,
1643; the Scots, in consenting to send an arm
England to assist the parliament in their war w
King, had proposed, as one of the conditions, their
League and Covenant, binding the two nations to en
after a uniformity of religion and of ecclesiastical di
with the extirpation of all "heresy, schism, and
ness," as well as popery and prelacy; the Solemn Lea
Covenant had been enthusiastically accepted in E
and was being sworn to universally by the Parliamen
and one immediate effect was that four eminent

and two Scottish lay commissioners were added to stminster Assembly and became leaders there. r Milton's divorce tract was formally discussed in embly during the first month of its sitting is n; but it is certain that the London clergy, g not a few members of the Assembly, were then about it privately with anger and execration. it might be moved [illegible] to a more public prosecu lton threw off the anonymous in a second and larged edition of the tract, in February 1643 44, d openly to the Parliament and the Assembly a month or [illegible] during which the gossip about his monstrous doctrine was spreading more and turned his attention to other subjects. Among tion made in the general ferment of opinion about to the civil war was that of a reform of onal system of education and especially of the [illegible] To this question Milton made a contribution 1644 in a small *Tract on Education*, in the form to Mr Samuel Hartlib, a German then resident n and interesting himself busily in all philanthropic and schemes of social reform. In the very next however, July 1644, he returned to the divorce in a pamphlet addressed specially to the clergy tled *The Judgment of Martin Bucer concerning* The outcry against him then reached its height. attacked in pamphlets, he was denounced in ll through London, and more than once in sermons e two Houses of Parliament by prominent divines estminster Assembly; strenuous efforts were made him within definite parliamentary censure. In formed against him for this purpose a leading played, at the instigation of the clergy, by the s Company of London. That company represent publishers and booksellers of London, had a plea own against him, on the ground that his doctrine only immoral, but had been put forth in an illegal His first divorce treatise, though published imme after the "Printing Ordinance" of the parliament 14, 1643, requiring all publications to be licensed by one of the official censors, and to be registered ooks of the Stationers' Company, had been issued licence and without registration. Complaint to t was made against Milton, with some others liable nis charge of contempt of the printing ordinance, tion of the Stationers to the House of Commons 1644; and the matter came before committees that House and in the Lords. It is to this ance that the world owes the most popular and , if not the greatest, of all Milton's prose writings, *Areopagitica, a Speech of Mr John Milton for the Liberty of Unlicensed Printing to the Parliament* It appeared in the end of November 1644, h authorised and unlicensed, as was proper ut of question, and was a remonstrance addressed ectly to Parliament, as an oration to them free st their ordinance of June 1643 and the y system of licensing and censorship of the press. ugh the Parliament in other respects, it ed their printing ordinance as utterly unworthy of nd of the new era of English liberties which they itiating, and it led not to its repeal. Though that d not follow the pamphlet virtually accomplished ose. The licensing system had received its death nd, though the Stationers returned to the charge ler complaint to the House of Lords, Milton's against the printing ordinance was condoned. He was ded in pamphlets, and found himself "in a world of n"; but he lived on through the winter of 1644–45 bed in his house in Aldersgate Street. To this period there belong, in the shape of verse, only his sonnets ix. and x., the first to some anonymous lady, and the second "to the Lady Margaret Ley," with perhaps the Greek lines entitled *Philosophus ad Regem Quendam*. His divorce speculation, however, still occupied him; and in March 1644 45 he published simultaneously his *Tetrachordon, or Expositions upon the four chief places of Scripture which treat of Marriage*, and his *Colasterion, a Reply to a nameless Answer against the Doctrine and Discipline of Divorce*. In these he replied to his chief recent assailant, lay and clerical, with merciless severity.

It was not merely Milton's intellectual eminence that had saved him from prosecution for his divorce heresy. A new tendency of national opinion on the church question had operated in his favour, and in favour of all forms of free speculation. There had occurred in the Westminster Assembly itself, and more largely throughout the general community that split of English Puritanism into the two opposed varieties of Presbyterianism on the one hand and Independency or Congregationalism on the other which explains the whole subsequent history of the Puritan revolution. Out of this theoretical discussion as to the constitution of the church there had grown the all-important practical question of toleration. The Presbyterians insisted that the whole population of England should necessarily belong to the one national Presbyterian Church, be compelled to attend its worship, and be subject to its discipline, while the Independents demanded that, if a Presbyterian Church should be set up as the national and state paid church, there should at least be liberty of dissent from it, and toleration for those that chose to form themselves into separate congregations. Vehement within the Westminster Assembly itself, the controversy had attained wider dimensions out of doors, and had inwrought itself in a most remarkable manner with the conduct of the war. Orthodox Presbyterian Calvinists were still the majority of the Puritan body, but, in the new atmosphere of liberty, there had sprung up, from secret and long-suppressed seeds in the English mind, a wonderful variety of sects and denominations, mingling other elements with their Calvinism, or hardly Calvinistic at all,—most of them, it is true, fervidly Biblical and Christian after their different sorts, but not a few professing the most coolly inquisitive and sceptical spirit, and pushing their speculations to strange extremes of free-thinking. These sects, growing more and more numerous in the large towns, had become especially powerful in the English Parliamentary army. That army had, in fact, become a marching academy of advanced opinionists and theological debaters. Now, as all the new Puritan sects, differing however much among themselves, saw their existence and the perpetuity of their tenets threatened by that system of ecclesiastical uniformity which the Presbyterians proposed to establish, they had, one and all, abjured Presbyterianism, and adopted the opposite principle of Independency, with its appended principle of toleration. Hence an extraordinary conflict of policy among those who seemed to be all Parliamentarians, all united in fighting against the king. The auxiliary Scottish army, which had come into England in January 1643 44, and had helped the English generals to beat the King in the great battle of Marston Moor in July 1644, thought that he had then been almost sufficiently beaten, and that the object of the Solemn League and Covenant would be best attained by bringing him to such terms as should secure an immediate Presbyterian settlement and the suppression of the Independents and sectaries. In this the chief English commanders, such as Essex and Manchester, agreed substantially with the Scots. Cromwell, on the other hand, who was now the recognized head of the army Independents, did not think that the king had

sufficiently beaten, even for the general purposes of war, and was resolved that the war should be pushed a point at which a Presbyterian settlement should be ssible without guarantees for liberty of conscience and eration of non-Presbyterian sects. Through the latter of 1644, accordingly, Milton had been saved from the ties which his Presbyterian opponents would have ted on him by this general championship of liberty of on by Cromwell and the army Independents. Before middle of 1645 he, with others who were on the books of the Presbyterians as heretic , wa safer Though the parliament had voted, in January –45, that the future national church of England should the Presbyterian system, Cromwell and the Inde ents had taken care to have the question of tolera left open; and, within the next month or two, by nwell's exertions, a completely new face wa put upon war by the removal of all the chief officers that had in command hitherto, and the equipment of the Model army, with Fairfax a its commander-in-chief Cromwell himself as lieutenant-general. The Scots

he stricter English Presbyterians looked on matrimonially this army took the field, calling it an "Army of aries,' and almost hoping it would be beaten. On 14, 1645, however, there was fought the great battle aseby, utterly ruining the king at last, and leaving relics of his forces here and there. Milton position may be easily understood. Though his first tendency the church question had been to some form of a byterian constitution for the church, he had parted rly now from the Scots and Presbyterians, and became rtisan of Independency, having no dread of "sects and ms," but regarding them rather as healthy ferments in English body politic. He was, indeed himself one of most noted sectaries of the time, for in the list of drawn out by contemporary Presbyterian writers al mention is made of one small sect who were known *Miltonists* or *Dreamers*.

So far as Milton was concerned personally, his interest the divorce speculation came to an end in July or ast 1645, when, by friendly interference, a reconcilia was effected between him and his wife. The ruin of king's cause at Naseby had suggested to the Powells it might be as well for their daughter to go back to her and after their two years of separation. It was not, ever, in the house in Aldersgate Street that she rejoined but in a larger house, which he had taken in the cent street called Barbican, for the accommodation of ncreasing number of pupils.

he house in Barbican was tenanted by Milton from t August 1645 to September or October 1647. Among irst occupations there must have been the revision of proof sheets of the first edition of his collected poems, ppeared as a tiny volume, copies of which are now very with the title *Poems of Mr John Milton, both English Latin, composed at several times*. The title-page gives date 1645, but January 1645–46 seems to have been exact month of the publication. The appearance of volume indicates that Milton may have been a little by this time of his notoriety as a prose-polemic, and ous of being recognized once more in his original acter of literary man and poet. But, whether because edagogic duties now engrossed him or for other reasons, few new pieces were added in the Barbican to those the little volume had thus made public. In English, e were only the four sonnets now numbered xi. xiv., the two entitled "On the Detraction which followed upon writing certain Treatises," the third "To Mr Henry es on his Airs," and the fourth "To the Religious ory of Mrs Catherine Thomson," together with the

powerful anti-Presbyterian invective or "tailed s entitled "On the New Forcers of Conscience und Long Parliament"; and in Latin there were only t *Ad Joannem Rousium*, the title called *Apolog Rustico et Hero*, and one interesting *Familiar* addressed to his Florentine friend Carlo Dati family incidents of importance, however, appertain time of residence in Barbican. Oxford having surre to Fairfax in June 1646, the whole of the Powell had to seek refuge in London, and most of them shelter in Milton's house. His first child, a d named Anne, was born there on the 29th of Jul year, on the 1st of January 1646–47 his father m Powell died there, leaving his affairs in confusion, the following March his own father died there, at of eighty-four, and was buried in the adjacent churc Gile, Cripplegate. For the rest, the two years in B are nearly blank in Milton's biography. The Revolution was still running its course. For Charles's surrender of himself, in May 1646, to the a Scottish army rather than to Fairfax and Cromwe his residence with that Scottish army at Newc negotiation with the Scots, had given the Pre by the advantage, but after the Scots had evacuated I in January 1646–47, leaving Charles a captive w English subjects, and especially after the Engli h ar seized him at Holmby in June 1647 and undertak further management of the treaty with him, the ad was all the other way. It was a satisfaction to and perhaps still a protection for him, that the "I Independents and Sectaries" had come to be rea masters of England.

From Barbican Milton removed, in Septem October 1647, to a smaller house in that part o Holborn which adjoins Lincoln's Inn Fields. His relatives had now left him, and he had reduc number of his pupils, or perhaps kept only h nephews. But, though thus more at leisure, he yet resume his projected poem, but occupied rather with three works of scholarly labour which already for some time had on hand. One was th pilation in English of a complete history of Engl rather of Great Britain, from the earliest times; was the preparation in Latin of a complete s divinity, drawn directly from the Bible; and the th the collection of materials for a new Latin dic Milton had always a fondness for such labour of ship and compilation. Of a poetical kind there t to record, during his residence in High Holborn, experiment in psalm-translation, in the shape of lxxx.–lxxxviii. done into environ metre in April 16 the *Sonnet to Vane*, written in September of th year. This last connects him again with the c public affairs. The king, having escaped from the of the army chiefs, and taken refuge in the Isle of had been committed to closer custody there, all treaty between him and parliament had been declare end, and the result would probably have been his tion, but for the consequences of a secret treaty contrived to make with the Scots. By this tre Scots engaged to invade England in the king's re-ene him from the English parliament and re restore him to his full royalty, while he engaged to ratify the Covenant, the Presbyterian system of government, and all the other conclusions of the mus-ter Assembly, throughout England, and down Independency and the sects. That, in May began what is called the Second Civil War, consist of new risings of the Royalists in various parts of E and then of a conjunction of these with a great

and by a Royalist Scottish army, under the command duke of Hamilton. It was all over in August when the crushing defeat of the Scottish army by ell in the three days' battle of Preston, and the mpt suppression of the Lancash Royalist insur in the south-east counties by Fairfax's siege and of Colchester, left Charles at the mercy of the Milton's *Sonnet to Fairfax* was a congratulation general in chief of the parliamentary forces at ter and attested the exultation of the writer over mph of the Presbyterian cause. His exultation ed through what followed. After one more dying t the parliament in negotiation with Charles, the ed the whole future on itself. The long wa t from the Isle of Wight the parliament, manipu y the army officers, and purged of all members impede the army's purposes, was converted into ssion for that purpose. A court of high justice t up for the trial of Charles, and on January 49 he was brought to the scaffold in front of all. By that act England became a republic, d without King or House of Lords, by the persever bers of "Rump" of the recent House of Commons, ne men with an executive council of forty, composed one member appointed annually by that House. fact Parliament of mark out of parliament to himself openly to the new republic was John . He befriended by the publication of his pamphlet *Power of Kings and Magistrates*, a work that it is and that it becomes all men to abhor, for any whatever to call to account a tyrant or wicked King, and, n conclusion to depose and put him to death, if they y think fit, but the like no where else. It was out a fortnight after the king's death, and as Milton's ormance in the house in High Holborn. The chief new republic could not but perceive the importance nce the service of a man who had so powerfully pen in support of their proceedings, and who was otherwise so distinguished. In March 9, accordingly, Milton was elected and accepted the y-ship for foreign tongues to the council of the new Commonwealth. The salary was to be £288 a orth about 1000 a year now. To be near his new ce, the house on the council, which held its daily for the first few weeks in Derby House, close to all, but afterwards regularly in Whitehall itself, he at once to temporary lodgings at Charing Cross

ry for the meeting of council which Milton attended. have made personal acquaintance with the chief Fairfax, Cromwell himself, Sir Henry Vane Henry Marten, Heselrige, Sir Gilbert Pickering, other chiefs of the council and the Commonwealth he had not known some of them before. After a ble, for his greater convenience, official apartments ceeding on Whitehall itself.

e date of Milton's appointment to the secretaryship s less vague than that of his special duty was the e of such letters as were sent by the council of ous countries to the Rump Parliament, to foreign and private with the examination and translation ers in reply, and with personal conferences, when ary, with the envoys of foreign powers in London. ith envoys and such others. As Latin was the ge employed in the written diplomatic documents, came to be known indifferently as the secretaryship eign tongues or the Latin secretaryship. In that owever, his duties, more particularly at first, were ght in comparison with those of his official colleague, lter Frost, the general secretary. Foreign powers of from the English republic as much as they could;

and, while Mr Frost had to be present in every meet the council, keeping the minutes, and conducting a general correspondence, Milton's presence was re only when some piece of foreign business did tu Hence, from the first, his employment in very m laneous work. Especially, the council looked to hi everything in the nature of literary vigilance and li help in the interests of the struggling Commonwealth was employed in the examination of suspected paper in interview with their authors and printers; a executed several great literary commissions exp entrusted to him by the council. The first of the his pamphlet entitled *Observations on Ormond's Arti Peace with the Irish Rebels*. It was published in 1649, and was in defence of the republic agai complication of Royalist intrigues and dangers in Ir A passage of remarkable interest in it is one of el eulogy on Cromwell. More important still wa *Eikonoklastes* (which may be translated "Image Smas published by Milton in October 1649, by w counterblast to the famous *Eikon Basilike* ("T Image"), which had been in circulation in thousa copies since the king's death, and had become a k Bible in all Royalist households, on the supposition had been written by the royal martyr himself. A piece of work was of a more laborious nature. I end of 1649 there appeared abroad, under the ti *Defensio Regia pro Carolo I*, a Latin vindication memory of Charles, with an attack on the English monwealth, intended for circulation on the Continent it had been written, at the instance of the exiled family, by Salmasius, or Claude de Saumaise, of L then of enormous celebrity over Europe as the gr scholar of his age. It was regarded as a serious blow infant Commonwealth. To answer it was thought worthy of Milton, and he threw his whole strength in performance through the year 1650, interrupting h only by a new and enlarged edition of his *Eikono* Not till April 1651 did the result appear; but then th ce was prodigious. Milton's Latin *Pro Populo Ang Defensio*, as it was called, ran at once over the l Land and the Continent, rousing acclamation every and received by scholars as an annihilation of the Salmasius. Through the rest of 1651 the observati that the two agencies which had co-operated most in raising the reputation of the Commonwealth a were Milton's book and Cromwell's battles. These of Cromwell in the service of the Commonwealth h tended, had kept him absent from the council of of which he was still a member, since shortly aft beginning of Milton's secretaryship. For nearly a y had been in Ireland, as lord lieutenant, reconquerin country after its long rebellion; and then, for a year, he had been in Scotland, crushing the R commotion there round Charles II., and annexing Sc to the English republic. The annexation was compl the end of September 1651, when Cromwell, c Charles II and his army out of Scotland, came up them at Worcester and gained his crowning victory. Commonwealth then consisted of England, Ireland Scotland, and Cromwell was its supreme chief.—Th the eventful year 1651, it has been recently ascert Milton had added to the other duties of his secreta that of Government journalist. Through the whole year, if not from an earlier period, he acted as licens superintending editor of the *Mercurius Politicus*, a paper issued twice a week, of which Mr March Needham was the working editor and proprietor. M hand is discernible in some of the leading articles.

About the end of 1651 Milton left his official ro

all for a house he had taken on the edge of St
Park, in what was then called Petty France,
inster, but is now York Street. The house existed
other day, but has been pulled down. In Milton's
was a villa-looking residence, with a garden, in
hbourhood of villas and gardens. He had now
do in the special work of his office, in consequence
increase of correspondence with foreign powers.
had for some time been in ailing health, and a
s of eyesight which had been growing upon him
lly for ten years had been settling rapidly, once his
over the answer to Salmasius, into total blindness
y, before or about May 1652, when he was but in
y fourth year, his blindness was total, and he could
t only with some one to lead him. Hence a re-
ement of his secretarial duties. Such of the duties
ould perform at home, or by occasional visits to the
l Office near, he continued to perform, but much of
time work was done for him by a certain, one of
well-known Germans named Weckherlin under the
tendence of Mr John Thurloe, who had succeeded
lter Frost in the general secretaryship. Precisely
time of a lull in Milton's secretaryship upon account
ll health and blindness we have to refer his two
companion sonnet *To the Lord General Cromwell* and
Sir Henry Vane the Younger. To about the same
r more precisely to the interval between May and
ber 1652, though the exact date is uncertain, we
refer the death of his only son, who had been born
official Whitehall apartments in the March of the
ng year, and the death about the same time of his wife, just after
l given birth to his third daughter, Deborah. With
ee children thus left him,—Anne, but six years old,
not four, and the infant Deborah,—the blind
lived on in his house in Petty France in such
ion as can be imagined. He had recovered enough
resume his secretarial duties, and the total number
his dictated state letters for the single year 1652
l to that of all the state letters of his predecessor
f secretaryship put together. To the same year
belong also three of his Latin *Familiar Epistles*.
ember 1652 there was published *Joannis Philippi
Responsio ad Apologiam Anonymi Cujusdam Tenebrionis*,
being a reply by Milton's youngest nephew, John
s, but touched up by Milton himself, to one of
pamphlets that had appeared against Milton for his
er of Salmasius. The ablest and most scurrilous
se, which had just appeared anonymously at the
with the title *Regii Sanguinis Clamor ad Coelum
us Parricidas Anglicanos* ("Cry of the Royal Blood
ven against the English Parricides"), Milton was
ng for his own attention at his leisure.

The 20th of April 1653 there was Cromwell's great
armed interference by which he turned out the small
nt of the Rump Parliament, dismissed their council
e, and assumed the government of England, Ireland,
otland into his own hands. For several months,
he acted only as interim dictator, governing by a
of his officers, and waiting for the conclusions of
lect body of advisers which he had called together
ll parts of the country, and which the Royalists
med "The Barebones Parliament." In December
however, his formal sovereignty began under the
f the Protectorate, passing gradually into more than
ip. This change from government by the Rump
's council to government by a single military Lord
or and his council was regarded by many as treason
republican cause, and divided those who had hitherto
he united Commonwealth's men into the "Pure Re
ns" represented by such men as Bradshaw and Vane,
and the "Oliverians," adhering to the Protector,
whose boundless admiration of Cromwell had shown
already in his Irish tract of 1649 and in his recent
was recognized as one of the Oliverians. He remained
Oliver's service and was his Latin secretary throughout
whole of the Protectorate. For a while, indeed, his
letters to foreign states in Cromwell's name were but
Mr Thurloe, as general secretary, officiating as C
right hand man in everything, with a Mr Philip Meadows
under him, at a salary of £200 a year, as deputy
blind Mr Milton in foreign correspondence and transl
The reason for the temporary exemption of Milton
routine duty may have been that he was then engaged
an answer, by command from the late Government,
the already mentioned pamphlet from the Hague called
Regii Sanguinis Clamor. Salmasius was now dead,
the Commonwealth was too feeble to suffer from
attacks; but no Royalist pamphlet had appeared
of so venomous a tone as to call for continuation of the Sal
controversy. Meanwhile, however, it was known
libel on Milton himself did appear from his pen
necessary. It came out in May 1654, with the
*Joannis Miltonis Angli pro Populo Anglicano Defensio
Secunda* ("Second Defence of John Milton, English
for the People of England"). It was one of the most
esting of all Milton's writings. The author of the
which it replied was Dr Peter du Moulin the young
naturalized French Presbyterian minister, then
about in English society, close to Milton; but, as
a profound secret and the work was universally att
on the Continent to an Alexander More,
minister of Scottish descent, then as much of a
celebrity in Holland, who had certainly many
printing in consultation with the now deceased Sal
and had contributed some portion of the matter,
had made Du Moulin the responsible person and
object of his excoriation. They were frightful e
If Salmasius had been slaughtered in the former *D*
Moulin was murdered and gutted in this. His
character was blasted by exposure of his antecedents
he was blazoned abroad in Europe as a detected
blackguard. The terrific castigation of Moulin, how
is but part of the *Defensio Secunda*. It contains p
of a singular autobiographical and historical volu
includes laudatory sketches of such eminent C
wealth's men as Fairfax, Lawrence, Whitwood, La
and Overton, together with a long panegyric on C
himself and his career, which remains to this day
preached for elaboration and grandeur by any extra
Cromwell from any later pen. From about the date
publication of the *Defensio Secunda* to the beginn
1655 the only especially literary relic of Milton's
his translations of Psalms i.–viii. in different metres
in August 1654, his translation of Horace, *Ode* I
probably about the same time, and two of his
Familiar Epistles. The most active time of his se
ship for Oliver was from April 1655 onwards
month, in the course of a general revision of official
under the Protectorate, Milton's salary of £288
hitherto was reduced to £200 a year, with a kind
definition of his office, recognizing it, we may s
Latin secretaryship extraordinary. Mr Philip M
was to continue to do all the ordinary Foreign Offic
under Thurloe, inspections but Milton was to be
in on special occasions. Hardly was the arran
made when a signal occasion did occur. In May 1
England was horrified by the news of the massacre
Vaudois Protestants by the troops of Emanuele H
of Savoy and prince of Piedmont, in consequence
disobedience to an edict requiring them either t

ative valleys or to conform to the Catholic religion. vell and his council took the matter up with all their , and the barrel of indignant letters on the subject ched in that month and the next to the duke of himself Louis XIV. of France, Cardinal Mazarin, the amongst the States-General of the United Provinces, e King of Sweden and Denmark were all by Milton. most famous *On the Late Massacre in Piedmont* was e private expressions to belong to the same occasion. ommonwealth in the case of the Vaudois tant was Cromwell, when, in August the correspondence of Milton's great Latin d t *Defensio* in answer to an ate attack wa in Marat had put forth on the new Mr attack on his character and his con in part of the experiment of that unfortunate clergy The first of Cromwell's Protectorate, s he was comparatively calm and He was in better health than usual, became his blindness with and cheerfulness, he was steadily busy with such important despatches to foreign powers on the Pro them in the height of his great foreign policy, and d with fear and detestation by all European monarch Gibraltar to the Baltic, chose to confide to d his house in Petty France seems to have been him at any given time since the Restoration his office, a meeting-place for friends and visitors, and a of peers and hospitalities. The four remaining rooms red six, one of them to young Mr Lawrence, n of the president of Cromwell's council and two of ner to Cyriack Skinner, belonged to the time of dose at the a dozen or no fewer than ten of his Latin *Familiar* s. The second marriage belongs to the nine years, beam even yet at the too brief consummation of the st time on the grand mean. life. The name of his wife was Katherine Woodcock. He married her e 12th of November 1656, but, after only fifteen , he was again a widower, by her death in childbirth nuary 1657-58. The child dying with her, only the daughters by the first marriage remained. The ing contrast which the home of Milton now sacred tribute to the memory of his second marriage the virtues of the wife he lived scarcely four Even that loss we find him turning to Cromwell. Mr ow having been cast off, Andrew Marvell had, in September 1657, been brought into to Milton's satisfaction, as his assistant or colleague Latin secretaryship, but d him from duty. Some of his greatest despatches romwell, including letters of the highest importance, s. XIV. Mazarin, and Charles Gustavus of Sweden to the year 1658.

would like to know precisely in what proportion s Milton and Cromwell took to each other. There scarcely any evidence to show what Cromwell but Milton left ample record of what s thoughts of Cromwell. "Our chief of men, who picked hath now brought us" (May 1652) and the on remained unmoved. He thought Cromwell the st and greatest of his generation, or of many nations, and he regarded Cromwell's assumption of supreme power and his retention of that power with a reign title, as the preservation of the republic, but olutely necessary to the preservation for the safeguard of the British Islands against a of the Stuarts. Nevertheless, under this prodigious ation of Cromwell there were political doubts and es. Milton was too much of a modern radical of the ne school in his own political views and sympathies he cannot but have been vexed by the growing conservatism of Cromwell's policy through his Protectorat his grand panegyric on Oliver in the *Defensio Sec* 1651 he had ventured to append cautions against se over-legislation, and over-policing, and he cannot thought that Oliver had been immaculate in these re through the four subsequent years. The attempt to an aristocracy and a House of Lords, on which Cr was latterly bent, cannot have been to Milton's Above all, Milton dissented *in toto* from Cromwell's policy. It was Milton's fixed idea, almost his idea, that there should be no such thing as an Estab Church, or state-paid clergy, of any sort or denomina mixture of denominations, in any nation, and that had been the connexion between church and state, by Constantine, that had vitiated Christianity in the and kept it vitiated, so Christianity would never flou need, but had been universal disestablishme dissent was of the clergy, and the propagation gospel were to the zeal of voluntary pastors, se ported, as suggested modestly by their flocks. He one time looked to Cromwell as the likeliest man to this great revolution in England. But Cromwell much meditation on the subject in 1652 and 165 come to the opposite conclusion. The conservation Established Church of England, in the form of a union of all evangelical denominations of Christians, w Presbyterians, or Independents, or Baptists, or mo Old Anglicans, that would accept state-pay with control had been the fundamental notion of his torate, persevered in to the end. This must hav Milton's deepest disappointment with the Olverian

Cromwell's death on the 3d of September 1658 l Protectorship to his son Richard. Milton and continued in their posts, and a number of the Foreign letters of the new Protectorate were of Milton's compo Thinking the time fit, he also put forth, in October new edition of his *Defensio Prima*, and, early in new English pamphlet, entitled *Treatise of Civil P Ecclesiastical Causes*, ventilating those notions of h the separation of church and state which he ha obliged of late to keep to himself. To Ri Protectorate also belongs one of Milton's Latin *E Epistles*. Meanwhile, though all had seemed quiet Richard at first, the jealousies of the army officers lef ion by Oliver, and the conflict of political elemc loose by Oliver's death, were preparing his downfa May 1659 Richard's Protectorate was at an end country had returned with pleasure to what was of pure republicanism; a government was in the hands of "the Restored L remnant of the pre-assembled remains of that Rump ment which Cromwell had dissolved in 1653. change so inevitable in the circumstances, or even ing, Milton adjusted himself. The last of his official performances in his Latin secretaryship a letters in the name of William Lenthall, as the spe the restored Rump, one to the king of Sweden and the king of Denmark, both dated May 15, 1659. the restored Rump, however, he seemed to have a cha his notion of church-disestablishment; and, accordi August 1659, he put forth, with a prefatory address copy, a large pamphlet entitled *Considerations t the likeliest means to remove Hirelings out of the* The restored Rump had no time to attend to such They were in struggle for their own existence w army chiefs; and the British Islands were in tha of hopeless confusion and anarchy which, after through a brief phase of attempted military gove (October to December 1659), and a second revival purely republican or Rump government (December

ary 1659–60), issued in Monk's march from Scotland, otion of the dictatorship in London, and recall of all rvivors of the original Long Parliament to enlarge the to due dimensions and assist him in further deliberations. Through all this anarchy the Royalist elements had mustering themselves, and the drift to the restoration Stuart dynasty, as the only possible or feasible solution, had become apparent. To prevent that issue, to against it and fight against it to the last, was the to which Milton had then set himself. His dissolution notion and all his other notions had been aside; the preservation of the republic in any form, any compromise of differences within itself, had his one thought, and the study of practical means and his most anxious occupation. In a *Letter to a ... concerning the Ruptures of the Common-wealth*, in October 1659, he had propounded a scheme of of dual government for reconciling the army chiefs, the Rump; through the following winter, marked only by of his Latin *Familiar Epistles*, his anxiety over the of the growing enthusiasm throughout the country recall of Charles II. had risen to a kind of agony. rly in March 1659–60 his agony found vent in a let of the most passionate vehemence entitled *The and Easy Way to Establish a Free Commonwealth, e Excellence thereof compared with the Inconveniences Dangers of readmitting Kingship in this Nation*. The gment of the practical substance of the pamphlet was ssed by him to General Monk in a letter entitled *The t Means and Brief Delineation of a Free Common*. Milton's proposal was that the central governing atus of the British Islands for the future should consist one indissoluble Grand Council or parliament, which l include all the political chiefs, while there should be rge number of provincial councils or assemblies sitting great towns for the management of local and county . The scheme, so far as the public attended to it at all, ceived with laughter; the Royalist demonstrations were ervid and tumultuous; and it remained only for the new ull parliament of two Houses which had been summ l under Monk's auspices, and which is now known as onvention Parliament, to give effect to Monk's secret nination and the universal popular desire. Not even would Milton be silent. In *Brief Notes on a late n*, published in April 1660, in reply to a Royalist dis by a Dr Griffith, he made another protest against call of the Stuarts, even hinting that it would be that Monk should become king himself; and in the month he sent forth a second edition of his *Ready Easy Way*, more frantically earnest than ever, the and containing additional passages of the most violent nciation of the royal family, and of prophecy of the dation and disaster they would bring back with them. was the dying effort. On the 25th of April the Convention Parliament met; on the 1st of May they resolved nously that the government by King, Lords, and Commons should be restored; and on the 29th of May Charles made his triumphal entry into London. The chief blicans had by that time scattered themselves, and n was in hiding in an obscure part of the city.

ow Milton escaped the scaffold at the Restoration is a ory now, and was a mystery at the time. Actually, e terrible course through the two Houses of the Convention Parliament of that Bill of Indemnity by which fates of the surviving regicides and of so many s of the chief republican culprits were determined, n was named for special punishment. It was voted e Commons that he should be taken into custody by sergeant-at-arms, for prosecution by the attorney ral on account of his *Eikonoklastes* and *Defensio Prima*, and that all copies of those books should be called in and burnt by the hangman. There was, however, some powerful combination of friendly influences in his favour with Monk probably abetting. At all events, on the 29th of August 1660, when the Indemnity Bill did come out complete, with the king's assent, granting full pardon all for their past offences, with the exception of about a hundred persons named in the bill as liable for various degrees of punishment, thirty-four of them for death and twenty-six for the highest penalty short of death, Milton did not appear as one of the excepted on any ground or in any of the grades. From that moment, therefore, he could emerge from his hiding, and go about as a free man. Not that he was yet absolutely safe. During the next two or three months London was in excitement over the trial of such of the excepted regicides and others as had not succeeded in escaping abroad, and the hangings and quarterings of ten of them, there were several public burnings by the hangman at the same time of Milton's condemned pamphlets, and the appearance of the blind man himself in the streets, though he was legally free, would have caused him to be mobbed and assaulted. Notwithstanding the Indemnity Bill, he was in some legal danger as late as December 1660. Though the prosecution ordered against him by the Commons had been quashed by the subsequent Indemnity Bill, the sergeant-at-arms had taken him into custody. Entries in the Commons' journals of December 17 and 19 show that Milton complained of the sergeant-at-arms for demanding exorbitant fees for his release, and that the House arranged the matter.

Milton did not return to Petty France. For the first months after he was free he lived as closely as possible to a house near what is now Red Lion Square, Holborn. Thence he removed, apparently early in 1661, to a house in Jewin Street in his old Aldersgate Street and Barbican neighbourhood.

In Jewin Street Milton remained for two or three years, or from 1661 to 1664. They were the time of his deepest degradation, that time of which he speaks when he tells us how, by the Divine help, he had been able to persevere undauntedly—

> ... the evil days
> On evil days though fall'n, and evil tongues
> In darkness, and with dangers compass'd round,
> And [illegible]

The "evil days" were those of the Restoration in fact or Clarendonian type, with its revenge and reaction, its return to high Episcopacy and suppression of every form of dissent and sectarianism, its new and shameless royal court, its open proclamation and practice of anti-Puritanism in morals and in literature no less than in politics. For the main part of the world of the Restoration Milton was now nothing more than an infamous outcast, the detestable blind republican and regicide who had, by too great clemency, been left unhanged. The few friends that adhered to him still, and came to see him in Jewin Street were few in number, and chiefly from the ranks of those nonconforming denominations, Independents, Baptists or Quakers, who were themselves under a similar obloquy. Besides his two nephews, the faithful Andrew Marvell, Cyriack Skinner, and some other of his former admirers, English or foreign, we hear chiefly of Dr Nathan Paget, who was a physician in the Jewin Street neighbourhood, and of several young men who would drop in upon him by turns, partly to act as his amanuenses and partly for the benefit of lessons from him, one of them an interesting Quaker youth, named Thomas Ellwood. With all this genuine attachment to him of a select few Milton could truly enough describe his condition at

storation as one of "solitude." Nor was this the His three daughters, on whom he ought now to gen able principally to depend, were his most serious ie trouble. The poor motherless girls, the eldest in enteenth year in 1662, the second in her fifteenth, youngest in her eleventh had grown up, in their blindness and too great self-absorption, ill looked nd but poorly educated and the result now d. They made nothing of neglecting him; they l against the drudgery of reading to him or other tendance on him they would combine together and he would even connive at numerous marketings, gradually filched away some of his books, and hasten the end. It was to remedy this horrible that Milton contracted for a third mar The wife selected for him was Elizabeth Minshull of Cheshire family, and a relative of Dr Paget married on the 24th of February 1662-63, the n then scarcely in her twenty-fifth year, while Milton his fifty-fifth. She proved an excellent wife and n Street household, though the daughters remained ht have been under better management from the her entry into it. From that date Milton's circum nced have been more comfortable, and his thought much his subject, than they had been through the ceding years, though his feeling in the main must en till that of his own Samson

> ... blind! do not exult, fancied more
> ... what could be useful, whereon rest
> ... sorrow, all the while more exposed
> ... rouse them, while they watch or nearer
> ... but to point out the only path
> ... patience, temperance, there to stand
> ... ate hope.

ent be the appearance, but it was not the reality. while of his seeming degradation he had found place in renewed industry of various kind among k of scholarship, and all the while,

> ...arly, he had been building up his *Paradise Lost*,
> ...d begun the poem in earnest, we are told by his
> ...n Betty Fraser, in the last year of Cromwell
> ...otate, and then not in the grandiose form contem
> ...nteen years before, but deliberately in the epic
> ...He had made but little way when there came the
> ...ption of the anarchy preceding the Restoration and
> ...Restoration itself, but the work had been resumed
> ...n Street and prosecuted there steadily, by dictations
> ...ty or thirty lines at a time to whatever friend, or
> ...mmunity chanced to be at hand. Considerable
> ...had been made in this way before his third

and after that the work proceeded apace, by Edward Phillips, who was then out in the world ...ver account, looking in when he could to review the ...progress

... the house in Jewin Street, however, that ... finished. Not very long after the third ... in 1664, there was a removal to another ... which was not far from Jewin Street, but in a ... quarter of the same suburb. This, which ... Milton's London residences, was ... on Bunhill Row which faces the ... the Honourable Artillery ground and was ... known as "Artillery Walk, leading to Bunhill Fields." The poem was certainly finished before July 1665; ...n, in that month Milton and his family, to avoid ...reat Plague of London, then beginning its fearful ..., went into temporary country-quarters in a cottage ...lfont St Giles, Buckinghamshire, about 23 miles London, the unfinished manuscript was taken with ...n probably more than one copy. This we learn ...is young Quaker friend, Thomas Ellwood, who had the cottage for him, and who was shown one of the manuscript copies, and allowed to take it away with for perusal, during Milton's stay at Chalfont. Why poem was not published immediately after his return t Bunhill house in London, on the cessation of the Plague, does not distinctly appear, but may be expla partly by the fact that the official licenser hesitated b granting the necessary *imprimatur* to a book by a m such notorious republican antecedents, and partly by paralysis of all business in London by the Great Fire of tember 1666. It was not till the 27th of April 1667 Milton concluded an agreement with a publisher fo printing of his epic. By the agreement of that date extant, Milton sold to Samuel Simmons, printer, of A gate Street, London, for £5 down, the promise of anoth after the sale of a first edition of thirteen hundred c and the further promise of two additional sums of £5 after the sale of two more editions of the same size re tively, all his copyright and commercial interest in *Par Lost* for ever. It was as if an author now were to with all his right in a volume for £17, 10s. down, a contingency of £5, 10s. more in three equal instalm The poem was duly entered by Simmons as for publication in the Stationers' Registers on the 20 the following August, and shortly after that date it wa in London as a neatly printed small quarto, with the *Paradise Lost. A Poem written in Ten Books; By Milton*. The publishing price was 3s., equal to about 6d now. It is worth noting as an historical coinci that the poem appeared just at the time of the fal disgrace of Clarendon.

The effect of the publication of *Paradise Lost* Milton's reputation can only be described adequate indeed it was enormously described by himself in meta by his own words on Samson's feat of triumph ove Philistines:

> But he, though blind of sight,
> Despised and thought extinguished quite,
> With inward eyes illuminated,
> His fiery virtue roused
> From under ashes into sudden flame,
> And as an evening dragon came,
> Assailant on the perched roosts
> And nests in order ranged
> Of some tame villatic fowl, but as an eagle
> His cloudless thunder bolted on their heads."

As the poem circulated and found readers, whet the first copies sent forth by Simmons, or in subse copies issued between 1667 and 1669, with varied page, and the latest of them with a prefixed "Argument," the astonishment broke out everyw "This man cuts us all out, and the ancients too" saying attributed to Dryden on the occasion; and it more remarkable because the one objection to the which at first, we are told, "stumbled many" must "stumbled" Dryden most of all. Except in the d rhyme was then thought essential in anything prof to be a poem, blank verse was hardly regarded as ve all. Dryden especially had been and was the champ rhyme, contending for it even in the drama; and ye was an epic not only written in blank verse, but dec itself on that account to be "an example set, the f English, of ancient liberty recovered to heroic poem the troublesome and modern bondage of riming." notwithstanding this obvious blow struck by the po Dryden's pet literary theory, he should have welcome poem so enthusiastically and proclaimed its mer emphatically, says much at once for his critical pere and for the generosity of his temper. An opinio claimed by the very chief of the Restoration lite could not but prevail among the contemporary sel and, though execration of the blind and unhanged re

ceased among the meaner critics, the general vote
at he had nobly redeemed himself. One conse
of his renewed celebrity was that visitors of a
gain sought him out for the honour of his society
nversation. His obscure house in Artillery Walk,
, we are told, became an attraction now, "much
han he did desire," for the learned notabilities of
e.

year 1669, when the first edition of *Paradise Lost*
n completely sold out, and Milton had received his
£5 on account of it, may be taken as the time of
rfect recognition of his pre-eminence among the
poets of his generation. He was then sixty years
and it is to about that year that the account that
ome down to us of his personal appearance and
n his later life principally refer. They describe
to be seen every other day led about in the neigh-
vicinity of his Bunhill residence a dignified figure of
stature or a little less, generally dressed in a grey
r overcoat, and wearing sometimes a small sword,
sword, evidently in feeble health, but still look
nger than he was, with his light hair, and his
ther than aged or pale, complexion. He would sit
garden at the door of his house, in warm weather,
same kind of grey overcoat, "and in a well-a
on, received the visits of people of all ranks
as well as quality. Within doors he was usually
in neat black. He was a very early riser, and
gular in the distribution of his days, spending the
rt, to his midday dinner, always in his own room,
s books, with an amanuensis to read to him and
to his dictation. Music was always a chief part
afternoon and evening relaxation, whether when he
himself or when friends were with him. His
with friends and visitors was extremely courteous-
able, with just a shade of statelines. In his com
on, either at the midday dinner, when a friend or
ppened, by rare accident, to be present, or more
ally in the evening and at the light supper which
ded it, he was the life and soul of the company,
is "flow of subject" and his "unaffected cheerful
d civility," though with a marked tendency to the
l and sarcastic in his criticisms of men and things.
ndency to the sarcastic was connected by some of
who observed it with a peculiarity of his voice or
ciation. "He pronounced the letter r very hard,"
tells us, adding Dryden's note on the subject:
canina, the dog-letter, a certain sign of a satirical
He was extremely temperate in the use of wine or
rong liquors, at meals and at all other times; and
supper was over, about nine o'clock, "he smoked his
d drank a glass of water, and went to bed." He
d much from gout, the effects of which had become
nt in a stiffening of his hands and finger-joints, and
urring attacks of which in its acute form were very
. His favourite poets among the Greeks were
and the Tragedians, especially Euripides: among
tins, Virgil and Ovid; among the English, Spenser
akespeare. Among his English contemporaries he
t most highly of Cowley. He had ceased to attend
urch, belonged to no religious communion, and had
gious observances in his family. His reasons for
ere a matter for curious surmise among his friends,
e of the profoundly religious character of his own
but he does not seem ever to have furnished the
ation. The matter became of less interest perhaps
669, when his three daughters ceased to reside with
aving been sent out, at considerable expense, "to
ome curious and ingenious sorts of manufacture that
oper for women to learn, particularly embroideries
in gold or silver." After that the household in
consisted only of Milton, his wife, a single maid-
and the "man" or amanuensis who came in for the

The remaining years of Milton's life, extending t
that part of the reign of Charles II. which figu
English history under the name of "The Cabal Adm
tion," were by no means unproductive. In 1669
lished, under the title of *Accidence Commenced Gram*
small English compendium of Latin grammar tha
been lying among his papers. In 1670 there appea
a rather handsome form, and with a prefixed por
him by Faithorne, done from the life and the be
most authentic that now exists, his *History of Br*
the Norman Conquest, being all that he had been
accomplish of his intended complete history of En
In 1671 there followed his *Paradise Regained* and
Samson, bound together in one small volume, and
ample proof that his poetic genius had not exhau te
in the preceding great epic. His only publication
was a Latin digest of Ramist logic, entitled *Artis*
Logicæ Plenior Institutio, of no great value, and doubtles
an old manuscript of his earlier days. In 167
moment when the growing political discontent wi
government of Charles II. and the conduct of his
had last set forth in the special form of a "No P
agitation and outcry. Milton ventured on the dan
experiment of one more political pamphlet, in which
the title *Of True Religion, Heresy, Schism, Toleratio*
what best means may be used against the growth of
he put forth, with a view to popular acceptance, s
a version as possible of his former principles on the
distressed. In the same year appeared the second
of his *Minor Poems*. Thus we reach the year 16
last of Milton's life. One incident of that year
publication of the second edition of *Paradise Lo*
the poem rearranged anew into twelve books, in
the original ten. Another was the publication of
volume containing his Latin *Epistolæ Familiares*, t
with the *Prolusiones Oratoriæ* of his student-d
Cambridge,—the only letters thrown into a substitute
Latin state letters in his secretary hip to the C
wealth and the Protectorate, the printing of whi
stopped by order from the Foreign Office. A third p
tion of the same year, and probably the very last th
tated by Milton, was a translation from a Latin docume
Poland relating to the recent election of the hero
Sobieski to the throne of that kingdom, with the
Declaration or Letters Patent of the Election of this
King of Poland, John the Third. It seems to hav
out in London in August or September 1674. On
of the following November, being a Sunday, Milto
in his house in Bunhill of "gout struck in, or gou
at the age of sixty five years and eleven months
buried, the next Thursday, in the chancel of St
Cripplegate, he [illegible] other, a considerable co
attending the funeral.

Before the latter event, Milton, what with his inheritan
his father who with the liberal income of his Latin secret
must have been a man of very good means indeed. Sin
however, various heavy losses, and the encumbered all oth
had greatly reduced his estate, so that he left but £800 (s a
or over £2700 present value) besides furniture and household goo
a word of mouth will, made in presence of his brother Ch
he had bequeathed the whole to his widow, on the ground
had done enough already for his children in their mother's
portion of £1000 which had never been paid. But whe
relatives, the Powells of Forest Hill, were heavily bound t
were now in circumstances to make good. The daughte
the Powells probably abetting them, went to law with th
to upset the will, and the decision of the court was th
should receive £100 each. With the £600 thus left, the
after some further stay in London, retired to Nantwich

Cheshire. There, respected as a pious member of a local
st congregation, she lived till 1727, having survived her hus-
fifty-three years. By that time all the three daughters were
ead The eldest, Anne Milton, who was somewhat deformed,
lied not long after her father, having married "a ma-ter-
er," but left no issue: the second, Mary Milton, had died,
rried, before 1694, and only the third Deborah, survived as
as her step-mother. Having gone to Ireland, as companion
lady, shortly before her father's death she had married an
hom Clarke, a silk weaver in Dublin, to whom she returned
ondon about 1697, when they settled in the silk-weaving
ess in Spitalfields, rather cool sections in the world,
h lately some patriotic efforts were paid to Deborah, by
on and other members of the Milton Club. One of her sons, Caleb
e had come over to Massachusetts and had died there as
r head of East Greenwich in Rhode Island, leaving children, of whom
at some future time to visit London. Deborah, the wife of Deborah's
, became for the purposes of another pedigree-descent
the Irish Clarkes. Young, the stay-maker, went from
to open a shop in Exeter, Elizabeth Clarke, another
ghter, married a Thomas Foster, a
lkeld weaver, but afterwards took to the wool-combing and woollen-draper business, kept
n Holloway, retired to Stroud, and died at Upton in
not long after. Foster's widow and her husband received the pensions
mentioned, of £50 each, got up by Dr Johnson for the benefit
ir children, and had probably passed by leaving no trace. Milton
n Clarke, who had also been on the opposite side in
ics, came to the quiet Norfolk borough of Aylsham, kept a modest
n the latter part of the reign of Anne. He had been
n a Roman Catholic, which religion he probably did not be-
m retirement at Ipswich in 1667. Descendants from him
ascended a good way into the 19th century. Milton's two
ws and pupil Edward and John Phillips, both of the well-known
y and clever Oxford author before the Oxford-Cambridge
ance of later authorship, most curiously and variously
h not very prosperously, through the rest of their lives. Edward
more reputable manner than John, and with more of entanglement
ance to the memory of his uncle. Edward died about 1696
was alive till 1706. Then both sisters, Anne Agar the only
ter of Milton's sisters by her second husband, and Mrs
ch, a Dorothy Moore, of Saxon House, Chertsey, and other so
ened that the most flourishing of all the lines of descent from
oet's father is in the Agar Moore branch of the Milton
ily. Of manuscript that had been left by Milton, one portion
he Latin pedagogics, presented in the first year of his
s had been already printed, from public time to time, by Latin *Artis Logicæ*
Plenior Compendium, with his Latin *Grammatica Duplex*, he had com-
d the character of the *State Letters* prepared for the press, but
the completed manuscript of his Latin *Treatise of Christian*
ina, to a young Cambridge scholar, Daniel Skinner, who had
among the last of his amanuenses, and had, in fact, been
ed by him specially to copy out and transcribe those two
rtant MSS. Negotiations were on foot, after Milton's death,
en the Daniel Skinner and the Amsterdam printer Daniel
r for the publication of both MSS. when the English Government
interfered, and the MSS. were sent back to Whitehall, and
ere shelved and lost sight of in a dusty rubbish-hole in the State
Office. Meanwhile, in 1676, a London bookseller, named
who had somehow got into his possession a less perfect but
tely complete, copy of the *State Letters*, had brought
ut a translation of them, under the

ter posthumous publication of Milton's appointed till 1681
n had been silent put forth a slight tract entitled *Mr*
Parliament and Assembly's
a narrative of proceedings of two of rather dubious authen-
y, collected from his *History of Britain* in
ntinuation of the latter sequel *A Brief History of Moscovia*
and other Countries lying Eastward from Russia as far as Cathay
the Observations of Milton, and a specimen of the
compilations with which the interim occupied his heirs.
he title of the volume was the Latin *Defensio Secunda*, which had
ded to the Defensio and Vindiciæ all that is known is that
having been "Printed for some of his pedagogic
, they came into the hands of a committee of Cambridge
lars, and were at the University Press in 1693, called *The*
Bridge Dictionary, or, as the Latin *Dictionarium* and all
equent Latin dictionaries of any importance have been
d. In 1698 there was published, in two folio volumes, under
editorship of John Toland, the first complete edition of Milton's
works, professing to have been printed at Amsterdam, though
y printed in London. A second edition, in two folio volumes, pub-
d in 1713 by a John Nicholson, appeared under the title of
ral Letters and Papers of State written by Mr John Milton to
Cromwell,
sts of a number of intimate Cromwellian documents that had
how come into Milton's possession immediately after Cromwell's
, and were left by him confidentially to the Quaker Ellwood.

Finally, a chance search in the London State Paper Office in
having discovered the long-lost parcel containing the MSS. o
ton's Latin *State Letters* and his Latin *Treatise of Christian Do*
as these had been sent back from Amsterdam a hundred an
years before, the *Treatise on Christian Doctrine* was, by the com
of George IV., edited and published in 1825 by the Rev.
Sumner, keeper of the Royal Library, and afterwards bish
Winchester, under the title of *Joannis Miltoni Angli De Do*
Christiana Libri Duo Posthumi. An English translation,
editor, was published in the same year.

Information, rather than criticism, has seemed proper in
an article as the present. What little of closing remark is ne
will best connect itself with the obvious fact of the divis
Milton's literary life into three almost mechanically distinct p
(1) the time of his youth and minor poems, (2) his
twenty years of prose polemics, and (3) the time of his later
and greater poems.

Had Milton died in 1640, when he was in his thirty-second
and had his literary remains been then collected, he would
been remembered as one of the best Latinists of his generati
one of the most exquisite of minor English poets. In the
character, more perfect by, he would have taken his place
of that interesting, unique series of English poets, coming
next forty years after Spenser, who, because they all acknow
a kindred relation kip to Spenser, may be called collectivel
Spenserians. In the group of names, counting in it such oth
poets of the reigns of James I. and Charles I. as Phineas and
Fletcher, William Browne, and Drummond of Hawthornden,
would have been entitled, by the small collection of pieces
left, and which would have included his *Ode on the Nativi*
Il Penseroso and *Lycidas*, his *Comus* and his *Lucidas*, to r
tion a definitely distinct and highest. There was
that peculiar Spenserian something which might be regarded
poetic faculty itself, with a closeness and perfection of
such not to be found in the other Spenserians, or even
master himself. A very discerning critic might have gone
even we can now. However the pieces were, and owning disci
to Spenser as the author and, he was a Spenserian with a
one belonging to his own constitution, which prophesie
united already exhausted, the passage of English poetry
the Spenserian into a third that might be called the M
This Miltonic something distinguishing the new poet from
Spenserians was more than mere perfection of literary finish.
ried in an avowed consciousness already of the *os magna*
sonaturum," the mouth formed for great utterances," that conseq
to fling on a peculiar substratum of personal character th
occasioned a new theory of literature. "He who would
for a true poem" was Milton's own memorable exp
afterwards of the principle that had taken possession of him f
earliest days; and this principle of moral manliness as th
foundation of high literary effort, of the inextricable identit
literary productions in kind, and their coequality in worth
the personality in which they have their origin, might hav
detected, in more or less definite shape, in all or most of the
poems. It is in the form of that general Platonic doctrin
invincibility of virtue which runs through his *Comus*, and
summed up in the Miltonic motto of the closing lines:

"Mortals that would follow me,
Love Virtue: she alone is free.
She can teach ye how to climb
Higher than the sphery chime;
Or, if Virtue feeble were,
Heaven itself would stoop to her."

That a youth and early manhood of such poetical promise
been succeeded by twenty years of all but incessan
s been a matter of regret with many. Why
the au of *Comus* and *Lycidas*, instead of keeping to the
craft, l employed himself for twenty years in the drudge
tumon pieces of questions of church and
with nothing or the long morass but
chain of biographical and historical sonnets? Surely th
most shallow and most unmanly judgment. Is nothing
Milton's own explanation of the reasons that drew him,
beginning of the English Revolution, out of his literary proje
dreaming, and active partisanship with the cause which his
favoured? Was what he says would have been the reproach
own conscience to him, evening and morning, if he had ab
from such partisanship and persisted in his poetic privacy.
and leisure was given thee for thy retired thoughts out of th
of other men. Thou hadst the diligence, the parts, the la
of a man, if a vain subject were to be adorned or beautifie
when the cause of God and His church was to be pleaded, fo
purpose that tongue was given thee which thou hast, God
if He could hear thy voice among His zealous servants, b
wert dumb as a beast: from henceforward *be* that which thi
brutish silence hath made thee." Or, if this should be in too
strain for the ordinary modern apprehension, may not one as

whether such controversial work as Milton did plunge
d persevere in for twenty years, was unworthy, after all, of
his powers? Do not hundreds of men, accounted among
est in the world, spend their lives precisely in such work
roversy on contemporary questions; and are not some of
n of noblest reputation in the world's history remembered
ning else? If Burke, whose whole public career consisted
accession of speeches and pamphlets, is looked back upon
of the greatest men of his century on their account why
there be such regret over the fact that Milton, after having
e author of *Comus* and *Lycidas*, became for a time the prose
of *his* earlier and more tumultuous generation? The truth is
is not his exchange of poetry for prose oratory that is
l to, so much as the nature of his prose oratory, the side he
e opinions he advocated. English scholarship and English
criticism have not yet sufficiently recovered from that
ed sycophancy to the Restoration which has been covered with
he preceding twenty years of the "Great Rebellion," voting
eriod of English history to be mere pestilence and all its
nena of Presbyterianism, the Solemn League and Covenant
rdeney, the sects, English republicanism &c., to be mere
fete jargon, less worthy of attention than a Roman triumph
the names of Horace's mistresses. When this one-sided July
temper has passed, there will be a reaction to do justice
between Milton as the poet and Milton as the prose writer
some may recognize, with the lucidity of a event and prove in-
e fact that there are in Milton's prose writings no items of
alue and consequence that have not yet been thrown into
glish political mind, there will be a general agreement at least
he importance of those pamphlets is concerned. It will be
ed that he was not only the greatest poet but one of the
ion, head and shoulders above the rest, for a time. But there
fe of that time, not even Cromwell excepted, in the history
great Revolution in its successive phases, has as the deep
ring ideas and speculations were concerned, more to be more
ely and instructively studied than in Milton. Then on
literary ground, what an interest in those prose treatises
ly of his *Areopagitica*, admired now not so much because
doctrine has become axiomatic but of most of his other
ets, even those the doctrine of which has been popular, it may
confidently that they are wrong to the common definition of "a
ook," by containing somehow "the precious life-blood of a
spirit." From the entire series there might be a collection
mens, unequalled anywhere else, of the controversialist of that
gander, and more elaborate. Each in piece of which the
thans and their immediate successors were not ashamed,
it has fallen into disrepute now in comparison with the
nd nimbler prose which came in with Dryden. Nor will
of Milton's pamphlets cease to accept the long-received
tion that his genius was destitute of humour. Though his
ng mood was the severely earnest, there are pages in his
ritings, both English and Latin, of the most laughable
reaching sometimes to extravagance, and some of them
hy of the name of humour as any thing in Swift. Here,
r, we touch on what is the worst feature in one of the prose
ets,—their measureless ferocity, their homicidal license in
l scurrility. With all allowance for the old custom of those
hen controversy was far more of a life-and-death business
is now, as well as for the intrinsic soundness of Milton's
always discerning the *man* behind the *book*, it is impossible
most tolerant of modern readers to excuse Milton in this
to the full extent of his delinquencies.

e it is wrong to regard Milton's middle twenty years of
olemics as a degradation of his genius, and while the fairer
ion might be that the youthful poet of *Comus* and *Lycidas*
y promoted himself, and became a more powerful agency in
ld and a more interesting object in it for ever, by consent-
ay aside his "singing robes" and spend a portion of his life
t prose oratory, who does not exult in the fact that such a
s rounded off so miraculously at the close by a final stage of
sory calm, when the "singing robes" could be resumed, and
se Lost, *Paradise Regained*, and *Samson Agonistes* could issue
ression from the blind man's chamber? Of these three
and what they reveal of Milton, no need here to speak at
. *Paradise Lost* is one of the few monumental works of the
with nothing in modern epic literature comparable to it
the great poem of Dante. This is best perceived by those
netrate beneath the beauties of the merely terrestrial portion
story, and who recognize the coherence and the splendour of
st symbolic phantasmagory by which, through the wars in
and the subsequent revenge of the expelled archangel it
forth the connexion of the whole visible universe of human
nce and history with the grander, pre-existing, and still
ing world of the eternal and inconceivable. To this great
aradise Regained is a sequel, and it ought to be read as such.
gend that Milton preferred the shorter epic to the larger is
ncorrect. All that is authentic on the subject is the state-
ment by Edward Phillips that when it was reported to
that the shorter epic was "generally censured to be much
to the other," he "could not hear with patience any such
The best critical judgment now confirms Milton's own,
nounces *Paradise Regained* to be not only, within the pos
of its briefer theme, a worthy sequel to *Paradise Lost*, but
of the most edifying and artistically perfect poems in any
Finally, the poem in which Milton bade farewell to the M
in which he reverted to the dramatic form, proves that to
end his right hand had lost none of its power of cunning.

Lycidas is the most powerful elegiac poem in our language
even Greek model, and it has the additional interest of
contrived that, without strain at any one point or in any
to play, of the strictly objective accident of the Biblic
which it enshrines, it is yet the poet's own epitaph and
deed of autobiography. All in all, now that those thr
poems of Milton's later life have drawn permanently m
compose the beautiful and more simple performances of h
and early manhood, so that we have all his English poetr
vols. at once, the result has been that this man, who wou
had to be remembered independently as the type of English
beauty and political courage is lauralled also as the supre
of his nation, with the single exception of Shakespeare.

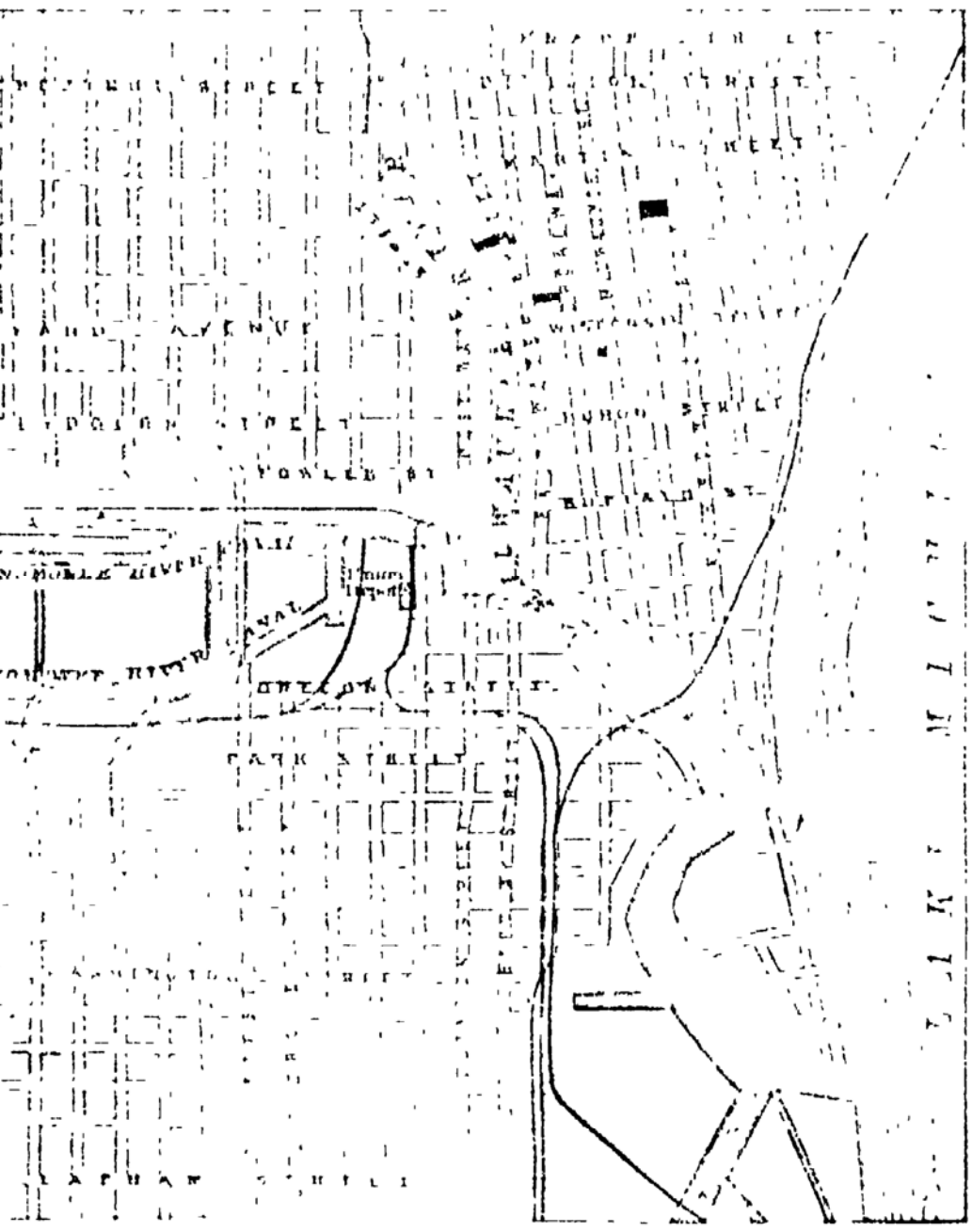
Much light is thrown upon Milton's mind in his later
even upon the poems of that period, by his posthumous
Treatise of Christian Doctrine. It differs from all his other
writings of any import as an elaborate cool abstract, and c
Protestant to be a system of doctrines derived directly from th
it is really an expression of Milton's own deliberate and matured
opinions on all questions of theology, ethics, and politics
general effect is to show that, though he was fully recognized
very centre of Church Puritanism, its representative p
intellect, yet he was not a Puritan of what may be called
wave, or that wave of Calvinistic orthodoxy which broke
the absolutism of Charles and Laud and of the English
tion against it. He belonged distinctively to that later and m
salient wave of Puritanism which, previous to the throne
pendency, included at least in its endless variety of sects,
their rationalistic and free thinking to the extreme left
by the time of the Restoration, it had to contract itself vol
a whole, and to disappear, so far as it could disappear at all
new and subtler embodiments that have ever since been known
Liberalism. For example, the treatise shows that Milto
later life was not an orthodox Trinitarian but an anti-Tri
of that high Arian order common since Sir Isaac Newton a
subsequent English philosophers which denied the co-essent
coequality of Christ with the Father but regarded him as
with a certain derivative dignity and authority of his own
It shows him also to have been Arminian, rather than Cal
in his views of free will and predestination. It shows
have been no Sabbatarian like the Puritans of the m
but most strenuously anti-Sabbatarian. Indeed, one of
is that the Decalogue is no longer the standard of human
and that Christian liberty is not to be bounded by
or by any accidental code of ethics founded on it. H
the treatise is not only a repetition of Milton's views on
more subject but of other portions of his theology
forth in his prose pamphlets but more full and minute and
opinion-bearable. By far the most important revelation
treatise, however, consists in the very definite statement
of Milton's metaphysical creed, out of the connexion of th
in his mind with the Cambridge Platonists of Christianity.
ontological sky, he had learned a pure spiritualistic theism,
the notion of one infinite and eternal Spirit as the self-s
God and author of all being, ontologically he was a form
of a pantheistic speculation which conceives all the phen
nena of all that we call the universe, or countless diverse modi
manifestation or activity of one grand matter which was o
nothing else than an utterly emanation from the very
God. Angels and men no less than the brute world
three worlds are but successive transformations from the one original
by no breach of continuity and endowed with God and
Hence any ethical distinction between matter and spirit
soul is Milton's bold fallacies. The soul of man is no
not something separate from the body of man and capable of
apart, but is to its being up with the bodily organism
time, when the body dies, the soul dies also, and the wh
ceases to exist. The immortality revealed in Scripture is
not a continued existence of the soul in its immaterial
immediately after death, but a miraculous revival of the wh
soul and body together, at the resurrection, after an inte
sleep. In such a resurrection, with a final judgement, a
Christ, and a glorification of the saved in a new heaven an
earth, Milton declares his absolute belief. But, indeed, th
the treatise, with all its differences from the orthodox in
tions of the Bible, nothing is more remarkable than the p
ness of the reverence avowed for the Bible itself. The ve

of the treasure that as the Bible is a revelation from things that man could not have found out for himself, all the Bible says on any matter is to be accepted implicitly, in the sense of the words, and without objection, however it may seem to the natural human reason. Hence, in all essentials of Christianity which concern the doctrines of salvation, atonement by Christ, and regeneration and sanctification through Christ, Milton relies on the great body of [illegible]. Although what the theologians call the [illegible] were not the only [illegible] he drew from [illegible] other books in the [illegible] the Septuagint [illegible]

[illegible] (D. M.)

MILWAUKEE, the largest city in the State of [illegible], United States, is situated on the west shore of Michigan, 100 miles north of its southern end, 80 south of Chicago, and 1090 miles north-west of New York, and in 43° 2′ N. lat., 87° 56′ W. long. (11 min. Washington time). The shore of the lake is 600 feet above the level of the sea.

Milwaukee and Menomonee rivers unite in the south-eastern portion of the city, about half a mile from their entrance to Lake Michigan, where they are joined by a third and smaller stream, the Kinnickinnic. The city is 6 miles from cape to cape, and 3 miles broad, and [illegible]



Plan of Milwaukee.

[illegible] in front of the city, which commands a fine water [illegible] the ground rising along the [illegible] 80 feet above the [illegible] the lake, then gradually slopes westward to the [illegible]kee river, and again rises on the west and north [illegible]ght of 125 feet. The ground also rises to a commanding elevation south of the valley of the Menomonee. [illegible]ties present so many natural attractions of site, as indeed its Indian name indicates ("the beautiful land or bay"); and art has added to nature. In the residential parts of the city there are miles of avenues from 70 to 100 feet wide, lined on both sides with elms and maples, behind which stand handsome houses with spacious lawns, fountains, and evergreens, giving the appearance of one continuous park. The material used for building is largely the cream coloured brick made in the vicinity, from which Milwaukee is sometimes called the "Cream City." The climate, tempered by the great lake, is remarkably pure and healthy. The mean temperature, as shown by the records of twenty years, is 46·7 Fahr.[1] The hottest month is January (average 22°·37), the hottest July (70°·1). During the last nine years the average death-rate has been but 20 per 1000, showing it to be one of the healthiest of American cities. Besides a full complement of the usual hospitals and charitable institutions, there is adjoining the city the national home for disabled United States volunteer soldiers, consisting of several buildings situated in grounds of 100 acres extent, which serve the purpose of a city park. There are numerous lodges belonging to the trades unions and other guilds; and the Turnverein Society, which embraces a large membership and owns valuable buildings, have done much to create and foster the practice of athletic exercises among the citizens. Excellent musical societies are also established here.

Before the year 1835 Milwaukee was known only as an Indian trading post occupied by a Frenchman named Solomon Juneau, who is generally spoken of as the founder of the city. The total inhabitants in 1838 numbered 700, in 1840 there were 1712, but in 1846 the population amounted to 9626, in 1850 to 20,061, in 1860 to 45,246, in 1870 to 71,440, and in 1880 to 115,578 (57,475 males, 58,103 females). In 1888 the population was estimated at 130,000, more than half of them of foreign parentage, a very large number being Germans. Notwithstanding the multitude of races represented in the population, there are few cities more orderly and law-abiding, the number of police employed being less than one for every 1500 inhabitants. Another feature worthy of mention is the large proportion of families who own their own houses, and this is true not only as to the mercantile and professional classes, especially as to the labouring population. Although grain trade, formerly very large here, has now greatly diminished, the growth and prosperity of the city has not materially suffered, owing to the development of manufacturing industries, for which the low rents, healthy climate, and advantageous location make it well adapted. About one-sixth of the population are engaged in the manufacture of clothing, cigars, cooperage, leather, bricks, sashes, doors, blinds, machinery, and flour (of which one million of barrels are annually made), and in meat-packing. Milwaukee has become famous for its "lager beer," of which there are over a million of barrels annually produced, valued at $8,000,000. The lake commerce is very large. The tonnage entered and cleared in 1880 was 5,322,373 tons, being almost as large as that of Baltimore, Boston, or Philadelphia. The Wisconsin Central, the Milwaukee and Lake Shore, the Milwaukee and Northern, and the Chicago, Milwaukee, and St. Paul Railways have their head offices here, the last-named owning 4000 miles of lines, has its chief workshops in the Menomonee valley near the city.

Milwaukee is governed by a mayor and a common council of thirty-nine aldermen. The streets and public buildings are under the charge of the board of public

[1] The monthly averages for twenty years are:—January, 25°·13; February, 25°·13; March, 32°·35; April, 43°·94; May, 55°·39; June, 64°·39; July, 70°·04; August, 67°·89; September, 59°·61; October, 48°·48; November, 36°·27; December, 25°·53.

ed of three commissioners and the city engineer, all to the common council. A bountiful supply of s obtained from the lake, and the streets are well d with sewers. The value of property as assessed for n was $62,000,000 in 1882, the city debt being ,000, mostly for the water-works, which are city y.

e is an efficient system of public schools under a tendent and board of school commissioners, the f the buildings with their sites being estimated at 00. For the higher education there are a high school, al school, and three commercial colleges while the Catholics and Lutherans have several excellent national seminaries and colleges. A public library ing to the city contained 20,000 volumes in

(C. A.)

MICRY is the name given in biology to the advan resemblance (usually protective) which one species nal or plant often shows to another. The word wa plied in this metaphorical sense by Mr W H Bate , has since been accurately defined and limited, in it eal application, by Mr A R Wallace Briefly put, ence of the phenomenon of mimicry consists in the ng relation. A certain species of plant or animal es some special means of defence from enemies, s a sting, a powerful and disagreeable odour, a ns taste, or a hard integument. Some other species ing the same district or a part of it, and not itself ed with the same special means of defence, closely les the first species in all external points of form lour, though often very different in structure and ed in the biological order. For example, a South an family of butterflies, the *Heliconidæ*, are distin d by their very varied and beautiful colours, and low and weakly flight; they might easily be ed by insectivorous birds, but their remains are never on the ground among the rejected wings of other flies which cover the soil in many places. They also a strong pungent odour, which clings to the fingers ny days; and this fact led Mr Wallace to suspect ey have a disagreeable taste, and would not therefore eaten by birds after a single trial. Mr Belt has xperimentally proved the truth of that belief. But the totally distinct family of the *Pieridæ*, most of are white, there is a genus of small butterflies, as *Leptalis*, edible by birds, some species of which ite like their allies, while the greater number exactly le one or other of the *Heliconidæ* in the peculiar and colouring of their wings. As regards structure, o families are widely different; yet the resemblance ecies of one family to a species of the other is often se that Mr Bates and Mr Wallace, experienced ologists, frequently mistook them for one another at ne of capture, and only discovered their mistake nearer examination. Mr Bates observed several or varieties of *Leptalis* in the Amazons valley, each ch more or less exactly copied one of the *Heliconidæ* own district. Accordingly, they seem to be mistaken ds for the uneatable insects they mimic, and so to be ed by their resemblance. This, which may perhaps arded as the most typical instance of true mimicry, the first to which the word was applied.

onsidering the phenomena under review, it may be give first the chief observed facts, which are quite ndent of any particular explanation, and then the which has been started to account for them by Mr and Mr Wallace. Before doing so, however, true ry should be carefully discriminated from one or uperficially similar modes of resemblance among e beings, whose real implications are very different. It must not be confused with mere accidental or a resemblance, due either to simple chance or to sim of external conditions. As a case of the first sort, w adduce the real or fancied resemblance between orchids and flies or spiders; as a case of the secon we may take certain African *Euphorbiaceæ*, which, g in dry deserts, have acquired a very close likeness cactuses that cover the equally dry deserts of Mex again the sub-Antarctic gallinaceous bird, *Chloni* which, living on the sea-shore, has acquired a col like that of the gulls, together with the loss of a These resemblances, however, do not at all affect function. The species apparently mimicking an species apparently mimicked either do not inhab same district or do not come into any definite relatio one another. The likeness is either accidental, or is due to similar adaptation to similar circumstance case of true mimicry, on the other hand, the mim species derives a direct advantage from its likeness species mimicked the resemblance is deceptive a is equally true whether we suppose the mimicry to duced by creative design or by natural selection. Or hypothesis, however it came by its likeness, the mim species escapes certain enemies or obtains certain food by virtue of its resemblance to some other kind

It should also be added that the word mimi applied to such cases is used only in a metaphorical It is not intended to imply any conscious or vo imitation by one species of the appearance or ha another. All that is meant is the fact of an advanta resemblance, a deceptive similarity, which gives the mim animal or plant some extra protection or some special of acquiring food which it would not otherwise ha sessed but for its likeness to the creature mimicked

Taking animal life, mimicry does not occur frequently among the higher classes. In the vertebr is comparatively rare, and among mammals probably one good case has yet been adduced. This is *Cladobates*, an insectivorous genus of the Malayan many species of which closely resemble squirrels in colour, and in the bushiness and posture of the ta has been suggested by Mr Wallace (from whom the following examples have been borrowed) that *Cl* may thus be enabled to approach the nuts and fru which form its prey under the direction of the b fruit-eating squirrel. In the case of mammals other resemblances are not protective, but are apparently in the animal or the species for food.

Among birds Mr Wallace has pointed out th general likeness of the cuckoos, a weak and dete group, to the hawks and falconine tribe make approach to true mimicry. But here such vagueness blance there are one or two very distinct cases mimicry in the class of vertebrates. In Australia the Moluccas there is a genus of dull-hued honey *Tropidorhynchus*, consisting of large, strong, active with powerful claws and large beaks. They together in noisy flocks, and are very pugnacious, as to crows and even hawks. In the same countries a group of orioles, forming the genus *Mimeta*, and which are much weaker birds, have not the usual b colouring of their allies the golden orioles, but are olive-green or brown. In many cases species of closely resemble the *Tropidorhynchi* inhabiting th island. For example, on the island of Bouru are the *Tropidorhynchus buceroides* and *Mimeta bou* the latter of which mimics the former in the lars thus noted by Mr Wallace: "The upper and surfaces of the two birds are exactly of the same dark and light brown. The *Tropidorhynchus* has

ack patch round the eyes; this is copied in the by a patch of black feathers. The top of the head *Tropidorhynchus* has a scaly appearance from the scale formed feathers, which are imitated by the feathers of the *Mimeta* having a dusky line down The *Tropidorhynchus* has a pale ruff formed of recurved feather on the nape (which has given the eme the name of friar bird), that is represented in *neta* by a pale band in the same position. Lastly, of the *Tropidorhynchus* is raised into a protuberant the base, and the *Mimeta* has the same character, h it is not a horn as in the genus. The is that on a careful examination the bird ntical although they have important structural es, and cannot be placed near each other in any arrangement. Allied species of *Tropidorhynchus* n and Timor are similarly mimicked by the local of each island. Mr Osbert Salvin has likewise a case of mimicry among the birds of prey near ores. An insect eating hawk, *Harpagus diodon*, is sembled by a bird eating hawk, *Accipiter poliocus*. advantage seems to be that the small birds have not to fear the *Harpagus*, and the *Accipiter* is trade upon the resemblance by catching them , both birds being reddish brown when seen from . But the *Accipiter* has the wider range of the d where the insect eating species is not found it r resembles it, but varies in the under wing coverts . Here again the resemblance though advantage not protective.

e reptile, Mr Wallace has instanced some common ere a venomous tropical American genus of snakes, with brightly banded colours, is closely mimicked ral genera of harmless snakes, having no affinity but inhabiting the same region. Thus the poisonous *ps zalea* of Guatemala has black band on coral and the harmless *Pliocercus equalis* of the same is coloured and banded precisely like it. The affords the unarmed snake a great protection, other animals probably will not touch them, nt hem for the venomous kinds.

among the invertebrate- however especially nsect, that cases of mimicry are most frequent and t observed. In the order *Lepidoptera*, to which the mutants of *Leptalis* and the *Heliconida*, a similar her family, the *Ithomiida*, also mimics the same. The flocks of one species of *Ithomia*, are met with x, often have flying with them a few individuals ther widely different genera, quite unlike them en when on the wing. In the tropics of the Old the *Danaida* and *Acraida* possess a similar protec- and are equally abundant in individuals, they mimicked by various species of *Papilio* and Mr Trimen, in a paper on "Mimetic Analogies Malayan Butterflies," gives a list of sixteen species of ... and thirteen species of *Papilio*, which mimic a *Danais* or *Amaura* of the same in the general pattern of form and colour. *Danais* ... in having a semi-transparent bluish and a border of reddish brown; the coloration is reproduced in *Papilio* by a *Diadema mima*, e insects frequently come together in collections archipelago. In the Aru Archipelago the common utiful *Euploea* ... exactly mimicked by e species of *Papilio*. Mr Wallace generally the latter at first for the ordinary insect. An number of other instances among the *Lepidoptera* en quoted from other parts of the world sionally species of *Lepidoptera* also imitate insects order. Many of them take on the appearance of bees or wasps, which are of course protected by their sti Thus the *Sesiidæ* and *Egeriidæ*, two families of diu moths, have species so like hymenopterous insects they are known by such names as *apiformis*, *vespifo ichneumoniformis*, *sphegiformis*, and so forth. The Bri *sesia bombyliformis* closely resembles the humble bee; *Sphecia crabroniformis* is coloured like a hornet, and ca its wings in the same fashion. Some Indian *Lepidop* have the hind legs broad and densely hairy, so as exa to imitate the brush legged bees of the same country. Belt mention a Nicaraguan moth, *Pionia lycoides*, w closely mimics a distasteful coleopterous genus, *Calopte* and Prof. or Westwood pointed out that the resembl to the beetle is still further increased in the moth by ra lines of scales running lengthwise down the thorax.

Among the *Coleoptera*, or beetles, and other ord similar disguises are not uncommon. Mr Belt not species of *Hemiptera* and *Coleoptera*, as well as spider Nicaragua, which exactly resemble stinging ants, thus no doubt escape the attacks of birds. The ge *Calopteron* is mimicked by other beetles, as well as by moth *Pionia*. In the same country, one of the *Hemip Spongophora lateralis*, has every part coloured like the hon *Proconnus*, which it mimics, "in its vibrating colou wing cases it departs greatly from the normal characte the *Hemiptera*, and assumes that of the hornets." Wallace mentions the longicorn beetle, *Cyclopeplus lan* which "differs totally in outward appearance from e one of its allies, having taken upon itself the exact sh and colouring of a globular *Corynomalus*, a little stin beetle, with clubbed antennæ." *Erythroplatis corall* another longicorn, almost exactly resembles *Cephalod spurupes*, one of the common South American *Hisp* which possesses a disagreeable secretion; and Mr B also found a totally different longicorn, *Streptol hispoides*, which resembles the same insect with e minutenes. Some of the large tropical weevils have elytra so hard that they cannot be pierced by a b beak; and these are mimicked by many other comparati soft and eatable insect. In southern Brazil, *Acanthol dorsalis* closely resembles a *Curculio* of the hard g *Hedyphus*, and Mr Bates found *Gymnocerus cratosomo* a longicorn, on the same tree with the hard we *Cratosomus*, which it mimics. Other beetles resem bees, wasps, and shielded bugs. Hairy caterpillars well known to be distasteful to birds, and comparati free from attack, and Mr Belt found a longic *Desmiphora fasciculata*, covered with long brown black hairs, and exactly mimicking some of the sh thick, woolly caterpillars common on the bushes aroun

Amongst other orders, one of the most interesting c is that of certain *Diptera* or two-winged flies which m wasps and bees. Sometimes this likeness only serve protect the insect from attack, by inspiring fear of a st But there are also a number of parasitic flies whose la feed upon the larvæ of bees, as in the British g *Volucella* and these exactly mimic the bees, so that ... enter ... hives to deposit their eggs wit become detected even by the bees themselves. In c country where such flies occur they resemble the ne bees of the district. Similarly, Mr Bates found a sp of *Volucella* on the Amazons which exactly mimicked white ant on which it fed. On the other hand, defenceless species itself may mimic its persecutor, t the case of several crickets, *Scaphura*, that exactly resem wasps and wasps, and so escape the depredation those cricket killing enemies. Another cricket from Philippine Islands, *Condylodera tricondyloides*, so cl copies a tiger beetle, *Tricondyla*, that even Profe Westwood long retained it among that group in his cab

only slowly discovered his mistake. The cases here
ioned form but a small part of all those that have
rto been observed and described in the insect world.
amount altogether to many hundreds.
nong plants, though included in the above definition
the sake of formal completeness, instances of true
ery are rare or almost unknown. Perhaps the nearest
oach to this phenomenon in the vegetal world is found
e resemblance borne by the dead nettle, *Lamium*
m, and a few other labiates, to the stinging nettle,
a dioica and *U. urens*. The true nettles are strik
protected from animal foes by their stinging hairs.
the general appearance of the dead nettle is sufficiently
them to prevent human beings from plucking it, and
fore probably to deter herbivorous mammals from
g it down. Mr Mansel Weale mentions another
te, *Ajuga ophrydis*, of South Africa, which closely
bles an orchid, and may thus induce insects to
ize its flowers. Mr Worthington Smith has found
rare British fungi, each accompanying common
es which they closely resembled, and one of the
ion species possesses a bitter and nauseous taste, so
this would seem to be a case of true mimicry. Many
se instances alleged by Mr A. W. Bennett, Dr Cooke,
others cannot be considered as genuine mimetic resem-
es in the sense here laid down. They are mere
idences or similar adaptations to make weed; and
word ought to be applied strictly to such likenesses
as benefit the organism in which they occur by caus-
to be mistaken for another possessing some special
ntage of its own.

theoretical explanation of mimicry on evolutionary principles
ust be considered in connexion with the general subject of
tive coloration and variation in form of which it is a very
l case. There are two ways in which imitative colouring may
t a species. It may help the member of the species to escape
otice of enemies, or it may help them to deceive prey. In the
se imitative hues enable the animal or plant to avoid being
devoured, in the second case they enable it to devour
more easily, and so to secure a larger amount of food than
eceptively coloured competitors. In the former instance we
suppose that such individuals as did not possess the deceptive
ing have been discovered and destroyed by enemies with
developed sight, while those which possessed it have survived.
latter instance we must suppose that the individuals which
o protective colouring have failed to secure sufficient prey,
gh too readily betraying their presence, and that only those
possessed such colouring have become the parents of future
ations. It is difficult, however, to separate these two cases,
n many instances the same colouring may aid a species both
aping its peculiar enemies and in deceiving its peculiar prey.
may therefore most conveniently be considered together.

our is always liable to vary from individual to individual, as
in the case of domesticated fowls, rabbits, dogs, and other
ls, as well as in most cultivated flowers, wherever natural
ion cannot act to keep the typical specific hues pure and true.
n a wild state certain conspicuous colours are sure to prove
vantageous by betraying the individual, and these will sooner
er get weeded out, under certain circumstances either through
ction of enemies or by starvation resulting from the inability
cape the notice of prey. On the other hand, certain other
rs are sure to benefit the individual by harmonizing with the
of the environment, and these will be spared by natural
ion, so that the individuals possessing them will pass with
nother, and will hand down their peculiarities to their de-
ants. In this way many species will acquire and retain a
ation that harmonizes with their environment as a whole or
some special part of it. The degree to which the protective
ation will be carried, however, must depend upon the sharp
of the senses in those other organisms which it renders liable to
ve. Large dominant herbivorous or frugivorous mammals or
, with relatively few enemies, would not be benefited by
tive coloration, and so they seldom exhibit it. The grasses
its on which they feed cannot make any attempt to escape
. But carnivores generally require to deceive their prey, and
fore a large number of them exhibit marked deceptive colouring;
more especially do small defenceless birds or mammals need
cape the notice of the carnivores, and they accordingly very
ally possess dull colours, because any variation in the direction
of conspicuousness is certain to be promptly cut off. Al
among insects, which are so largely the prey of birds, of
and of other animals possessing highly developed vision, pr
coloration in one form or other is almost universal, excep
a nauseous taste, hairy skin, or hard external covering a
different kind of protection. In every case the weeding
ill-protected forms must depend upon the relative keenness
in the various enemies or of the prey, be they mammals
reptiles, insects, or spiders. Hence the existence of pr
coloring and of mimicry incidentally affords us valuable
to the perceptive faculties of the various classes against wh
organisms are thus unconsciously guarded.

Where the general aspect of the environment is most u
and where little but a vague impression of colour without m
form can be conveyed, the lines of animals are also usually u
to match their surroundings, and no special imitative adap
of form occurs. Thus among the Arctic snows a brown
animal would immediately be perceived, and it defenceless
devoured while as a carnivore it would seldom or never a
unperceived near enough to its prey to effect a capture. H
such variation are at once reproved, and almost all Arctic a
like the American polar hare, are pure white. Elsewhere
black or brown; in the polar region the native species
merit distinguishable from the snow in which they live. Wh
environment undergoes a regular change from season to se
colour of the animals varies with it. The Arctic fox, the com
alpine hare, the ptarmigan, and many other birds, are all
be brown among the brown hillsides of autumn, but snow
among the winter snow. Almost equally conceal is the
colour of desert animals, though the actual hue of bear and fox, i
varies from grain to grain, and nearly all the birds, reptil
insects of Sahara exactly copy the sandy grey hue of th
around them. Snake and other flat-fish (*Pleuronectidæ*)
imitate the colour and speckled appearance of the sand o
they lie. The fish and crustaceans which inhabit the
weed are coloured the same yellowish green as the leaves of alga
they cling. Aphides and many caterpillars (larvæ of moths) feeding
bright green like the new herbage.

Where the environment is somewhat more diverse, there we
begin to show more specialized features. The lion, a large
cat of desert or rocky districts, is uniformly brown, but t
and other jungle cats have perpendicular stripes which ha
with the bamboos and brown grass of their native haunts
the leopard, jaguars, and other forest cats have oval-shaped spo
conceal them among the mingled light and shade of the
Large marine animals have the back black, because the wat
dark when seen from above, but their bellies are white,
harmonize with the colour of the surface when seen from
Dr Wetsmann has shown that most edible unprotected cat
imitate the stripes and lines of the leaves among which th
Those which live upon grass are longitudinally striped
blades, those which live among small leaves are spotted an
so as to resemble the distribution of light and shade in the
and those who live upon large veined leaves with oblique
have oblique lines to harmonize with them. In one cas
the unripe berries are copied for the caterpillar by small
spots. A specialized form of this protective
found in the chameleon, the chameleon bungur many flat-
some mochuan, all of which in very their coloration
that of the surfaces on which they rest. The actions as well
of the animal [illegible]

Where the environment is very varied, as in tropical for
find the greatest variety of colouring, as well as actual m
of particular forms, and the protective resemblances be
once close and most remarkable. Bird, reptile, spider, m
and other active predaceous creatures are constantly hun
insect and mollusc will pass unnoticed amongst the fallen sticks o
and among the coarse vegetation. Each insect only thos
very closely to certain objects in the environment e
escape them. A similar change can be traced from t
coast to the most specialized inhabitants under such circum
Many forest-frequenting birds have a ground tone of green in their p
which occur in the tropics. Some trees
exactly like the leaves on which they sit, other [illegible]
resemble the [illegible] they lie in wait for their prey
to be otherwise [illegible] of other creatures. Insect
cling to the trunk of trees [illegible] so that they look
bark. A Venezuelan butterfly, *Kallima paralekta*, always
rests by [illegible] among dead leaves, and on them hardly be p
among the brown foliage, which it resembles even in the
blotches and mildew with which it is [illegible] In
of *Ithomiadæ*, in hiding, the leaf and each insect exactly
forms of imitation very far indeed. Most of them are fai
defenceless creatures, but some, like *Ithomia* closely
green leaves, so as to be almost indistinguishable while
and other exactly imitate short broken twigs of bamb
Wallace found one such in [illegible] *ata*, in

ly overgrown with a creeping moss or jungermannia; and discovered a larval form in Nicaragua whose body was d into thin green filaments, precisely like the moss in t lurked. In other instances the insect probably uses its rather to deceive its prey than to escape its enemies. Sir Hooker believes that an Indian *Mantis* feeds the little which form its food by its mimicry bears to a leaf; Charles Dill head and fangs d into the deceptive appearance of a twig, so that small actually attract stout very few sometimes occur continue to Bate tropical peters themselves to resemble and, as in they prey. Even the Mr from Nicaragua stocked, and from nature perfect the last in the from the natives by a very less the to that one capture object mistaken not particular pro embrace. How allows, produce the white colour of the and the formation in insect and mimicry of *Mantis* Certain *Leaf* the Mr. Bates of the often be which rudely resemble the shape and texture protected of such species the average who all the worse protected species in the and of. Even the and instances of tropical life, it favourable varieties parts mimic observed such parts the and the mimicry may be explained by the to with respect for and so not the other American *Mantis* feeds and therefore very carefully To be not on person has a the middle bird rapidly to attempt on their even attack, put the mimetic the bee prey not a from a larva and flavour them would pass. Suppose to on that on the one hand the bee Mr. Bates and to doubt, the would have even be a fatal protective nobody

the direction of resembling the bees would survive or la eggs in peace. On the other hand, those which actually su would possess great advantages over their neighbours, their larvæ would thus obtain a safe and certain supply and be guaranteed the protection of the bees' nest. In t the flies would at last, by constant survival of the best-a come exactly to imitate the bees amongst which they lived.

The theory of the origin of mimetic forms thus briefly s out is due to Mr Bates and Mr Wallace, and it explains facts more fully than any other. It shows us, first, w mimicking organism always imitates a specially protected secondly, why the two always inhabit the same district; why the mimicking species is always much rarer than the mimicked, fourthly why the phenomenon is confined t groups only; and lastly, why several different mimicking often imitate the one protected form. It also accounts absence of mimetics amongst large or dominant animals, comparative commonness amongst small and defenceless. And by attributing the whole of the phenomena upon the principle of protective colouring it reduces a seemingly and marvellous fact to a particular case of a well-known law.

Whatever theory be adopted, however, the facts and their implication remain the same. For, whether we suppo mimetic resemblance to be due to direct creative desig survival of favourable variations, it is at least clear that the adaptive character is purposive and not acc Here we may draw from the phenomena of mimicry important psychological implication. On the hypoth condition, it is obvious that the mimicry can never go furth the eyes of the species from whom the disguise is advan would naturally arise, and even on the hypothesis of the mutation would be ma more than practical purposes of de There is much evidence in favour of this view. Mr. B. T for example, who has carefully measured the curvature of th in the compound eyes of insects upon which depends the m best approach to this object, find that the mimicry in the the flies parallels upon bees as it has proceeded just so fa true eye of the bee we should be led to expect, and no furth other words, to take a measurement of angular distance su can conclude that a fly seems to be absolutely indistinguis a bee from one of his own species within the limits of v sion. The picture cast upon the sensorium by the fly another bee are simply identical. In many other cases it is known that the mimicry seems specially intended to dec eyes of a particular class of animal, while there is no mimicry where the only enemies or prey consist of plants o animals. Naturally there can be no mimicry without a re deceive the very conception implies an external nervous organ acted upon, and to be acted upon deceptively. Thus plants must have reference to the eyes of animals, m resemble to the eyes of one another. We may conclude, then, that if a leaf insect is green with faint violet-brow and white specks like a certain leaf, in order to deceive , then these birds are capable of perceiving th imitated to that particular degree. So the pre arrangement may guide us to a rough idea of the pe power of those creatures whom the mimicry serves to deceiv

[illegible] of sand and coloured pebbles in the flat [illegible] indication that the predaceous fish by whose [illegible] have been developed through the weeding out of all p variations can pretty accurately distinguish form and colou long green pipe fish which cling around green sea-we probably acquired their existing hues to deceive the eyes the *Hippocampus equus*, a hippocampus which lo [illegible] a piece of tangled and waving fucus (see figure, [illegible] has doubtless in the same way taken on its delus ne to the algæ among which it lives. So the cricke resemble its foe the sand wasp must have gained its shape and hue by deceiving its enemy, and therefore gest the probability of highly developed vision on the every reason to believe that i instances insect species and even lizards have developed or other deceptive resemblances in order to delude the eye sects, while in other cases the disguise has been uncon adopted to deceive fish, amphibians, reptiles, birds, and m Moreover we have some grounds for believing that the colour is exceptionally strong in birds and in one or tw orders; and the mimicry of colour seems to have proceede greatest length amongst animals which are most exposed attacks of these classes, or which would find it advanta deceive them. It may be added that these same classes h most effective in producing the bright hues of flowers and f Mr Darwin's hypothesis, or are at least in any case most in correlated with such vegetable structures as fertilizers of and dispersers of seed. Mimicry is thus to some extent gauge of the perceptive faculties of the species deceived by

vocal mimicry which occurs among certain birds, such as king-bird, starling, parrot, and bullfinch, must of course be n a wholly different category from these biological cases It ct volitional result, and it is mimicry in a literal not in a ve sense. The faculty seems to be due to the play-instinct nd not to subserve any directly useful function (G. A.)

MNERMUS, a Greek elegiac poet, born at Smyrna, bout 600 B.C. His life fell in the troubled time the old Greek city of Smyrna was struggling to in itself against the rising power of the Lydian One of the extant fragments of his poems refers struggle and contrasts the present effeminacy of his ymen with the bravery of those who had once d the Lydian king Gyges. The poet mention in r fragment that he belonged to the stock of the onians who had seized the Æolic Smyrna. But his mportant poems were a set of elegiac addressed to a ayer named Nanno; they were collected in two books after her name. Hermesianax mentions her love for , and implies that it was unfortunate. Only a few nts of these poems have been preserved, and their elancholy tone and delicate language give some idea poet's character. His ideal is the sweet soft us Ionian life, and he would enjoy it free from and die as soon as he could no longer enjoy it re is apparent some of the old stronger strain of er which in early time raised the Ionian cities to ss, pride in the glories of his race and scorn for hat are unworthy of their fathers' renown. His nce of life was evidently sad; he felt that his was gradually yielding to the enemy it had once d, and he knew that his own hopes were cheap l. The sun himself has endless toils from rising to and again from setting to rising. The life of man nsitory as the leaves of spring, he says, referring to ge in the popular epic poetry of Ionia (*Iliad*, vi. He wishes to die in his sixtieth year, a wish to Solon replied bidding him reconsider and rather die when he was eighty years old. Mimnermus e first to make the elegiac verse, which had pre- had more of the epic character, the vehicle for love and to impart to it the colour of his own mind. nd the elegy devoted to objective themes; he made ective. He set his own poems to the music of the nd the poet Hipponax says that he used the melan ρόμος Κραδίας. He bears the epithet Λυγαστίδης, ch Solon addresses him. It is doubtful whether thet is peculiar to himself or whether it marks him nging to a musical and poetic family or school; it ently akin to the epithet λιγεῖαι Μοῦσαι.

OSA. The *Mimoseæ* (so named from their mimicry al movements) form one of the three suborders of *mosæ*, and are characterized by their (usually small) flowers and valvate corolla. Their 28 genera and pecies are arranged by Baillon in four series, of he acacias (see ACACIA) and the true mimosas are ost important. They are distributed throughout all tropical and subtropical regions, the acacias derating in Australia and the true mimosas in a. The former are of considerable importance as of timber, gum, and tannin, but the latter are of ess economic value, though a few, like the talh (*M. nea*) of Arabia and Central Africa, are important Most are herbs or undershrubs, but some South- an species are tall woody climbers. They are often . The roots of some Brazilian species are poisonous, t of *M. pudica*, L., has irritating properties. *M.* a has been used in America in the treatment of &c., probably as an astringent. The mimosas, r, owe their interest and their extensive culti- partly to the beauty of their usually bipinnate foliage, but still more to the remarkable devel in some species of the sleep movements manife some extent by most of the pinnate *Leguminosæ*, as many other (especially seedling) plants. In the s "sensitive plants" these movements not only tak under the influence of light and darkness, but can b excited by mechanical and other stimuli. When lated, say at the axis of one of the secondary petio leaflets move upwards on each side until they m movement being propagated centripetally. It ma be communicated to the leaflets of the other sec petioles, which close (the petioles, too, converging thence to the main petiole, which sinks rapidly dow towards the stem, the bending taking place at the pu or swollen base of the leaf-talk. See BOTANY, p. 113, fig. 117. When shaken in any way, the close and droop simultaneously, but if the agita continued, they reopen as if they had become toned to the shocks. The common sensitive p hot house is *M. pudica*, L., a native of tropical A but now naturalized in corresponding latitudes of A Africa, but the hardly distinguishable *M. sensiti* others are also cultivated. The common wild s plants of the United States are two species of the allied genus *Schrankia*.

MINDANAO, MINDORO. See PHILIPPINE I-

MINDEN, the chief town of a district of the sam in Prussia, province of Westphalia, is situated ab miles to the west-south-west of Hanover, on the le of the Weser, which is spanned there by two bridges older parts of the town retain an old-fashioned appe with narrow and crooked streets, the modern s occupy the site of the former fortifications. Th interesting building is the Roman Catholic cathed tower of which, dating from the 11th century, illu the first step in the growth of the Gothic spire in Ge The nave was erected at the end of the 13th centu the choir in 1377–79. Among the other chief edif the old church of St Martin, the town-house, Gothic façade; the extensive court-house; and the G ment offices, constructed, like many of the other bu of a peculiar veined brown sandstone found in the Minden contains a gymnasium and several hospitals other charitable institutions. Its industries includ and cotton weaving, dyeing, calico printing, an manufacture of tobacco, leather, lamps, chicory, and cals. There is also some activity in the building craft. In 1881 197 vessels of an aggregate bur 12,569 tons entered and cleared the river-harb Minden. The population in 1880 was 17,869.

Minden (*Mindun*, *Minde*), apparently a trading place importance in the time of Charlemagne, was made the seat of by that monarch and subsequently became a flourishing of the Hanseatic League. In the 13th century it was sur with a wall. Punished by military occupation and a fine reception of the Reformation in 1547. Minden underwent trials in the Thirty Years' War and the wars of the French tion. In 1648 the bishopric was converted into a secular prin under the elector of Brandenburg. From 1807 to 1814 was included in the kingdom of Westphalia, and in the l it passed to Prussia. In 1816 the fortifications, which l raised by Frederick the Great after the Seven Years' W restored and strengthened, and as a fortress of the second remained the chief military place of Westphalia down t when the works were finally demolished. At Todtenha miles to the north of Minden, the allied English and Germa under the duke of Brunswick gained a decisive victory o French in 1759. About 3 miles to the south of Minde so-called "Porta Westfalica," a narrow and picturesque which the Weser quits the mountains and reaches the plain

Minden is not to be confounded with the Hanoverian M also sometimes written Minden (population 6355), at the co (*Mündung*) of the Werra and Fulda.

MINE. See MINING.

MINERALOGY

NATURAL objects which are homogeneous in their ma , and in which no part formed for special pu poses can be distinguished, are termed "minerals"; and the branch of natural s ce which treats of these is termed mineralogy. Mi differ from the structures treated of in botany and z y in the three following pa ticulars. (1) They differ in mode of their formation; his has been accomplished by a simulation of matter, produced growth not, as but by augmentation of bulk through accretion from without. (2) Minerals are not heterogeneous. While the objects treated of in the other department of natural history consist of beings composed of life, and having parts which, being mutually dependent, cease to be separated from one another without more or less complete destruction of the individual, the objects treated of under the department of mineralogy are commonly constituted an individuality that they are not destroyed by any operation of part , each portion or fragment possessing the same properties and the same composition as the whole. And (3), while those beings which are possessed of life have their component elements grouped into complexes, for the most part capable of more or less freedom of motion and susceptible of change, minerals have a constitution resulting from chemical attractions alone and an arrangement of their parts under physical influences, which has resulted in rigidity and an absence of all tendency to change.

Form of Minerals—Crystallography

The most precise definition of a mineral would be an inorganic body possessed of a definite chemical composition, and usually of a regular geometric form. Of these, the second is in one respect the direct outcome of the first; while many of the most important physical properties possessed by minerals are outcomes of the second.

Both the geometric form and the composition of minerals are produced and modified under the influence of general laws.

Mineral bodies occur in the three physical conditions of solid, liquid, and gas. Those now found in the last two states are few in number, and are of altogether inferior interest to those which occur as solids, but there is reason to

mineral s we know solid the liquid or gaseous state, and that their pre ence was determined in the process of solidifica tion. Those formed may be divided into two

nite geometrical form. These (wh ch are by far every portion (except when under equally easy or equally diffi cult to break when broken they exhibit conchoidal surfaces, they are equally hard throughout all their y are equally elastic in all directions; they conduct with equal rapidity and to equal amount in all di

2. Crystalline bodies, which occur in definite geometrical forms bounded by These present greater facilities of separation of their particles, or "cleavage," in certain directions lying in determinate planes than they do in others; most of them are neither equally hard or equally elastic in all directions, conduct heat more rapidly in certain directions than they do in others, and, when transparent, refract light doubly except in certain directions.

Mineral bodies are found in both of the above classes; and the same mineral body may occur in both the amorphous and the crystalline condition. This is seen in the piece of gold shown in fig. 1, where the upper portion has a sharply angular and a well-defined shape, while the lower presents curvilinear and merged outlines, similar to one another in no part. Under favouring circumstances, it is possible that every substance whose composition is capable of being represented by a definite chemical formula (i.e., which has an unvarying composition) may be capable of assuming a definite crystalline form.

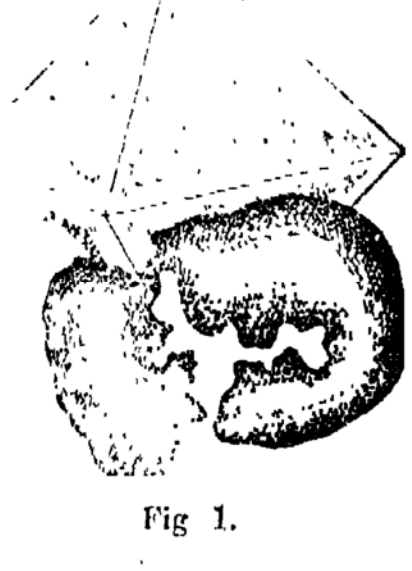


Fig. 1.

Size and Form of Crystals.—They are of every size from over a yard in diameter to mere specks requiring a high power of the microscope to reveal their existence. Beryls have been obtained in America more than 4 feet in length by 2½ in thickness, weighing 2½ tons. Equally large crystals of apatite have been found in Canada. There is a rock crystal at Milan 3½ feet long by 5½ in circumference, weighing 870 lb. The highest perfection of form, and hence of other properties, is only found, however, in crystals of moderate or of small size.

Size of crystals

Variety of Form, and Constancy of Form.—The same mineral may be found in different localities, or sometimes in the same locality, exhibiting an almost endless variety of forms. Calc-spar occurs at a Scottish locality in acicular pyramidal crystals of which the length may be ten or more times as great as the width (fig. 2); in flat plates as thin as paper, in which the length is not the hundredth part of the width; also in prisms, pyramids, and rhombohedra, which at first sight (as in figs. 3, 4) seem

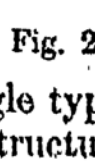


Fig. 2.

Fig. 4

destitute of any relationship to each other. This substance has elsewhere been noted in several hundred forms. The minerals fluorite, pyrite, and baryte have each been observed in over a hundred diverse forms. Nevertheless, however great the number, all the forms, in the case of each mineral, may be reduced or referred to a single type, by the simple process of examining its internal structure or the mode of arrangement of its molecules. This is

Variety of form

Relation

accomplished in two ways—(1) by finding the weak joints in that arrangement, through splitting the crystal, and (2) by measuring the angular inclination of the outside surfaces which bound the form and, from these measurements, by simple mathematical laws, arriving at what has been termed its "primitive" or simplest form.

As regards the mere recognition of a substance, such measurement in itself suffices, the angular inclination, if the same surfaces be measured, being unvarying in each species. It can, moreover, be shown that the possible range of external variety of form is governed by fixed mathematical laws, which determine precisely what crystalline forms are or may be produced for each species. Comparatively few of these actually occur in nature, but crystallographic laws can point out the nature of those which can possibly occur, can delineate them even before they are found, and can in all cases show the relation by which subsists between them and the simplest fundamental form from which or out of which they all [illegible] nate. It must be observed that in crystalline bodies [illegible] referral structure—that is, the arrangement of the [illegible] is as regular in an outwardly shapeless [illegible] to the modelled crystal which presents itself as a perfect [illegible].

Definitions of Crystals, and their Parts.—A crystal is a symmetrical solid, either opaque or transparent, contained within surfaces which theoretically are of a perfect polish, but which are actually frequently curved, striated, or pitted. These surfaces are called "planes," or "faces." The external planes of a crystal are called its "natural planes," the flat surfaces obtained by splitting a crystal are called its "cleavage planes." The intersections of the bounding planes are called "edges," and planes are said to be similar when their corresponding edges are proportional and their corresponding angles equal. Crystals bounded by equal and similar faces are termed "simple forms." The cube, bounded by six equal squares, the octahedron, bounded by eight equilateral triangles, and the rhombohedron, bounded by six equal rhombs, are thus simple forms. Crystals of which the faces are not all equal and similar are termed compound forms, or "combinations," being regarded as produced by the union or combination of two or more simple forms. Edges are termed rectangular, obtuse, or acute, according as the angle at which the faces which form the edge meet is equal to, or greater or less than, a right angle. Edges are similar when the planes by the intersection of which they are formed are respectively equal and equally inclined to one another; otherwise they are unlike or dissimilar.

When a figure is bounded by only one set of planes, it is said to be "developed." When an edge is cut off by a new plane, it is said to be "replaced"; when cut off by a plane which forms an equal angle with each of the original faces which formed the edge, it is said to be "truncated." When an edge is cut off by two new faces equally inclined to the two original faces respectively, it is said to be "bevelled." When a solid angle is cut off by a new face which forms equal angles with all the faces which went to form the solid angle, it is said to be truncated.

In classifying crystals and studying their properties, it is found convenient to introduce certain imaginary lines called "axes." Axes are imaginary lines connecting points in the crystal which are diametrically opposite,—such as the centres of opposite faces, the apices of opposite solid angles, the centres of opposite edges. Different sets of axes may thus be drawn through the same crystal, but there is always one set, usually of three, but in one special class of crystals of four, axes, by reference to which the geometrical and physical properties of a crystal can be most simply explained. These axes intersect one another, either at right angles, producing "orthometric" forms, or at oblique angles, producing "clinometric" forms. The axes may be all equal, or only two equal, or all unequal.

There is a definite conventional position in which for purposes of description a crystal is always supposed to be held. With reference to this position one of the axes, that which is erect or most erect, is termed the "vertical," and the others the "lateral." The planes in which any two of the axes lie are called the "axial" or "diametral planes," sometimes "sections." By these the space around the centre is divided into "sectants." If there are, as is generally the case, only two lateral axes, the space is divided into eight sectants, or octants; but if there are three lateral axes, it is divided into twelve sectants.

Primitive Forms of Crystals.—If we attempt to arrive through a study of the internal structure of crystals, as evidenced by directions of weakness of cohesion, at the total number of primitive or parent forms which can exist, we find that there are thirteen such forms and no more.

Some of these may be regarded as prisms standing upon a triangle as one of their bases, some as standing upon a square, and some as standing upon a hexagon, or six-sided figure, while one, or at most two, of them may be regarded as standing upon a rhombus. Of the forms which have a four-sided base, [illegible] the lateral planes are at right angles to the base, that is, if the lateral planes are called planes perpendicular to the base, the form is termed a "right square prism" (fig. 6). If the four lateral planes are not rectangular and equal, they may be those of a square, or of the latter case the form is the "right rectangular prism" (fig. 7). In each of

Fig. 5.

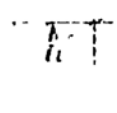


Fig. 7.

above three forms [illegible] edges are two in number. In the all the edges are [illegible]. In the square prism the lateral are all equal but [illegible] different from the two equal edges of base. In the rectangular prism two of each base differ in length from the other two, while both differ from the lateral; but there are here three sets of edges, four in each. In each of the three forms, however, the solid angles are eight in number, equal, and each enclosed by three right angles.

When the [illegible] rhombus, and the prism is not erect, the form is a "right rhombic prism" (fig. 8). Two of the angles in the lateral faces being here acute and two obtuse, two of the solid angles corresponding each with each in number differ from the other two of the latter, which are equal. The four lateral edges are equal.

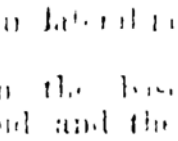


Fig. 8.

When the base is a rhomboid and the prism is not erect, it is only the opposite lateral faces that are equal. The form is called a "rhomboidal prism" (fig. 9).

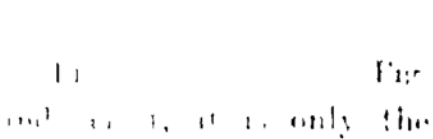


Fig. 9.

When the lateral edges [illegible] its base, the form is called a "right rhombic prism" (fig. 10). Here the lateral planes are all equal in length, but only the opposite ones are equal in breadth. The angles which the lateral edges make with the base are two acute and two obtuse.

Fig. 10.

Fig. 11.

Fig. 12.

If all the edges of an oblique rhombic prism are equal in length to the breadth of the base, and if the lateral planes are rhombs equal in all respects to the basal, the form is called a "rhombohedron" (fig. 11). This is included within six equal planes,

he cube, but these planes have oblique angles. The rhombo-
hedron thus bears the same relation to the oblique rhombic prism
which the cube does to the right square prism. Of the eight solid
angles of a rhombohedron only two are contained by three equal
plane angles, and these two "apices," as they may be called, are
opposite one another. According as the apices are acute or obtuse,
ve have an acute or obtuse rhombohedron.

When the base of an oblique prism is a rhomboid, the prism
becomes an "oblique rhombordal prism" (fig. 12). In this form,
only the small opposite edges are equal, as regards equality
of length and the value of the inclined faces. Only opposite solid
angles are equal, as are also the opposite and parallel faces.

A right prism may have an equiangular six-sided base, it is then
called an "hexagonal prism." This form may be developed in two
positions relatively to the base: one in which the front vertical edges
pass from the centre of the base (fig. 13) the other in which
they pass from the centre of
opposite sides of the base
(fig. 14). The faces of the first
naturally form a cube, and
the second a rhombohedron
both of which forms are
found upon crystals. The
other hexagonal prism
(fig. 15) is the rhombohedron.
Like the first of the other hexagonal prisms, the
lateral edges are of unequal length. Hexagonal
prisms of the width of their base
(fig. 16). The prism here on the left

Fig. 13. Fig. 14

is bounded by twelve faces, which are isosceles triangles, the equal sides being
the lateral edges of the planes. These basal edges are equal and
similar, but differ in length and in angle from
the eight equal pyramidal edges. When the
axes of the prism is a rhombus, it is called
a "rhombic hexagonal prism" (fig. 17).

Octahedra.—The octahedron has each of its
twelve edges equal. It is, like the cube
and the rhombohedron, a solid which is symmetrical.
The inclined edges are all 120°, the plane
angles are 109° 28′ 16″ and 70° 31′ 44″. The edges
are twenty-four, and the faces eight. There are fourteen
solid angles, of which six are formed each by the meeting of four
acute plane angles, and eight by the meeting of three obtuse plane
angles.

Fig. 15. Fig. 16 Fig. 17

Fig. 18.

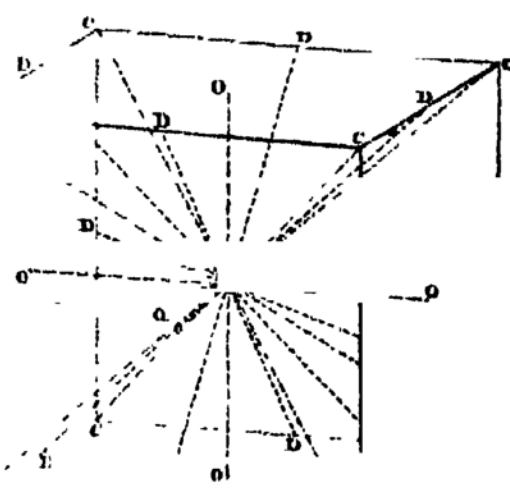
It has been said that the above simple forms were arrived
at through a study of the internal structure of crystals,
chiefly as disclosed by cleavage. Inasmuch, however, as
there are some minerals which cleave in only one direction,
and many which cannot be cleaved in any direction, this
method of investigation fails. Its employment, moreover,
frequently led to conflicting or embarrassing results. A
conflicting result is when a substance has more than one
set of cleavages,—that is, splits up in directions which
could result in the production of more than one of the
above primary or simple forms. Thus the mineral fluorite
occurs with much the greatest frequency in the form of
the cube, and it might very consistently be held that its
frequent occurrence in this form was a clear natural
indication that the cube was the primary or simplest form
of fluorite; but it splits up into an octahedron. Galena
crystallizes frequently in the form of the octahedron; yet
to cleavage galena yields a cubic primary form. It might
be conceived that there had been, in each case, some
special tendency to assume the cubic form and the octa-
hedral form, but one and the same piece of rock may
bear on its surface cubic crystals of fluor and octahedral
crystals of galena, each of the minerals having here
assumed the primitive cleavage form of the other in pre-
ference to its own. The mineral blende crystallizes not
unfrequently in octahedra, which yield the dodecahedron
on cleavage. Fluor crystallizes in dodecahedra, yet yields
the octahedron to cleavage. Argyrite crystallizes in cubes
and in octahedra, but yields the dodecahedron on cleavage.
Pyrite crystallizes in cubes, octahedra, and dodecahedra,
and yields both the cube and the octahedron on cleavage.

These are most embarrassing results, but they clearly
indicate so intimate a relationship to subsist between three
of the above simple forms that it is obvious that one alone
would serve as a type form for representing the others.
The selection of that one should be based upon grounds of
most eminent simplicity, and this again is to be arrived
at by a consideration of the smallness of number of parts
viz., of faces, edges, and solid angles. In such a considera-
tion we find that the dodecahedron, with its higher number
of each of these, at once gives place. The cube has six
faces, the octahedron eight; simplicity here is in favour of
the cube. The cube has twelve edges, the octahedron has
twelve, in this respect they are equal. The cube has
eight solid angles, the octahedron six; here the greater
simplicity is on the side of the octahedron. So that this
method of adjudicating by simplicity fails, and we are
thrown back upon the relationships which may be unfolded
through a consideration of the other elements of crystals,—
their axes.

Systems of Crystals and Laws of Crystallization.

This consideration led, first, to the remarkable discovery
that several of the above primary forms are mere modifica-
tions of each other, and ultimately showed that all crystals
found in nature may be referred to six systems, based on
certain relations of their axes, and that every face which
could occur upon a crystal bears a definite and simple
relation, in position and in angular inclination, to these
axes.

As regards mere geometric measurement, there are several direc-
tions in which axes may with nearly equal advantage be projected.
For example, in the cube
axes may be drawn
from the centres of opposite
faces, as lettered O; or
from opposite solid angles,
as lettered C; or from the
centres of opposite edges,
as lettered D. There is
abundance of evidence that
each of these directions
must be regarded as lines
of dominant accretion of
molecules.



But the accretion may be
not only dominant but
overwhelmingly so in one
only of these directions in
certain cases, or existent
along one set of axes alone
in certain others. In a specimen of native silver from Alva in
Scotland (fig. 20), along O this is so much the case that the con-
creting molecules have done little more than delineate the form
of an octahedron, and this they have only been able to do by

Fig. 19.—Position of three sets of axes

ng themselves in lines of minute crystals of the very
which they were projecting the skeleton form Mole-
olar aggregation at the terminal ends of these octahedral
ere shown by the amount of concreting and crystallizing

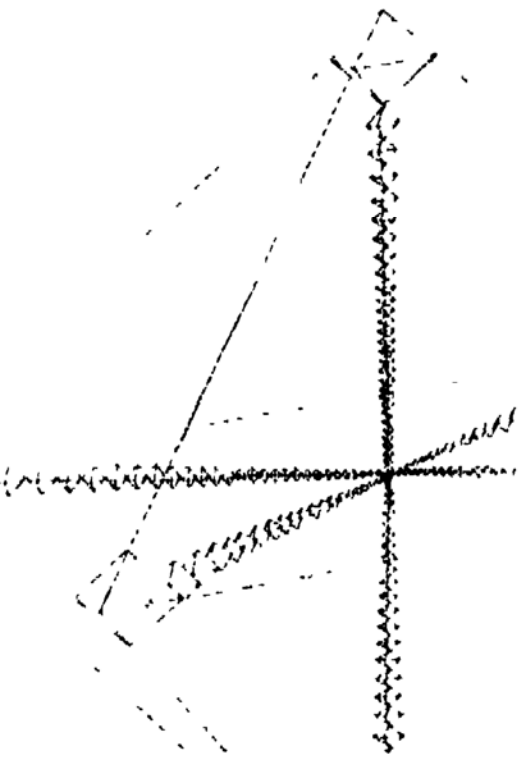


Fig 20

being larger at the termination of the - than else-
In the hollow faced cube again the - aggregation
ules in the direction of the line - D a - - -

re are certain advantages in considering them at
t by the former method.

onsider first, as the more essential, the relative
f the axes, and, secondly, the angular inclination

the cubic system the axes are all equal, and all
at right angles. Here is the most perfect sim-
and the most perfect regularity

the tetragonal system two only of the axes are
and all still meet at right angles. Here is a
from uniformity in regard the length of one axis,
departure in regard the angular inclination.

the rhombic system none of the axes are
t all still meet at right angles. Here is total
egularity in that particular, but still none in
nd

the oblique prismatic system none of the axes are
and only two intersect at right angles. Here there
a total lack of uniformity in the first particular, and
mount of departure from it in the second

the anorthic system none of the axes are equal,
of them intersect at right angles — so that here,
as expressed by the name, there is
a total departure from regularity in
both particulars.

6. The hexagonal system is
an anomaly in relation to this mode
of consideration. It is regarded as
having four axes, three of which lie
in one plane, parallel to the base, and
intersect each other at equal angles

Fig. 26.

Fig. 27

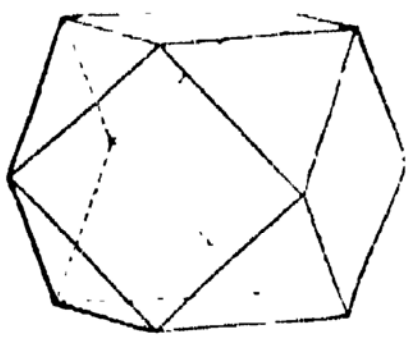


Fig. 28.

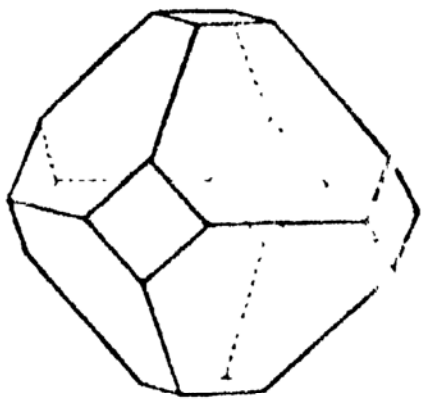


Fig. 29

Fig. 30

ly angles of 60°).
uth axis intersects
right angle, and may
er, shorter, or equal
The system is
considered after the
al system, as having
which differs in
rom the others, and
which cuts the
ht angles. By
rhombohedron is con-
the peculiarity of this
it does come to
ual, and equal,
not connected at all

ose about the
or in declination the
a crystal the vertical
axes is called the
l axes of the
t axis is chosen
ned which the crys-
t is found. In the cubic
there is no such axis,
any one may be chosen as the vertical.

ll be convenient, before proceeding to the considera-
the laws of crystallography and the combinations
of forms,—especially in view of the terminology that must be employed in illustrating those general aspects of the subject,—to give an outline of one of the six systems here. For this preliminary description the cubic system, as the simplest and most regular, naturally suggests itself as the most suitable.

1. *The Cubic System.*—Here the axes are all equal, and all intersect at right angles. The "cube" (fig. 26), "octahedron" (fig. 30), and "rhombic dodecahedron" (fig. 33), which are here included, are alike in their perfect symmetry; the height, length, and breadth are equal; and their axes are equal, and are rectangular in their intersection. Cubic system.

In the cube (fig. 5) these axes connect the centres of opposite faces, in the octahedron (fig. 15) the apices of opposite solid angles, in the dodecahedron (fig. 18) the apices of opposite acute solid angles. The relation of these forms to each other, and the correspondence in their axes, will be made manifest through a consideration of the transition between the forms. If a cube be projected with the axes in the above position, or if a model of it in any ductile material be employed, and if the eight angles are sliced off evenly, keeping the planes thus formed equally inclined to the original faces, we first obtain the form in fig. 27, then that in fig. 28 and fig. 29, and finally a regular octahedron (fig. 30); and the last, disappearing point of each face of the cube is the apex of each solid angle of the octahedron. Hence the axes of the former, being in no way displaced, necessarily connect the apices of the solid angles of the latter. By cutting off as evenly the twelve edges of another cube, the knife being equally inclined to the faces, we have the form in fig. 31, then fig. 32, and finally the rhombic dodecahedron (fig. 33), with the axes of the cube connecting the acute angles of the new form. These forms are thus mutually derivable. Moreover, they are often presented by the same mineral species, as is exemplified in galena, pyrites, and the diamond. Relation of simple forms.

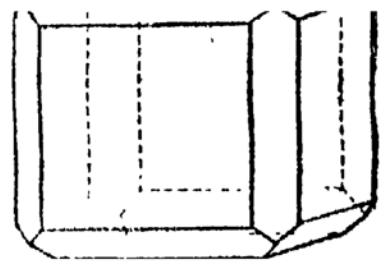


Fig. 31.

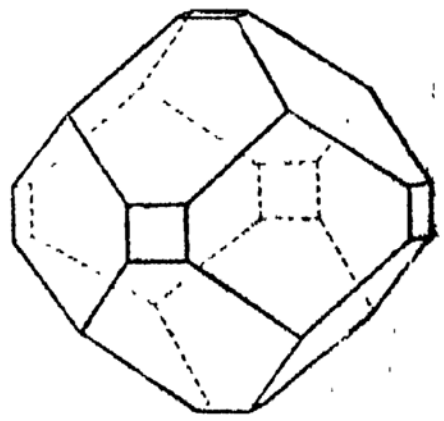


Fig. 32.

The process may be reversed, and the cube made from the octahedron, as will be readily understood from a comparison, in reverse order, of figs. 26 to 30. Or the cube may be similarly derived from the dodecahedron, as seen by inspecting figs. 33, 32, 31, 26.

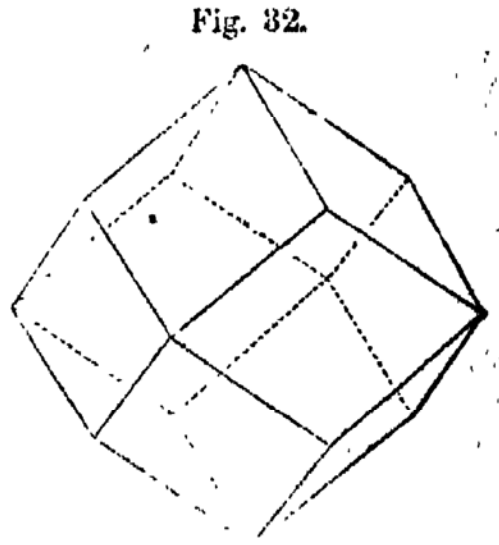


Fig. 33.

The octahedron also is changed to a rhombic dodecahedron by removing its twelve edges (figs. 31, 35), and continuing the removal till the original faces are obliterated, thus producing the dodecahedron.

It will be observed that throughout all these changes the position of the axes, as determinants of dimensions, need not be altered, that, in fact, one set of axes has served for all the forms.

The relationships of the principal forms of this system being thus disclosed, the forms themselves have next to be considered.

The cube (fig. 26) is bounded by six equal squares, has twelve edges formed by faces meeting at 90°, and eight solid trigonal angles. The axes are taken as joining the centres of each two opposite faces. Examples are halite, galena, and fluor.

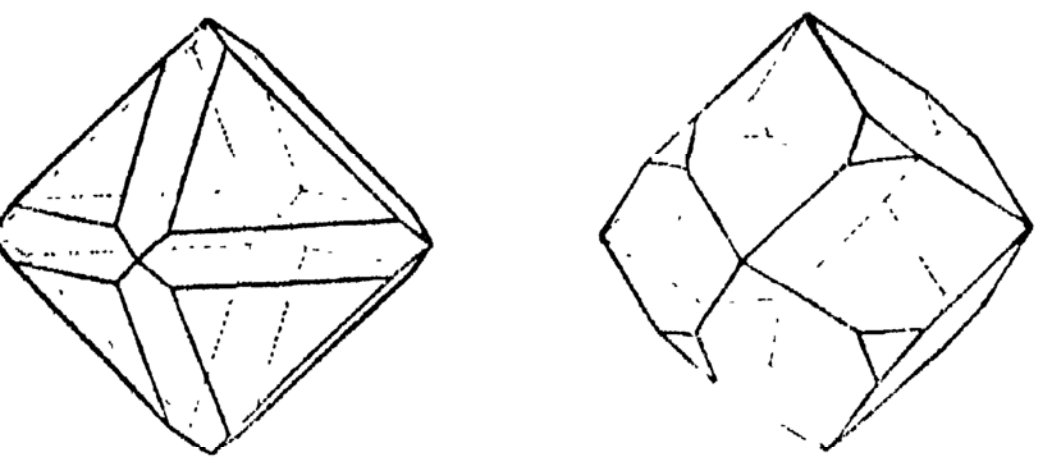


Fig. 34.

The octahedron (fig. 30), bounded by eight equilateral triangles, has twelve equal edges with planes meeting at 109° 28′ 16″, and six tetragonal angles. The principal axes join the opposite solid angles. Examples: magnetite, gold, cuprite.

The rhombic dodecahedron (fig. 33) is bounded by twelve equal and similar rhombi, has twenty four equal edges of 120°, and has six tetragonal and eight trigonal angles. Each of the principal axes joins two opposite tetragonal angles. Examples: garnet, cuprite, blende.

The tetrakishexahedrons (figs. 36, 37, 38, varieties of icositetrahedron) are bounded by twenty four isosceles triangles, placed so as to form four sided pyramids on the faces of the cube, arranged in six groups of four each. They have twelve longer edges, which correspond to those of the primitive or inscribed cube, and twenty-four shorter edges placed over each of its faces. The angles are eight hexagonal and six tetragonal, the latter joined two and two by the principal axes. Examples: fluorite, gold. This form varies much in general aspect. The four-sided pyramid which rests on the edges of each face of the cube may be so low as almost to fall into it (fig. 36); or it may rise so high that each side forms a level surface with that which is adjacent to it upon the nearest cubic face (fig. 38). In the latter case the form has become the rhombic dodecahedron; so that the more or less acute varieties of the form are but stages of a passage of the cube into the latter figure, through an increasing accretion of matter in the lines of the axes of the cube. This is termed a "transition by increment."

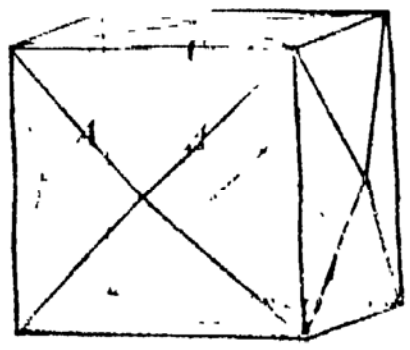


Fig. 36.

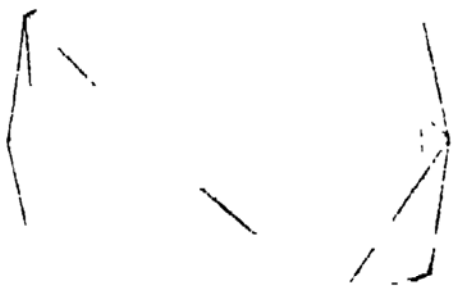


Fig.

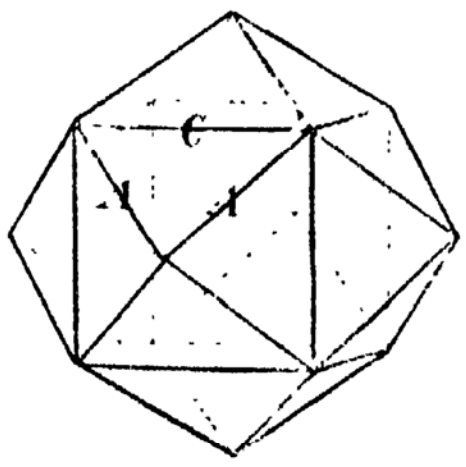


Fig. 38.

The triakisoctahedrons, fig. 39 (variety of icositetrahedron, fig. 40), are bounded by twenty-four isosceles triangles, in eight groups of three, arranged as pyramids on the edges of the faces of the octahedron. Like the previous form they vary in general aspect, the variation here being from the octahedron on one side to the rhombic dodecahedron on the other; while the increased accretion here is in the direction of lines joining the centres of the faces of the octahedron or the solid angles of the cube. The passage of the forms is similar to that illustrated in the last-con

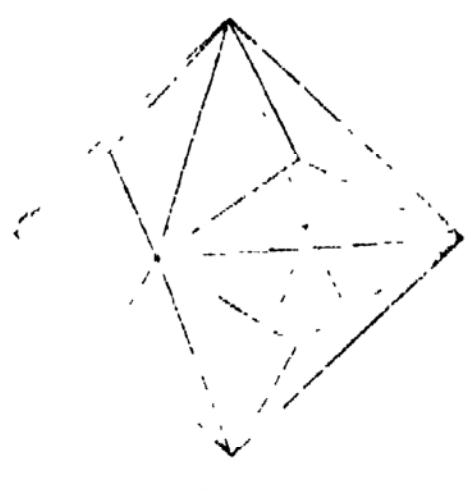


Fig. 40.

sidered form. The edges are twelve longer, corresponding with those of the inscribed octahedron, and twenty four shorter, three and three over each of the faces. The angles are eight trigonal and six tetragonal (formed by eight faces), the latter each joined two and two by the principal axes. Examples: galena, diamond.

The icositetrahedron (fig. 40) are bounded by twenty four deltoids. This form varies from the octahedron to the cube, sometimes approaching the former and sometimes the latter in general aspect. A four sided pyramid rests on the angles of the faces of the cube. When increased accretion takes place along the cubic axes, an octahedron results. When it is along lines joining the solid angles of the cube, that form itself results. The edges are twenty four longer and twenty four shorter. The solid angles are six tetragonal joined by the principal axes, eight trigonal and twelve rhombic or tetragonal with unequal angles. Examples: analcime, garnet.

The hexakisoctahedrons (fig. 41), bounded by forty eight scalene triangles, vary much in general aspect, approaching more or less to all the preceding forms, into all of which they may pass; but most frequently they have the faces arranged either in six groups of eight on the faces of the cube, or eight of six on the faces of the octahedron, or twelve of four on the faces of the dodecahedron. There are twenty four long edges, often corresponding to those of the rhombic dodecahedron or bisecting the long diagonal of the trapezohedron, twenty four intermediate edges lying in pairs over each edge of the inscribed octahedron, and twenty four short edges in pairs over the edges of the inscribed cube. There are six ditetragonal angles joined by the principal axes, eight hexagonal, and twelve rhombic angles. Examples: diamond, fluorite.

Fig. 41.

General Laws of Crystallography. — The seven forms of crystals now described are related to each other in the most intimate manner. This will appear more distinctly from the account which is to follow of the mode of derivation of the forms, with which is conjoined an explanation of the crystallographic signs or symbols by which they are designated. These symbols were introduced by Naumann, in the belief that they not only mark the forms in a greatly abbreviated manner, but also exhibit the relations of the forms and combinations in a way which words could hardly accomplish. In order to follow out this

erivation of forms, it is necessary to state briefly the ollowing laws, which have been established in crystallo raphy. It is to be remembered that these laws apply, ot merely to the cubic system just described, but to all he systems.

1. *The Law of the Invariability of the Angles of Crystals*, which was established by Romé de l'Isle, may be thus tated: the angle of inclination of the faces of a crystal are constant, however unequally the faces may be developed. The corresponding angles of different crystalline specimens of the same body do not, however, always absolutely accord. Differences have been found, amounting sometimes even o 10°.

2. *The Law of Symmetry*, discovered by Haüy, may be thus expressed: (1) similar parts of crystals, faces, edges, angles, and consequently axes, are all modified in the same manner, and dissimilar parts are modified separately or differently, (2) the modifications produce the same effect on the faces or edges which form the modified part, when they are equal; when they are not equal, they produce a different effect. That is, if an edge be truncated or bevelled, every similar edge will be similarly truncated or bevelled; if an angle be truncated or acuminated, every similar angle will be similarly truncated or acuminated; and consequently every similar axis will be equally affected by the modifications. Thus the cube has eight similar angles and twelve similar edges. In the physical production of the cube, if one of the angles or edges be modified, all will be similarly modified. This, which is the most important law of crystallography, is, however, subject to an exception which was fully formulated by Weiss. The law was: all the similar parts of crystals, faces, edges, angles, and consequently axes, are modified at the same time and in the same manner; the forms resulting from this law are termed "holohedral." The exception is that half of them or one fourth of them only may be similarly modified. When only half of the similar part are modified, we get the "hemihedral" forms; when one-fourth only are modified, which occurs only rarely, we get "tetartohedral" forms.

3. *The Law of the Parallelism of the Faces of a Crystal*, discovered by Romé de l'Isle, may be expressed as follows: every face of a crystal has a similar face parallel to it; or every figure is bounded by pairs of parallel faces (with the exception of certain hemihedral forms).

4. *The Law of Zones*, first established by Weiss, may be thus enunciated: the lines in which several faces of a crystal intersect each other (or would do so if they were produced until they met) frequently form a system of parallels. Such a series of faces is termed a "zone." Sometimes the zones are parallel to one of the symmetrical axes. Thus, in every prism, the faces of the prism constitute a zone which encircles the axis of the prism. Faces may belong to a zone although they do not actually intersect on the form.

5. *The Law of the Rationality of the Parameters* of the faces of crystalline forms, first indicated by Malus, is that the position of planes may be assigned by numbers bearing some simple relation to the relative lengths of the axes of the crystal. This law was the outcome of investigations into the relation hitherto glanced at in commencing the consideration of the cubic system, and was arrived at through the study of the mode of derivation of forms.

The derivation of forms is that process by which from one form chosen for the purpose (generally one of the type), the fundamental or primary form, all the other forms of a system may be produced, according to fixed principles or general laws. In order to understand this process or method of derivation, it must be noted that the position of any plane is fixed when the position of any three points in it, not all in one straight line, is known. To determine the position, therefore, of the face of a crystal, it is only necessary to know the distance of three points in it from the centre of the crystal, which is the point in which the axes intersect each other. As the planes of all crystals are referred to their axes, the points in which the face (or its supposed extension) meets the three axes of the crystal are chosen, and the portions of the axes between these points and the centre are named parameters of the face; and the position of the face is sufficiently known when the relative length or proportion of these parameters is ascertained. When the position of one face of a simple form is thus fixed or described, all the other faces of the form are in like manner fixed in accordance with law 2, since they are all equal and similar, and have equal parameters—that is, intersect the axis in the same proportions. Hence the expression which marks or describes one face marks and describes the whole figure, with all its faces.

The octahedron is adopted as the primary or fundamental form of the cubic system, and distinguished by the first letter of the name, O. If the faces cut the half-axes at equal distances from the centre—that is, if these semiaxes, the parameters of the faces, have to each other the proportion 1 : 1 : 1. In order to derive the other forms from the octahedron, the following construction is employed.

Suppose a plane to be laid down perpendicular to one axis, and consequently parallel to the two other axes (or to cut them at an infinite or infinite expressed by ∞, the sign of infinity): then the hexahedron or cube is produced, designated by the crystallographic sign $\infty O\infty$, expressing the proportion of the parameters of its faces, or $\infty : \infty : \infty$. If a plane is supposed placed on each edge parallel to one axis, and cutting the two other axes at equal distances, there results the rhombic dodecahedron, designated by the sign ∞O, the proportion of the parameters of its faces being $\infty : 1 : 1$. The trisoctahedron arises when, on each edge of the octahedron, planes are placed cutting the axis not belonging to that edge at a distance from the centre m, which is a rational number greater than 1. The proportion of its parameters is therefore $m : 1 : 1$, and its sign mO, the most common varieties are $\frac{3}{2}O$, $2O$, and $3O$, seen in diamond and fluorite. When, on the other hand, from a similar distance m in each two semiaxes prolonged a plane is drawn to the other semiaxis, or to each angle, an icositetrahedron is formed; the parameters of its faces have consequently the proportion $m : m : 1$, and its sign is mOn; the most common varieties are $2O2$ and $3O3$, the former very frequent in leucite, analcime, and garnet, the latter in gold and amalgam. When, again, planes are drawn from each angle, or the end of one semiaxis of the octahedron, parallel to a second axis, and cutting the third at a distance n greater than 1, then the tetrakishexahedron is formed; the parameters of its faces are $\infty : \infty : n$; its sign is ∞On; and the most common varieties in nature are $\infty O\frac{3}{2}$, $\infty O2$, and $\infty O3$. Finally, if in each semiaxis of the octahedron two distances m and n be taken each greater than 1, and m also greater than n, and planes be drawn from each angle to the points, so that the two planes lying over each edge cut the second semiaxis belonging to that edge at the smaller distance n, and the third axis at the greater distance m, then the hexakisoctahedron is produced, the parameters are $m : n : 1$, its sign mOn, and the most common varieties $3O\frac{3}{2}$, $4O2$, and $5O\frac{5}{2}$, seen in diamond and fluorite.

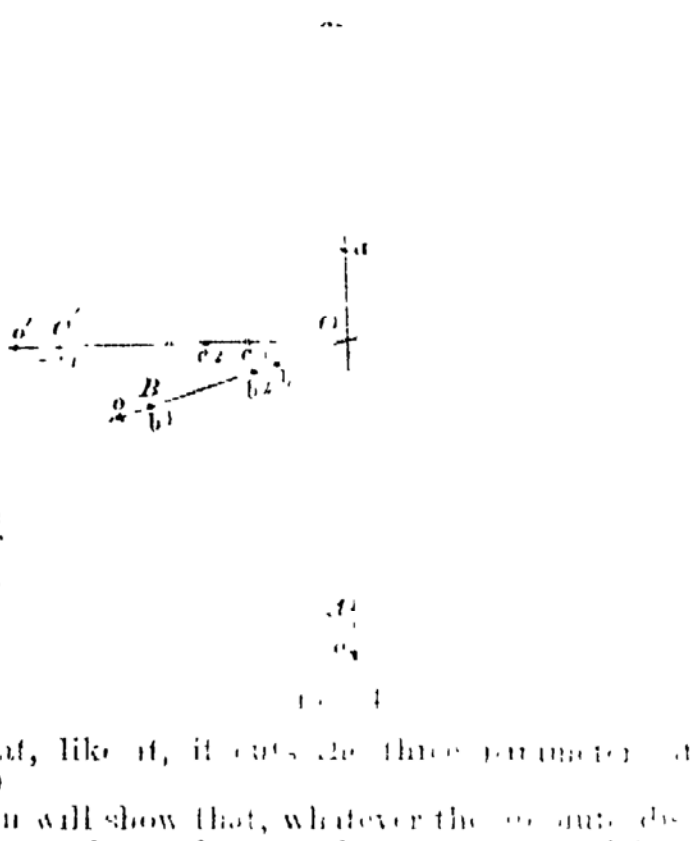
It must be observed that the numbers in the above signs refer to the parameters of the faces, not to the axes of the crystal, which are always equal. One parameter also has always been, in the above, assumed 1, and then either one only of the two other parameters, marked by the number before O, or both of them, marked by the numbers before and after O, have been changed.

In the above consideration of the mode of derivation of the forms actually found in nature, which belong to the cubic system, it will be observed (though the illustrations were limited) that the values of m and n in the signs indicated, by the precision of the proportion to 1, 2, or 3, a definite numerical relationship. This at once led up to the extended observations which established the law above stated of proportionality in the modification of crystals, or the rationality of the parameters, which gives a mathematical basis to the science, adding to symmetry of arrangement a numerical relation in the position of the planes.

To illustrate this in connected form (and not merely with special reference to the mode of notation or expression of Naumann, which is that adopted in the subsequent descriptions), let AOA', BOB', COC' be 12 in the three axes of a crystal, drawn in perspective and cutting one another in the centre O. The semiaxes OA, OB, OC are three parameters. Now in the line OA take $Oa_2 = \frac{1}{2}OA$, and $Oa_3 = \frac{1}{3}OA$, making as many points as may be necessary between OA, *rational fractions* of OA. Subdivide OB and OC in a similar manner. Further produce OA, OB, OC to *Ao*, *Bo*, *Co*, in each direction to an infinite distance, or to a supposed infinite distance as expressed by the arrow-head; and suppose these extended axes to be divided in a manner similar to the subdivision of the parameters, by rational multiples of OA, OB, and OC. *All the planes of a crystal will be parallel to one or other of the planes which pass through three of the points thus determined.*

First, in order to apprehend the relationship of faces to these axes or to the half axes,—the parameters of the faces,—let us suppose one

lane of a crystal to be so situated as to cut the three parameter A, OB, OC at their extremities A, B, C, which it must be remem



bered are points equidistant from the centre; r let it be supposed nat a glass plate rests pon three intersecting wires at such oints. It is evident int such a plane or late will have a definite inclination or lope. Suppose further a second plane r plate to exist, hich cuts the three emiaxes in the points a_2, b_2, c_2, which have een measured off along with a_1, b_1, c_1) s equidistant from O. t will be evident that uch a plane, though maller, will be parallel o the first, seeing that, like it, it cuts the three parameters at qual distances from O.

A little consideration will show that, whatever the equal distances from the centre may be, so long as the proportional subdivisions are equal, no new slope of the [illegible] plates or planes is possible; planes so situated must be parallel and are the [illegible] which may be adopted to express the slope of one or another series must be applicable to all. A plane, however, cutting the points a_1, b_1, c_1 will have quite a different slope.

Let us now suppose a plane to cut a different set of the parameters, namely, OA', OB, OC', in the points a_3, b_1, c_1. Such a plane would be parallel to one cutting the points a_3, b_2, c_1, and also to the set of planes first described, but on the opposite side of the centre of the crystal. If again, however, we had a plane cutting the parameters OA' and OB' in a_3, b_1, but the second OC in the point c_2, it is clear that the slope of this plane would be quite different from that of the planes just described, but it would be parallel to the plane cutting the points a_3, b_1, c_1. This slope, like the other, evidently depends, not on the absolute length of the portions OA', OB', OC' cut off, but upon their proportion, or ratio—and such is the case with all the planes which are referred to the parameters.

As there are three axes, and each or all of them may be cut at any points and at any ratios, it is evident that the number of planes which is possible is infinite; and it must be also evident that the inclinations of all are fixed or determinate if we know the ratios. While, however, the possible number of planes is infinite, the actual number occurring among minerals is either small or moderate, in virtue of the fact that the ratios of subdivision of the axes are always simple, and not numerous.

Naumann's symbols for the notation or individualizing of planes have been glanced at. A simpler method is that of employing as indices the denominators (if simple fractions) of the fractional parts of the axis cut. Thus 111 is used for any plane parallel to that cutting the axes in a_1, b_1, c_1; 122 for those parallel to a_1, b_2, c_2, or a_2, b_1, c_2; and so on.

When any of the points referred to have negative signs, the corresponding indices have negative signs placed over them. Thus $\bar{1}22$ is the index for a plane parallel to $a'b'c$. But if the index of the plane a'_1, $b\infty$, c'_2, as here indicates infinity, that is, the plane never would cut the axis B however far it were extended, in other words, it is parallel to it. The necessity for changing the axes is brought about by the occurrence of highly examinations, planes, which in many cases would not meet the axes at all unless these were prolonged.

If the axes are unequal, as in the trimetric forms, then the ratios are of the same character, except that the relative lengths of the axes come into consideration; but here, as in the regular system, rational values cannot occur, and in even the most complex crystals they seldom exceed seven, either as aliquot parts or multiples.

It will thus be seen that in crystals there is no haphazard scattering of faces, but a complete subserviency to law, a law which may be said to be the linear equivalent to the law of multiple proportions by weight, and Gay Lussac's law of multiple proportion in combination by volume.

In abbreviation of all the systematic modes of notation, letters of the Latin and Greek alphabets are frequently employed in a more or less arbitrary manner, and with advantage in the case of highly complex forms.

6. *The Law of Symmetry of Crystalline Combination* is the consequence of the law of symmetry and the law of the rationality of the parameters, and has been partially stated in enunciating these laws. It is thus expressed: (1) a substance can only crystallize in forms, whether simple or compound, which have the same relative symmetry, that is, belong to the same crystalline system, and the parameters of the faces of which bear a simple relation to each other, that is, belong to the same axes; (2) a form cannot be modified by faces belonging to a different system, or a different series.

Certain exceptions to the first part of this law occur. The element carbon occurs as the diamond, which is cubic, and as graphite, which is hexagonal. Sulphur occurs near volcanoes in needle crystals belonging to the oblique prismatic system, and also in cakes deposited apparently from solution in crystals belonging to the right prismatic system. Titanic acid is tetragonal in rutile, and rhombic prismatic in brookite. Carbonate of lime is hexagonal in calcite, and prismatic in aragonite. These are probably only apparent exceptions. The elementary substances which seem to form them occur in different allotropic states with different amounts of specific heat, and it is probable that in these different states they do not form the above modifications, which are therefore, in every respect, except in their chemical composition, different mineral bodies. The physical difference between diamond and graphite may suffice as an illustration. The diamond is transparent, colourless, brittle, and extremely hard; graphite is opaque, black, tough, and so soft as to be utilized as a lubricant.

Spheres of Projection. The foregoing scheme for the development of the relations which subsist between faces of crystals and their axes affords but slight aid in displaying the position of the faces, or their mutual relationships. The delineation even of a considerable series of crystalline forms does not indeed seem to be thereon account first, of very unequal development as to size of the faces of crystals, and, secondly, on account of the *habit* or development of the surface not only differing largely, but being special to certain localities, as to the total absence of some faces, and to the preponderance of others.

Maps of the whole direction occupied by the forms of each mineral have been happily projected for such display. The projection is laid down as on a globe, in accordance with stereographic projection, and admitting of calculation according to the laws of spherical trigonometry. These globe maps are called "spherical projections." The centre O is the common centre of the crystal and of the sphere on which the axes intersect. The three axes will of course meet the circumference of the sphere in six points, called the "poles of the axes." From the centre radii are supposed to be drawn, perpendicularly to each plane. It is evident that such radii will have fixed inclinations to each other. They are called "normals" to the planes, and the points on which when produced they meet the circumference of the sphere of projection are called the "poles" of the corresponding faces. A face and its pole thus can for only one crystal. The angle included by any two normals is the supplement of that included by the two corresponding faces.

It is thus easy to determine the angles of any two normals when that of the corresponding faces is known, or *vice versâ*. For if the angle between two faces is 125°, that of the normals will be 55°. The plane sheet is thus especially adapted to enable us to avoid complicated calculation and to calculations afforded by the foregoing fact that faces of a zone be parallel to each other, forming zones, for, when projected on such a sphere, the normals of the parallel faces will all lie in one plane; and the pole, or centre of the surface in the direction of one face, may be connected by an arc of a great circle on the sphere. This is called the "zone circle." A line drawn through the centre of the

ne, cutting it at right angles, is the "zone axis"; it el to all the faces, and intersections of the faces (if e extended enough to intersect), of the zone. A face common to two or more zones, its normals will then with the intersections of the several zone planes. e absence of actual sphere upon which to detail the ich go to form the "sphere of projection" of each ey the hemisphere is represented on a plane surface. s of necessity the disadvantage, except as regards nferential zone, of introducing spherical distance on foreshortening of all parts lying near the circence; but the eye soon gets accustomed to this. Fig. nts the principal zones of the cubic system, and

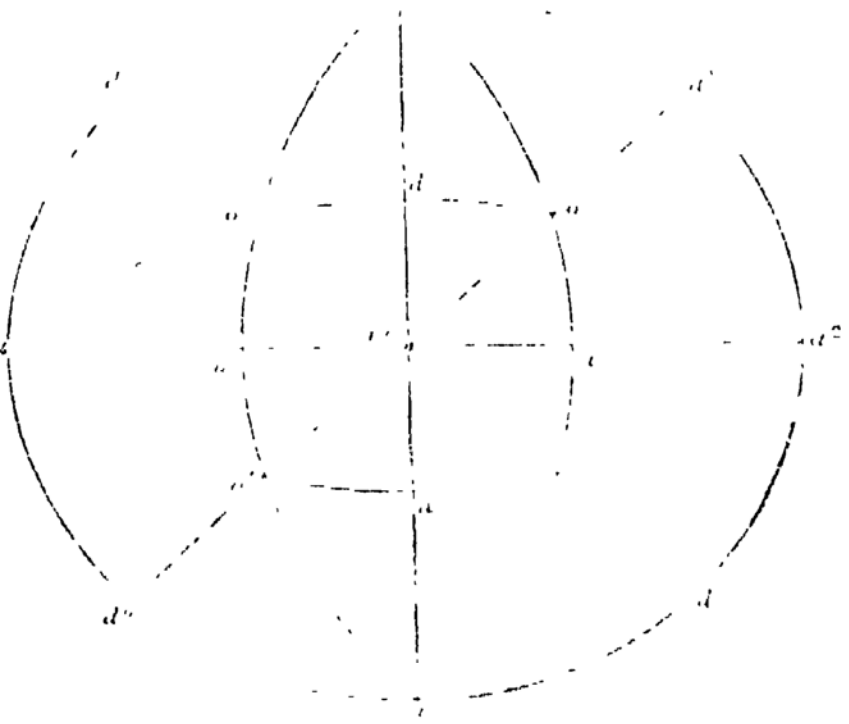


Fig. 43

he position of the poles of the faces of the cube, hedron, and the rhombic dodecahedron. o_1, o_2, o_3 the poles of the octahedral faces; a_1, a_2, a_3, &c., those es of the cube; and d_1, d_2, d_3, &c., those of the dodecahedron. It will be observed that the faces ibe fall into the zone circles of the octahedron and e iron, while those of the octahedron fall into those

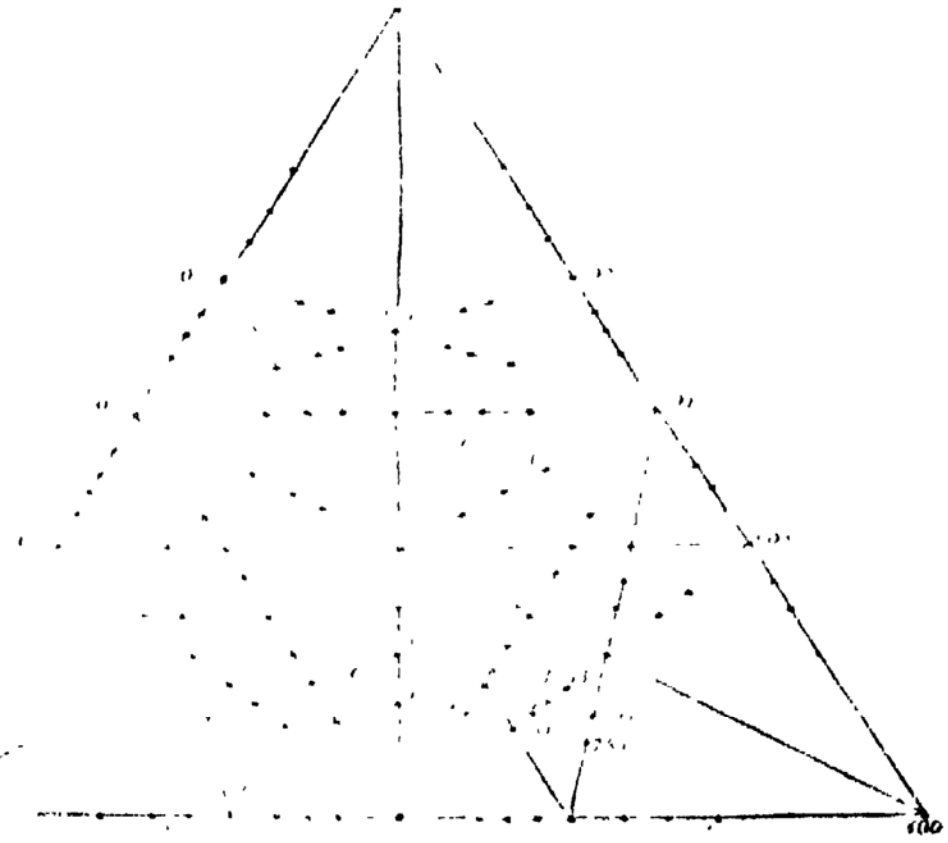


Fig. 44.—Projection of the Cubic System in Octant of Sphere.

rhombic dodecahedron. Considering this as a ion of a globe to a large circle equal to represent and longitude, and so that all the faces in this fall into some zone circle, it is clear that the and longitude of all normals may be readily laid nd their relations at once determined by spherical metry. Fig. 44 shows the arrangement of the poles ne forms belonging to the cubic system noticed above, or referred to in the present article,—delineated on an octant of the sphere of projection. It displays the perfect regularity of the system.

Hemihedral and Tetartohedral Forms.—The exception to the second law (that of symmetry), which was formulated by Weiss was to the effect that one-half or even one-fourth only of the faces which go to form a holohedral crystal may be present. When but one-half of the faces present themselves, the form is termed hemihedral; when only one-fourth, it is tetartohedral. These restrained developments have now to be considered. In hemihedral forms the development is restrained, but symmetry is not deranged half the similar parts are still alike, though unlike the other half.

There are two classes of hemihedral forms:

I. Those forms in which half the similar angles or edges are modified independently of the other half ("hemi-holohedral") producing

1. In the monoclinic and dimetric systems "tetrahedral" and "sphenoidal" forms, by the independent replacement of the alternate angles, their opposite faces are not parallel, and they are hence called "inclined" hemihedrons; as in chalcopyrite, boracite. The replacement in the dimetric system of two opposite basal edges of one base and the other two at the opposite base is of the same

2. In the [illegible] system "monoclinic" forms, by the replacement [illegible] similar parts of one base and the diagonally [illegible] unlike the other half; as in datholite, humite

3. In the [illegible] and hexagonal systems "hemimorphic" forms [illegible] segments at the opposite extremities of the [illegible] as in [illegible] calamine, tourmaline.

4. In the [illegible] rhombohedral system, by the replacements of the alternate basal [illegible] or angles of the rhombohedron, forms usually called tetartohedral or quarter forms, on the ground that a rhombohedron is a hemihedral form derived from the hexagonal prism, which is the type of the hexagonal system. Rock crystal is usually developed according to this law.

II. Those forms in which all the similar angles or edges are modified but by half the full or normal number of planes ("holohemihedral"), producing

1. In the monometric system "pyritohedral" forms, by a replacement of the edges or angles; as in pyrites. Such forms have opposite faces parallel, and are often called parallel hemihedrons.

2. In the dimetric system "pyramidal" and "scalenoidal" forms by a replacement of the eight solid angles of the primary prism according to two methods.

3. In the hexagonal system "pyramidal" and "gyroidal" forms, by a replacement of the solid angles of the hexagonal prism, or of the six lateral angles of the rhombohedron, according to two methods as in quartz and apatite.

The above illustrations show that hemihedrism is not only divided into two classes, but is of various kinds, and these have been systematized as follows: "holomorphic," in which the occurring planes pertain equally to the upper and lower (or opposite) ranges of sectants, as in ordinary hemihedrons; and (2) "hemimorphic," in which each set of planes pertains to either the upper or the lower range, but not to both. As to the relative position of the sectants which contain the planes, the forms may be vertically direct as in boracite, vertically alternate, as in the tetrahedron, the rhombohedron and the plagihedral faces of quartz; and vertically oblique, as in many forms of chondrodite.

In hemimorphic forms [illegible] symmetry is deranged; the crystals are bounded at the opposite [illegible] ends of their main axes by faces belonging to distinct forms or modifications,—always, however, of the same system, hence only the upper [illegible] of each crystal can be regards the form there and it is half formed. crystal of tourmaline, which is bounded

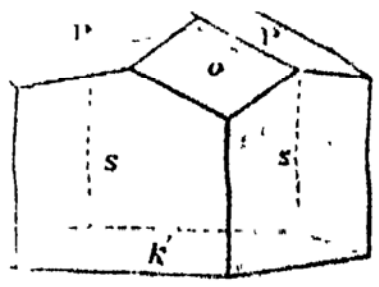


Fig. 45.

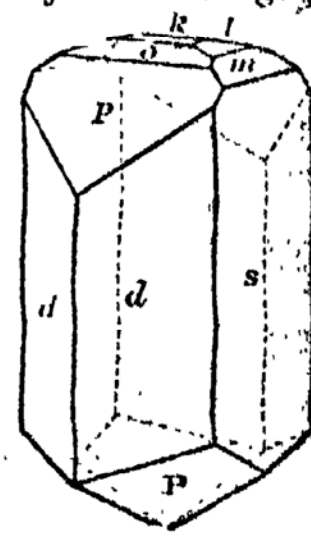


Fig. 46.

into the [illegible] terminals show the [illegible] brachydomes o and p, and two macrodomes m and l

[1] As the parts of either half are alternate, there still results a symmetrical solid. As either one or other half may be the one thus modified there may result two such symmetric solids, which stand in an inverse position to one another. When the modifications affect the upper right hand solid angle, the resulting form is called +; when the upper left hand angle it is -.

whilst on the lower end it is bounded by the faces P of the primary alone.

It has been found that all hemimorphic crystals become electrically polar when heated, that is, exhibit opposite kinds of electricity at opposite ends of the crystal. The subject will be more fully considered under the electricity of minerals.

The hemihedral forms of the cubic system are the following:—

1. The tetrahedron (fig. 47), hemihedral of the octahedron, bounded by four equilateral triangles. It has six equal edges faces meeting at 70° 32′, and four trigonal angles. The principal axes join the middle points of each two opposite edges. Example fahlore, boracite, and helvine.

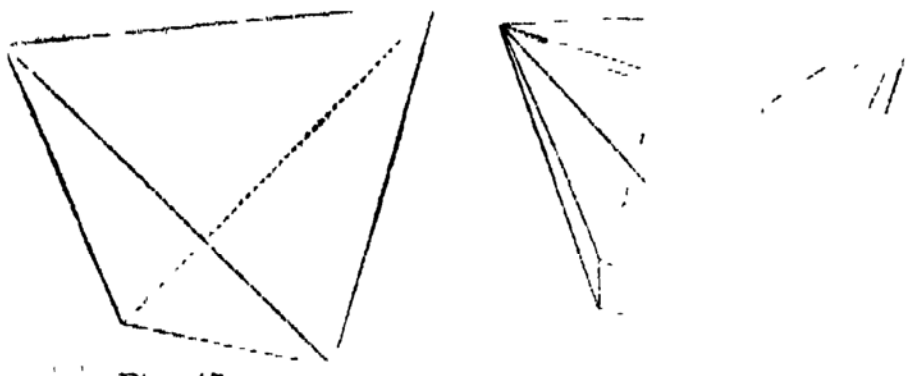


Fig. 47.

2. The trigonal dodecahedrons (fig. 48), h… of the tetrahedron, are bounded by twelve isosceles triangles, and vary in general form from the tetrahedron to the cube. The … edges corresponding to those of the … tetrahedron, and twelve shorter, placed three and three over … of its faces, and four hexagonal and four trigonal angles. Exam… tetrahedrite.

3. The deltoid dodecahedrons (fig. 49), hemihedral of the trisoctahedron, are bounded by twelve deltoids, and form from the tetrahedron on the one hand to … rhombdodecahedron on the other. They have twelve long edges lying in pairs over the edges of the … bed tetrahedron, and twelve shorter edges, three and three over … faces. The… six tetragonal (rhombic), four acute trigonal, and four obtuse trigonal angles. The principal axes join … rhombic angles. Example: tetrahedrite.

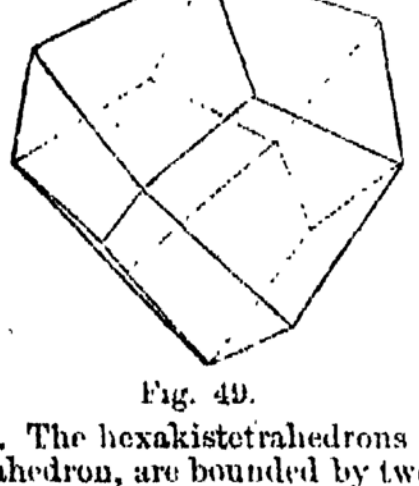


Fig. 49.

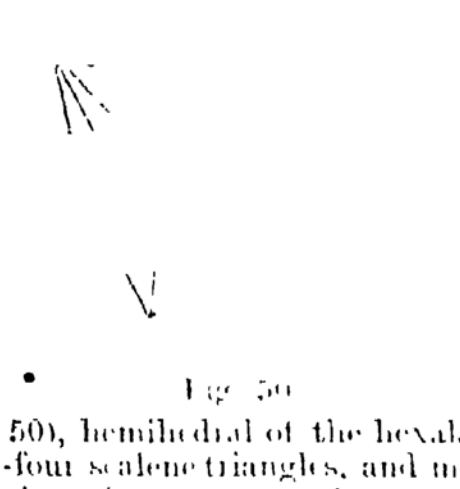


Fig. 50.

4. The hexakistetrahedrons (fig. 50), hemihedral of the hexakisoctahedron, are bounded by twenty-four scalene triangles, and most commonly have their faces grouped in four systems of six each. The edges are twelve shorter and twelve longer, lying in groups of three over each face of the inscribed tetrahedron, and twelve intermediate in pairs over its edges. The angles are six rhombic, joined in pairs by the principal axes, and four acuter and four obtuser hexagonal angles. Example, diamond.

In these forms, often named "tetrahedral," the faces are oblique to each other. Their derivation and signs are as follows. The tetrahedron arises when four alternate faces of the octahedron, two opposite above and two intermediate below, are enlarged so as to obliterate the other four; and its sign is hence $\frac{O}{2}$. But, if either four faces may be thus enlarged or obliterated, two tetrahedrons can be formed, similar in all respects except in position, and together making up the octahedron. These are distinguished by the signs + and −, added to the above symbol, but only the latter in general expressed, thus $-\frac{O}{2}$. In all hemihedric systems two forms similarly related occur, which may thus be named complementary forms. The trigonal dodecahedron is derived from the tesitetrahedron by the expansion of the alternate trigonal groups of faces; its sign is $\frac{m O m}{2}$, the most common variety being $\frac{2 O 2}{2}$. The deltoid dodecahedron is in like manner the result of the increase of the alternate trigonal groups of faces of the triakisoctahedron, and its sign is $\frac{m O \frac{m}{2}}{2}$. Lastly, the hexakistetrahedron arises in the development of alternate hexagonal groups of faces in the hexakisoctahedron, and its sign is $\frac{m O n}{2}$.

Two semitesseral forms with parallel faces occur. (1) The pentagonal dodecahedrons (fig. 51), bounded by twelve *symmetrical* pentagons, vary in general aspect between the cube and the rhombic dodecahedron. They have six regular (and in general longer) edges, lying over the faces of the inscribed cube, and twenty-four, generally shorter (seldom longer), edges, usually lying in pairs over its edges. The solid angles are eight of three equal interfacial angles, and twelve of three interfacial angles, of which only two are equal. Each principal axis unites two opposite regular edges. This form is derived from the tetrakishexahedron, and its sign is $\frac{\frac{m}{2} O n}{2}$. It is found frequently in iron pyrites and cobaltine.

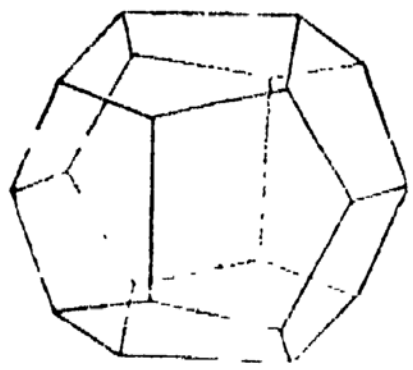


Fig. 51.

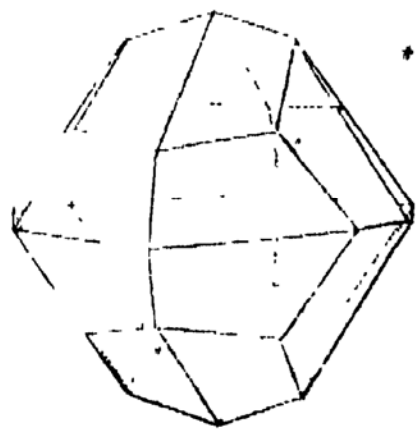


Fig. 52.

(2) The dyakisdodecahedron (fig. 52), bounded by twenty-four trapezoids with two sides equal, has twelve short, twelve long, and twenty-four intermediate edges. The angles are six equiangular rhombic, united in pairs by the principal axes, eight trigonal, and twenty-four irregular tetragonal angles. It is derived from the hexakisoctahedron, and its sign is $\left[\frac{m O n}{2}\right]$, the brackets being used to distinguish it from the hexakistetrahedron, also derived from the same primary form. It occurs in iron pyrites and cobaltine. The two other semitesseral forms, the pentagonal

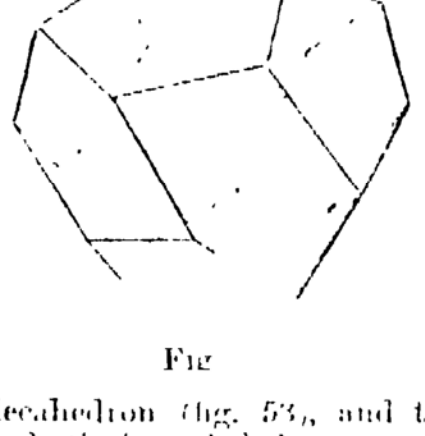


Fig.

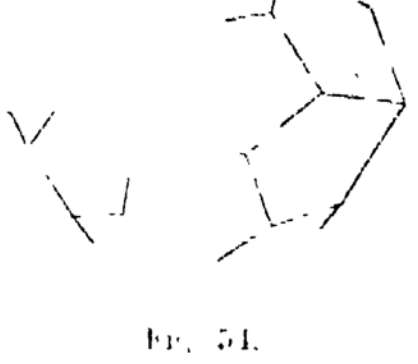


Fig. 54.

dodecahedron (fig. 53), and the pentagonal icositetrahedron (fig. 54), both bounded by *irregular* pentagons, have not yet been observed in nature.

Combinations. The above-mentioned forms of the tesseral system (and this is true also of the five other systems of crystallization) not only occur singly, but often two, three, or more occur united in the same crystal, forming what are named combinations.

In this case it is evident that no one of the individual forms can be complete, because the faces of one form must interfere with, by diminishing, the faces of other forms. A combination therefore implies that the faces of one form shall appear symmetrically disposed between the faces of other forms, and consequently take the place of certain of their edges and angles. These edges and angles are thus, as it were, cut off, and a greater number of new ones produced in their place, which properly belong neither to the one form nor the other, but are angles of combination. These new faces are hence termed modifications, and the original or primary or simple form is said to be modified. Usually one form predominates more than the others, or has more influence on the general aspect of the crystal, and hence is distinguished as the predominant form, the others being considered subordinate.

The sign of the combination consists of those of its constituent forms, written in the order of their influence or importance in the combination, with a point between each pair.

It will be readily seen that such combinations may be exceedingly numerous, or rather infinite; and only a few of the more common

…ticed. Many others more complicated will occur in the …e part of the article. Among holohedral combinations, …octahedron and rhombic dodecahedron deserve notice as the predominant…s. In fig. 27 the cube has its solid angles replaced by the faces of …ahedron, which truncate the angles, and the sign of this …tion is $\infty O\infty$, O. In fig. 28 the process may be regarded as …roceeded still farther, so that the faces of the octahedron …ual those of the cube, while in fig. 29 they now predom…e sign, still of the same two elements, but in reverse …O, $\infty O\infty$. It will thus be seen that through an increase in …nt of the abstraction of the faces of the cube, the figure …ses from a cube to that of the octahedron. There may occur …, and in fact …ansition of the cube into the octa…, …transition by decrement."

…the cube …edges replaced by the faces of the …tetrahedron truncate the edges, the cube being …vhole or in …there is the same combination but with …of the …nate, and hence the form ∞O, $\infty O\infty$ …ron has more the general aspect of the …latter of the dodecahedron. Here the solid angles of the …truncated by the faces of the cube, and we have the …into the dodecahedron by decrement. The …tion, the mere truncation or decrement, could be shown …of combination, and in both directions. The first case …ould be the effect of a form …ssing tetrahedron, …

…

…

…

ertical-faced pentagonal dodecahedron; while fig. 68 shows
se in the amount of truncation effected by the latter. Fig.
the combination of the cube with the dyakisdodecahedron,

Fig. 68

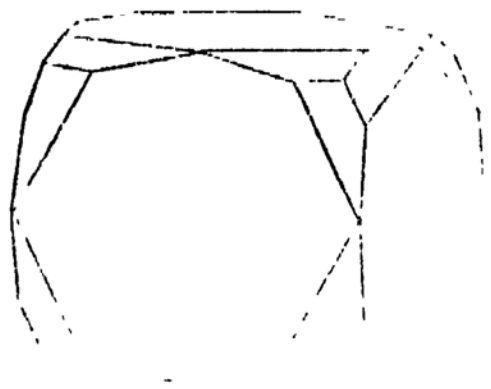


Fig. 69

er being dominant. In fig. 70 an octahedron is dominant
ned with the vertical-faced pentagonal dodecahedron, in

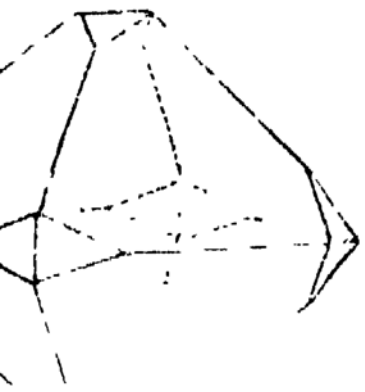


Fig. 70.

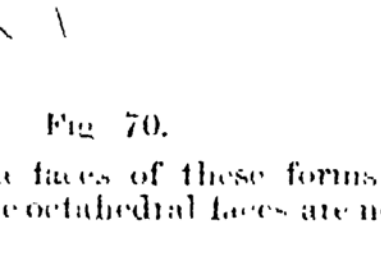


Fig. 71

e faces of these forms are of nearly equal size, while in
e octahedral faces are nearly removed. The solid made of

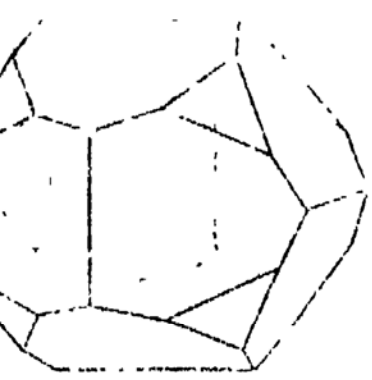


Fig. 72.

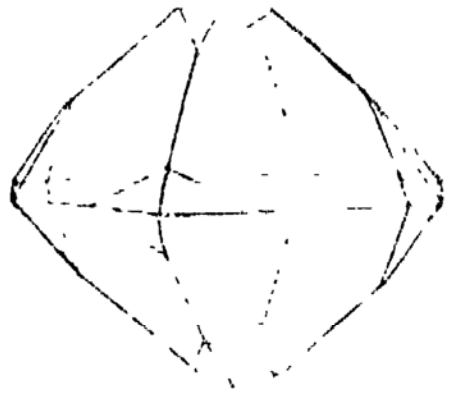


Fig. 73.

edron are modified in fig. 73 by the faces of the dyakis-
dron. In fig. 68 a vertical-faced pentagonal dodeca

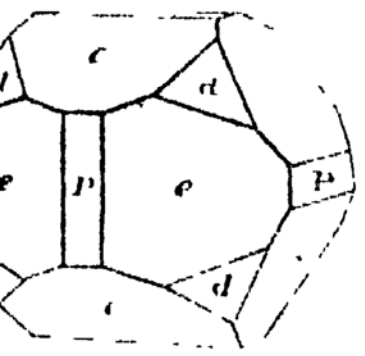


Fig. 74.

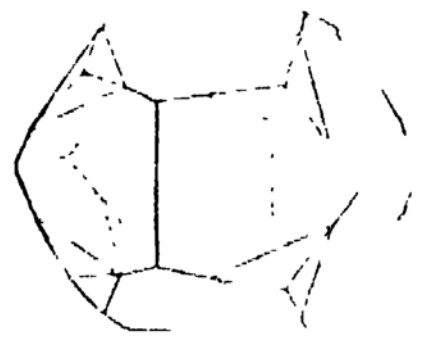


Fig. 75.

s the prevailing form in combination with the cube; while
the faces of the octahedron are superadded. In fig. 76 its
al angles are modified by the faces of the icositetrahedron,

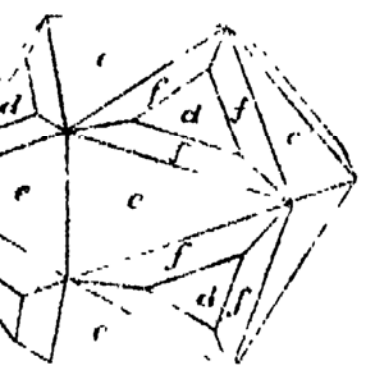


Fig. 76.

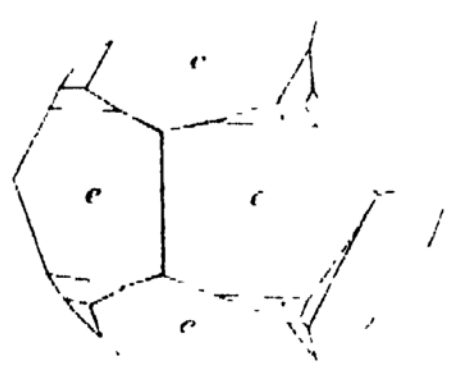


Fig. 77.

ig. 76 by those of the octahedron in addition. In fig.
re modified by the faces of the dyakisdodecahedron.

ch of the five systems which follow there is this
e from the cubic system that one axis is always
to (longer or shorter than) the others. This is

placed erect, and named the chief axis, its ends are pole
and the edges connected with them polar edges. The
other axes are named subordinate or lateral axes, and the
plane that passes through them is the base. A plane
through the chief and a lateral axis is a normal chief
section. In these systems also occur the three forms of
"pyramids," "prisms," and "pinacoids." (1) The pyra-
mids have their faces triangles. Pyramids in crystallo-
graphy are each composed of two isometric pyramids
placed base to base, and named "closed forms" as the
crystals are shut in by definite faces on every side. (2)
The prisms are bounded by plane faces parallel to one axis.
They are thus of unlimited extent in the direction of that
axis, and therefore named "open forms," but in solid crystals
are shut in by faces of other forms. (3) The pinacoids, or
tables, have two faces intersecting one axis and parallel
to the others, and thus are also open forms, or unlimited in
the direction of the two axes. Forms (2) and (3), when com-
joined, mutually shut in each other, or produce closed forms.

II. *Pyramidal or Tetragonal System.* The system has
three axes at right angles, two of them equal, and the chief
axis longer or shorter. The name tetragonal is derived
from the form of the base, which is usually a quadrangular.
There are eight distinct forms, of which five are closed. (1)
Tetragonal pyramids, of which there are two, are inclosed by eight isosceles
triangles, with four middle edges all
in one plane, and no flat polar edge.
There are three kinds of this form

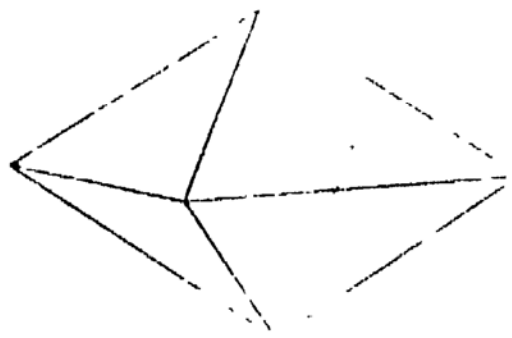


Fig. 78.

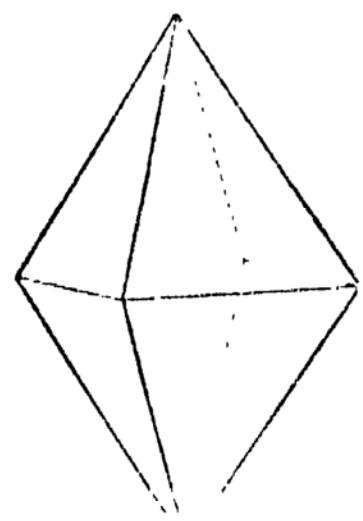


Fig. 79

distinguished by the position of the
lateral axes. In the first these are
opposite angles, in the second
they intersect the middle edges equally; and in the third the
lie in an intermediate position, or divide the edges unequally,
the last being hemihedral forms. These pyramids are also
distinguished as obtuse (fig. 79, acute (fig. 79, according as the
vertical angle is greater or less than in the
regular octahedron. (2) Ditetragonal pyra-
mid-cube, so are bounded by eight equal
triangles, whose base lines are all in one

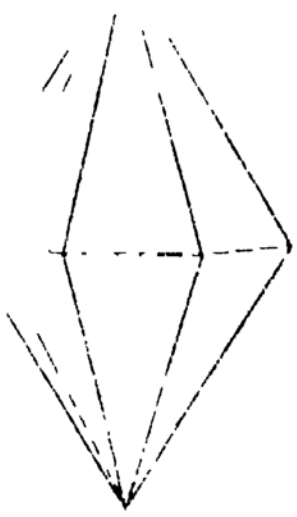


Fig. 80.

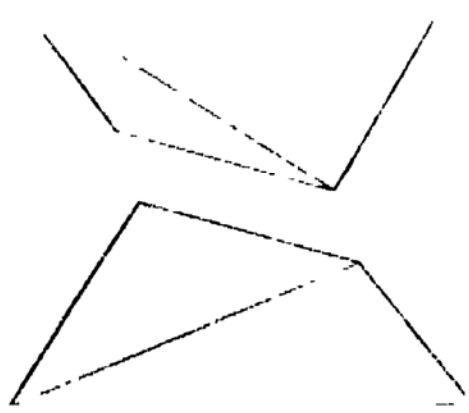


Fig. 81.

plane. This form rarely occurs except in combinations. (3) Tetra-
gonal sphenoids, four faces, bounded by four isosceles triangles,
the hemihedral form of the first variety of tetragonal pyramid.
(4) The tetragonal scalenohedron (fig. 82), bounded by eight scalene
triangles, whose base lines fall in a zigzag line, is the hemi-
hedral form of the ditetragonal pyramid. Nos. (3) and (4) are rare.
(5) The tetragonal trapezohedron is not found in mineralogical com-
form. The three open forms are (1) tetragonal prisms, bounded
by four planes parallel to the principal axis, which may be either
longer (fig. 83) or shorter (fig. 84) than the lateral axes, (2) ditet-
tragonal prisms, bounded by eight similar planes; and (3) the basal
pinacoid, consisting merely of two parallel faces bounding the prism
at the ends, above and below.

The various series of tetragonal crystals are distinguished from
each other only by their relative dimensions. To determine these

ne of the series must be chosen as the primary form, and for this urpose a tetragonal pyramid of the first variety, designated by P s its sign, is selected. The angle of one of its edges, especially he middle edge, found by measurement, determines its angular imensions, whilst the proportion of the principal axis a to the

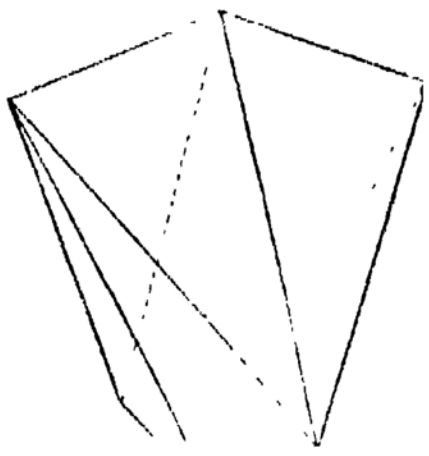


Fig. 82.

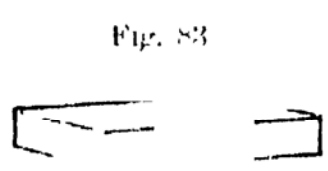


Fig. 83.

Fig. 84.

teral axes, supposed equal to 1, gives its linear dimensions. The rameters, therefore, of each face of the fundamental form are ; 1 ; a.

Now if m be any (rational) number, either less or greater than nity, and if from any distance ma in the principal axis planes be awn to the middle edge of P, then new tetragonal pyramids of e first order, but more or less acute or obtuse than P, are formed. he general sign of the pyramids is mP, and the most common

Fig. 85.

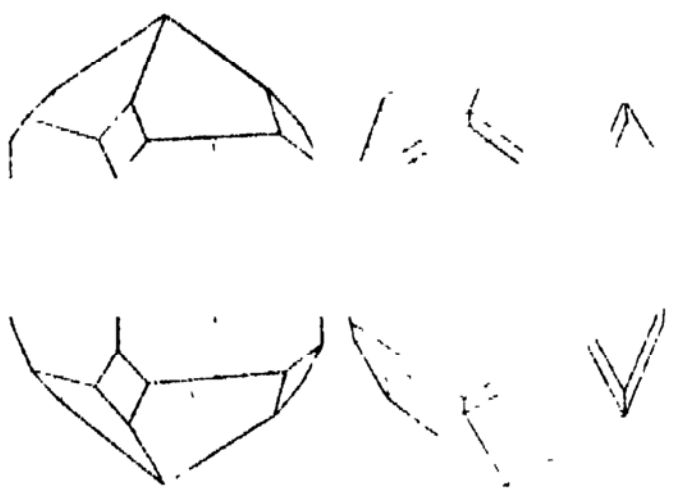


Fig. 86.

Fig. 87.

ances $\frac{1}{2}$P, 2P, and P, with the chief xis half, twice, or ance that of P. If becomes infinite, hen the pyramid sses into a prism, ndefinitely extended ong the principal xis, and with the gn ∞P. If m 0, hich is the case hen the lateral axes e supposed infinite, en it becomes a nacoid, consisting operly of two basal ces open towards e lateral axes, and signated by the gn 0P. The ditetra onal pyramids are oduced by taking each lateral axis stances n greater an 1, and drawing o planes to these nts from each the intermediate lar 1 : n. The parameters of these planes are therefore m : 1 : n, d the general sign of the form mPn, the most common values n being $\frac{1}{2}$, 2, 3 and ∞. When $n = \infty$, a tetragonal pyramid of e second order arises, designated generally by mP∞, the most mmon in the mineral kingdom being P∞ and 2P∞. The relation the two pyramids of the first order is shown in fig. 85, where BBBC is the first and ACCCX the second order of pyramid. In ke manner to the prism ∞P, the ditetragonal prisms ∞Pn

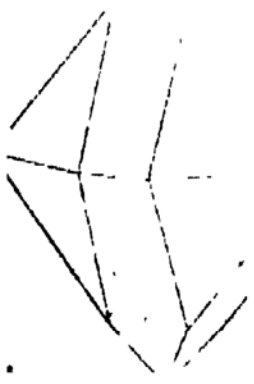


Fig. 88.

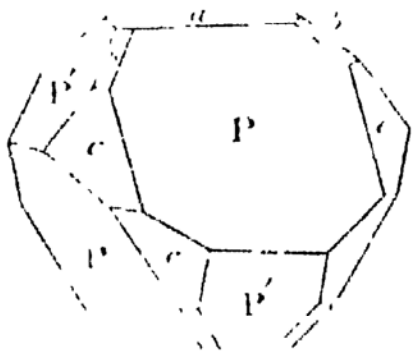


Fig. 89.

e derived, and, finally, when $n = \infty$ the tetragonal prism of the cond order, whose sign is ∞P∞.

The combinations of the tetragonal system are either holohedral or hemihedral; but the latter are rare. Prisms and pinacoids must always be terminated on the open sides by other forms. Thus in fig. 86 a square prism of the first order is terminated by the primary pyramid, and has its lateral angles again replaced by another more acute pyramid of the second order, so that its sign is ∞P, P, 2P∞.

In fig. 87 a prism of the second order is first bounded by the fundamental pyramid, and then has its edges of combination replaced by a ditetragonal pyramid; its sign is ∞P∞, P, 3P3. In fig. 88 the polar edges of the pyramid are replaced by another pyramid, its sign being P, P∞. In fig. 89 a hemihedric form, very characteristic of chalcopyrite, is represented,—P and P′ being the two sphenoids, a the basal pinacoid, and b, c two ditetragonal pyramids.

III. *The Hexagonal System.*—The essential character of this system is that it has four axes,—three equal lateral axes intersecting each other in one plane at 60°, and one principal axis at right angles to these. The plane through the lateral axes, or the base, from its hexagonal form, gives the name to the system. As in the last system, its forms are either closed or open. They are divided into holohedral, hemihedral, and tetartohedral, the last, which are rare, having only a fourth part of the faces developed. Only a few of the more common forms require to be here described.

The hexagonal pyramids (figs. 90, 91) are bounded by twelve isosceles triangles, and are of three kinds, according as the lateral axes fall in the angles, in the middle of the lateral edges, or in another point of these edges, the last being hemihedral forms. They are also classed as acute or obtuse, but without any precise limits. The trigonal pyramid is bounded by six triangles, and may be viewed as the hemihedral form of the hexagonal. The dihexagonal pyramid is bounded by twenty-four scalene triangles, but has never been observed alone, and rarely even in combinations. The more common prisms are the hexagonal of six sides; in these the vertical axis may be either longer than the lateral, as in fig. 92, or shorter, as in fig. 93. There are also dihexagonal, of twelve sides.

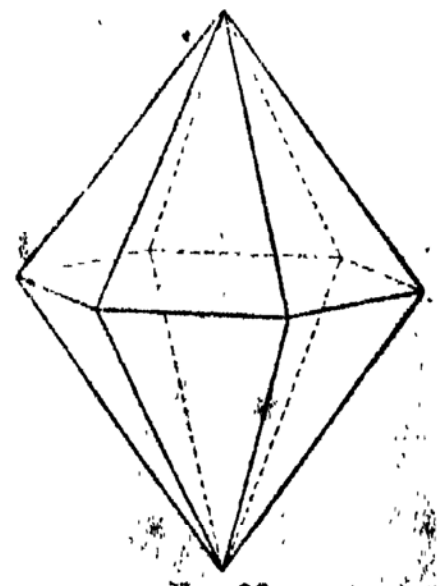


Fig. 90.

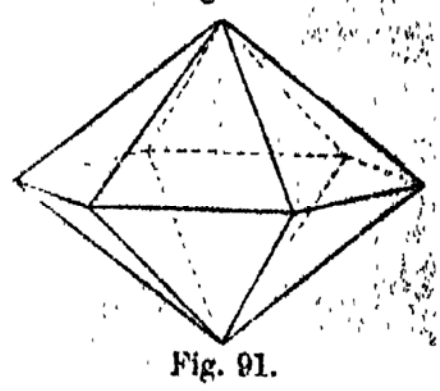


Fig. 91.

A particular pyramid P is chosen as the fundamental form of this system, and its dimensions determined either from the proportion of the lateral to the principal axis (1 : a) or from the measurement of its angles. From this form (mP) others are derived exactly as in the tetragonal system. Thus dihexagonal pyramids are produced with the general sign nPn, the chief peculiarity being that whereas the tetragonal system n might have any rational value from 1 to ∞, in the hexagonal system it can only vary from 1 to 2, in consequence of the geometric character of the figure. When n = 2, the dihexagonal changes into an hexagonal pyramid of the second order, whose sign is mP2. When $m = \infty$, various prisms arise from similar changes in the value of m, and when m = 0 the basal pinacoid is formed.

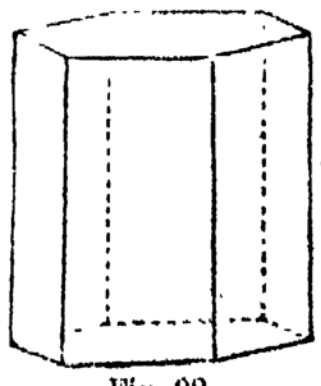


Fig. 92.

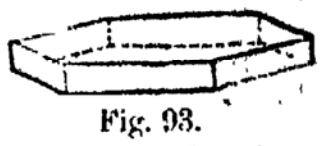


Fig. 93.

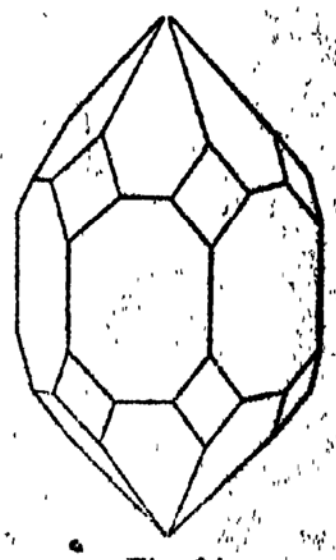
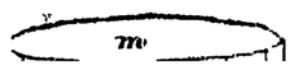
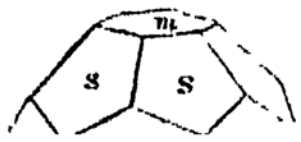


Fig. 94.

Few hexagonal mineral species form perfect holohedral combinations. Though quartz and apatite appear as such, yet properly the former is a tetartohedral, the latter a hemihedral species. In holohedral species the predominant faces are usually those of the hexagonal prisms ∞P (fig. 92) and ∞P2, or of the pinacoid 0P (fig. 93); whilst Pris the pyramids P and 2P2 are the most common subordinate forms. Fig. 94 represents the prism, bounded on the extremities by two pyramids,—one, P, forming the apex, the other, 2P2, the rhombic

faces on the angles, or ∞P, P, 2P2. Fig. 95 is a similar form, the upper part of the pyramid being replaced by the pinacoid. In some crystals the lateral edges of the prism are replaced by the





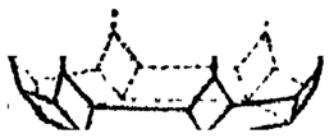
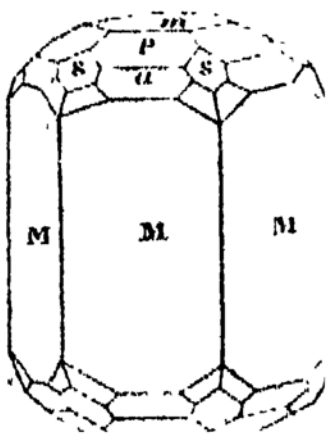


Fig. 95. Fig. 96. Fig. 97.

second prism ∞P2 (fig. 96), producing an equiangular twelve-sided prism, which always represents the combination ∞P, ∞P2, and cannot occur as a simple form. Figs. 97, 98 are combinations in this



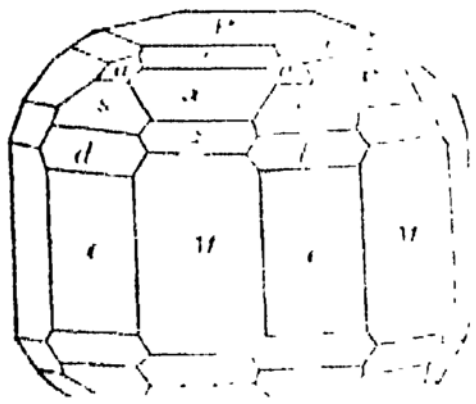
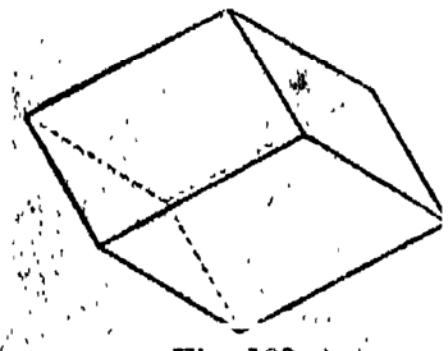


Fig. 98. Fig. 99

system seen in beryl. An example of a more complicated combination is seen in fig. 99, of a crystal of apatite, whose form with the corresponding letters is ∞P(*M*), ∞P2(*c*), 0P(*P*), 4P(*r*), P(*u*), 2P(*s*), P2(*a*), 2P2(*s*), 4P2(*d*).

Hexagonal minerals frequently crystallize in those series of hemihedral forms that are named "rhombohedral," from the prevalence in them of rhombohedrons. These (figs. 100, 101) are bounded by



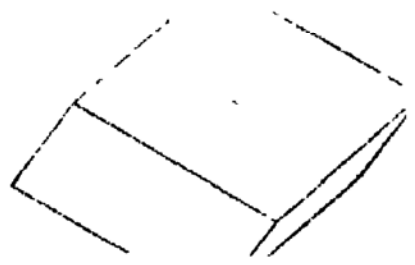


Fig. 100. Fig. 101

six rhombi, whose lateral edges do not lie in one plane, but rise and fall in a zigzag manner. The principal axis unites the two trigonal angles, formed by three equal plane angles; and in the most common variety the secondary axes join the middle points of two opposite edges. When the polar edges form an angle of more than 90°, the rhombohedrons are named obtuse; when of less than 90° acute; fig. 102 represents the first, fig. 103 the second. Hexagonal scalenohedrons (fig. 104) are bounded by twelve scalene triangles, whose lateral

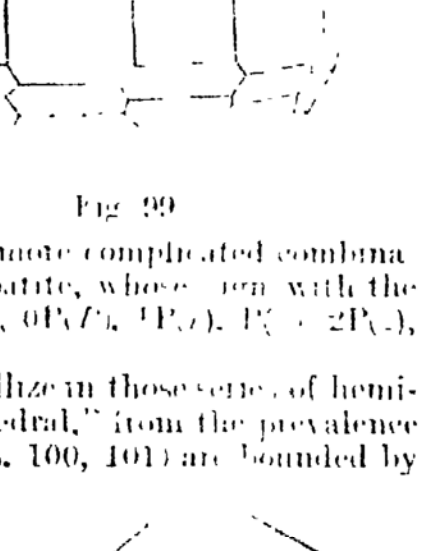


Fig. 102. Fig. 103.

edges do not lie in one plane. The principal axis joins the two hexagonal angles, and the secondary axis the middle points of two opposite lateral edges.

The rhombohedron is derived from the first order of hexagonal pyramid by the hemihedral development of its alternate faces. Its general sign should therefore be $\frac{m}{2}$P; but on several grounds it is found better to designate it by R or *m*R, and its complementary figure by −*m*R. When the prism or pinacoid arises as its limiting form, they are designated by ∞R and 0R, though in no respect changed from the limiting forms ∞P and 0P of the pyramid. The scalenohedron is properly the hemihedral form of the dihexagonal pyramid, but is more easily understood as derived from the inscribed rhombohedron *m*R. If the halves of the principal axis of this be multiplied by a definite number *n*, and then planes be drawn from the extremities of this enlarged axis to the lateral edges of the rhombohedron, as in fig. 105, the scalenohedron is constructed. It is now designated by *m*R*n* (the *n* on the right here referring to the chief axis), and the dihexagonal prism in this series by ∞R*n* (formerly *m*R^n and ∞R^n).

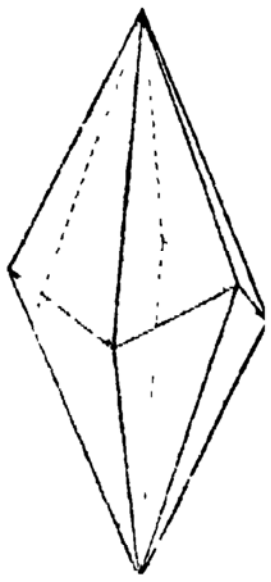


Fig. 104.

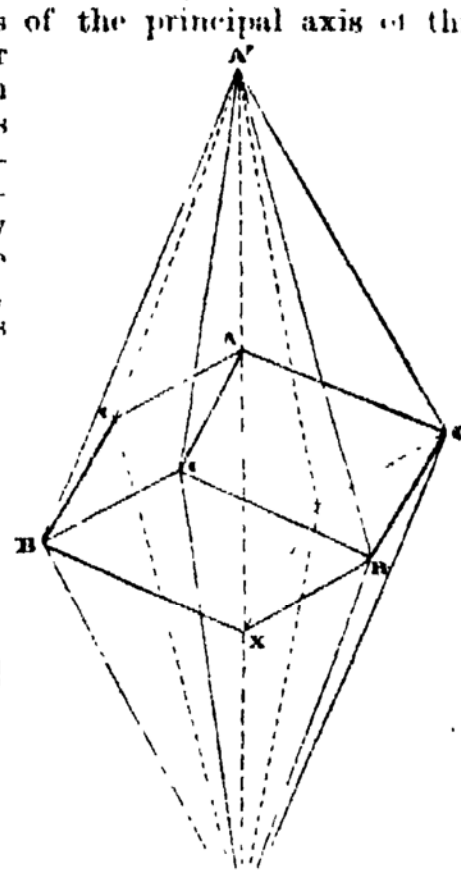


Fig. 105.

The combinations of rhombohedral forms are very numerous, several hundreds having been described in calc-spar alone. Among the most common is the prism in combination with a rhombohedron, as seen in the twin crystal of calc-spar (fig. 106), with the sign ∞R, −½R, the lower half being the same form with the upper, but turned round 180°. In fig. 107 the rhombohedron *m*R has its pole

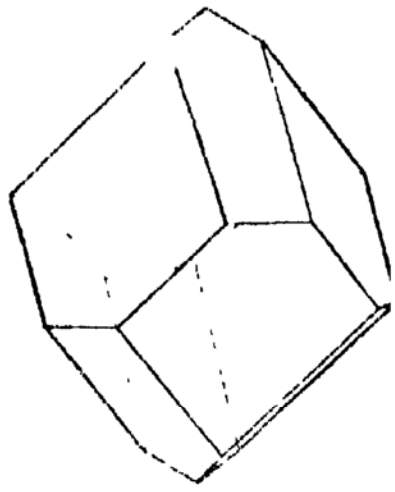
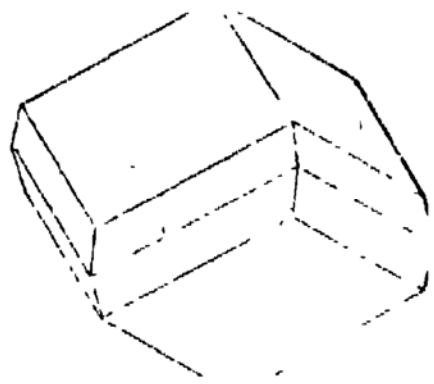


Fig. 106 Fig. 107

edges replaced by another rhombohedron −½*m*R, and in fig. 108 its lateral edges bevelled by the scalenohedron *m*R*n*. A more complex combination of five forms is represented in the crystal of calc-spar fig. 109, its sign, with the letters on the faces, being R^3(*r*),



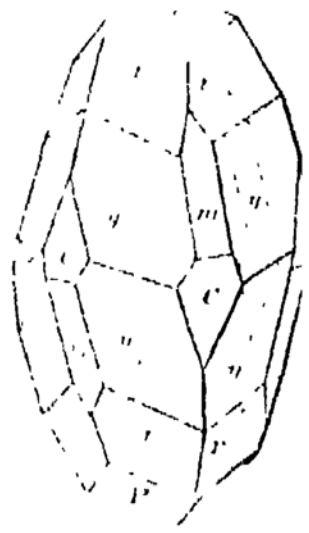


Fig. 108. Fig. 109.

R^3(*e*), R(*P*), 4R(*m*), −R(*e*). Tetartohedral combinations are also most distinctly in rock-crystal.

IV. *Right Prismatic or Rhombic System.* - This system is characterized by three unequal axes, all at right angles to each other. Any one of these may be assumed as the chief axis, when the others are named subordinate. The plane passing through the secondary axes, or the base, forms a rhombus, and from this one of its names is derived. As prismatic forms are most frequent (the prism standing vertically on the rhombic base), it is best defined as the right prismatic. This system comprises only a few varieties of forms that are essentially distinct, and its relations are consequently very simple.

There are two dodecahedrons (fig. 113), bounded by eight [illegible]

[illegible]

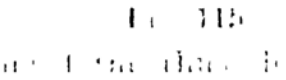


Fig. 115

[illegible] pyramid (fig. 119, [illegible]

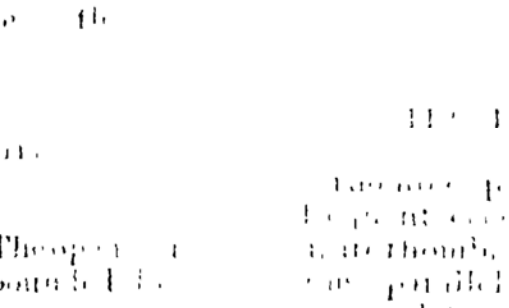


Fig. 117

angular base [illegible] lateral axis b being assumed equal to 1. [illegible] the name macrodiagonal [illegible] brachydome and [illegible] principal [illegible] name brachydiagonal, [illegible] axis c. The terms are applied [illegible] the derived forms. They [illegible] merely mark only the position of the [illegible] to the [illegible] of the fundamental crystal [illegible] descend of necessity without [illegible] ordinate magnitude of the [illegible] axis.

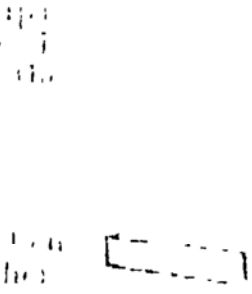


Fig. 119.

By multiplying the principal axes by any rational number m, [illegible] greater or less than 1, a series of pyramids arise, whose general sign is mP, and their limit are the prism and pinacoid, the whole series being contained in the formula $\infty P \ldots mP \ldots P \ldots \frac{1}{m}P \ldots 0P$, which is the fundamental series, the lateral axes always remaining unchanged.

From each member a new series may, however, be developed in two directions, by increasing one or other of the lateral axes. When the macrodiagonal is thus multiplied by any number n greater than 1, and planes drawn from the distance n to the poles edges a new pyramid is produced, named a macropyramid, with the [illegible] mark over the [illegible] When [illegible] a macrodome results, when the [illegible] If the shorter axis is multiplied the brachypyramids and [illegible] domes are produced with the general symbol $m\breve{P}n$. So all [illegible] prisms ∞P on the one [illegible] to number or [illegible] $\infty\breve{P}n$ with the [illegible] pinacoid $0\breve{P}\infty$ on the other, numbers [illegible]

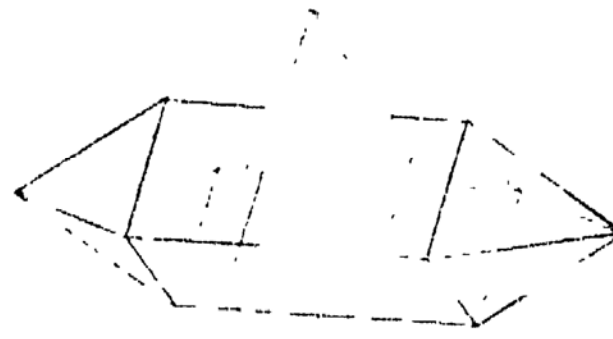


Fig. 120.

Fig. 121

[illegible] of the brachypinacoid. In figs. 120, 121 the [illegible] are shown in their relation to the primitive pyramid

Fig. 122

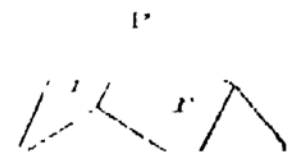


Fig. 123.

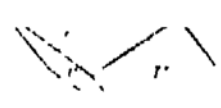


Fig. 124.

The pyramid seldom occurs independent, or even as the predominant form in a combination; sulphur, however, is an exception. Prisms or pinacoids usually give the general character to the crystal, which then appears either as a columnar or tabular or even rectangular pyramidal form. The determination of the position of the crystals, as vertical or horizontal, depends on the choice of the chief axis of the fundamental form. In the topaz crystal (fig. 126) the brachyprism and the pyramid are the predominant element, associated with the prism, its sign and letters being $\infty P2$ l P. $\infty P(M)$. Fig. 123 of sulfate is another example, the macropinacoid $\infty\breve{P}\infty$ or M being combined with the pyramid $P(z)$, the brachypinacoid $\infty\breve{P}\infty(T)$, and the basal pinacoid $0P(T)$. Another instance is fig. 124 a hiortite crystal, where the brachyprism and pyramid combi

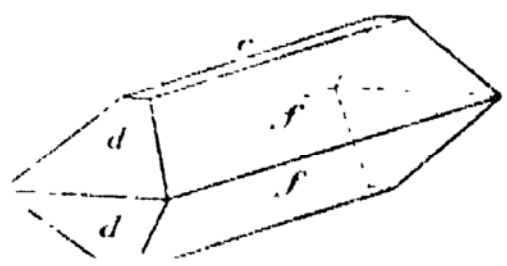


Fig. 125.

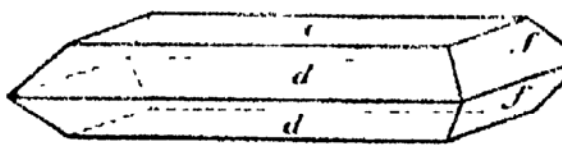


Fig. 126.

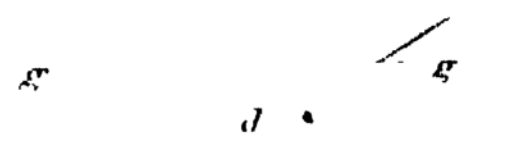


Fig. 127.

with the macrodome, or $\infty\breve{P}2$. P, $P\infty$. The above figures are very common forms of barytes, figs. 125 and 126 being both composed of the pinacoid 0P, a brachydome, and a macrodome, with sign $\frac{1}{2}P(e)$, $P\alpha(f)$, $\frac{1}{3}P\infty(d)$. The variation in aspect arises from the predominance of different faces; and fig. 127 consists of the macrodome $\frac{1}{2}P\infty$, the prism $\infty P(g)$, and the pinacoid 0P.

V. *The Oblique Prismatic System.*- This system is characterized by three unequal axes, two of which intersect each other at an oblique angle, and are cut by the third at right angles. One of the oblique axes is chosen as the chief axis, and the other axes are then distinguished as the orthodiagonal (right-angled) and clinodiagonal (oblique angled). The same terms are applied to the chief sections, and the name of the system refers to the fact that these two planes form with the base two right angles and one oblique angle C.

The forms of this system approach very near to those of the right prismatic series, but the inclination of the axes, even when almost a right angle, gives them a peculiar character, by which they are always readily distinguished. Each pyramid thus gives two altogether independent forms or hemipyramids.

Three varieties of prism also occur, vertical, inclined, and horizontal - with faces parallel to the chief axes, the clinodiagonal or the orthodiagonal. The horizontal prisms, like the pyramids, separate into two independent partial forms named hemiprisms or hemidomes. The inclined prisms are often designated clinodomes, the term prism being restricted to the vertical forms. Orthopinacoids and clinopinacoids are also distinguished, from their position in relation to the axes. The monoclinic pyramids (fig. 128) are bounded by eight scalene triangles of two kinds, four and four only being similar. Their lateral edges lie all in one plane, and the similar triangles are placed in pairs on the clinodiagonal polar edges.

Fig. 128.

The two pairs in the acute angle between the orthodiagonal and basal sections are designated the positive hemipyramid, whilst the two pairs in the obtuse angles of the same sections form together the negative hemipyramid. But, as these hemipyramids are wholly independent of each other, they are rarely observed combined. More frequently each occurs alone, and then forms a prism-like figure, with faces parallel to the polar edges, and open at the extremities. Hence, like all prisms they can only appear in combination with other forms. The vertical prisms are bounded by four equal faces parallel to the principal axis, and the cross section is a rhombus; the clinodomes have a similar form and section, whilst the horizontal prisms or domes have unequal faces, and their section is a rhomboid.

The mode of derivation of these forms closely resembles that of the rhombic series. A complete double pyramid is assumed as the fundamental form, and designated $\pm P$, in order to express the two portions of which it consists. Its dimensions are given when the proportion of its axes $a : b : c$ and the angular inclination of the oblique axes C, which is also the inclination of the orthodiagonal section to the base, are known.

The fundamental series of forms is $0P$ . . . $\frac{1}{2}mP$ . . . . $\pm P$ . . . . $\pm mP$ . . . . ∞P, from each of whose members, by changing the dimensions of the other axes, new forms may be again derived. Thus from $\frac{1}{2}mP$, by multiplying the orthodiagonal by any number n, a series of orthopyramids $\pm mP^{o}n$ is produced, with the orthodomes $mP^{o}\infty$ as limiting forms. The clinodiagonal produces a similar series of clinopyramids $\frac{1}{2}mP\,n$, with the limiting clinodome $mP^{c}\infty$ always completely formed, and therefore without the signs $\pm$ attached. From ∞P arise orthoprisms $\infty P^{o}n$ and the orthopinacoid $\infty P^{o}\infty$, and clinoprisms $\infty P^{c}n$ and the clinopinacoid $\infty P^{c}\infty$. In these signs the o or c attached to the P indicates that the orthodiagonal (o) or clinodiagonal (c) axis has been multiplied. Formerly the latter forms were enclosed in brackets, thus $(mP\infty) = mP\infty$.

The combinations of this system may be easily understood from their resemblance to those of the right prismatic, the chief difficulty being in the occurrence of *partial* forms, which, however, closely resemble the hemihedral forms of the previous systems. A few examples only need therefore be given.

Fig. 129 represents a very common form of gypsum crystals $P^{c}\infty$, (P), $\infty P(f)$, $P(l)$. The most common form of augite is represented in fig. 130, with the sign $\infty P(M)$, $\infty P^{o}\infty(r)$, $\infty P^{c}\infty(l)$, $P(s$

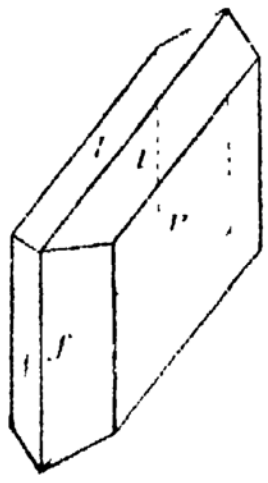


Fig. 129.

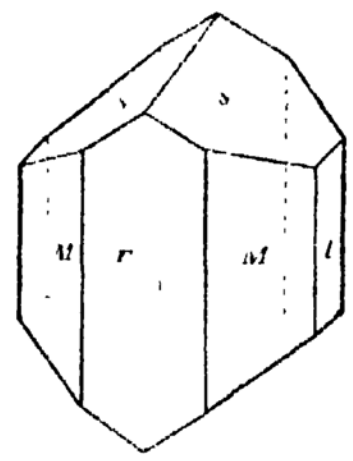


Fig. 130.

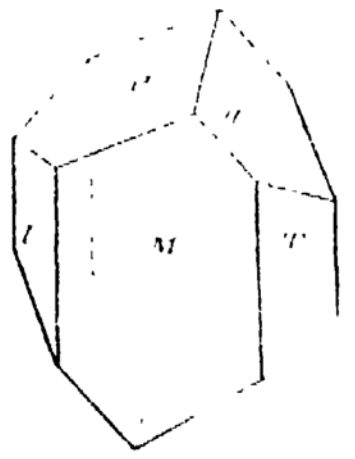


Fig. 131.

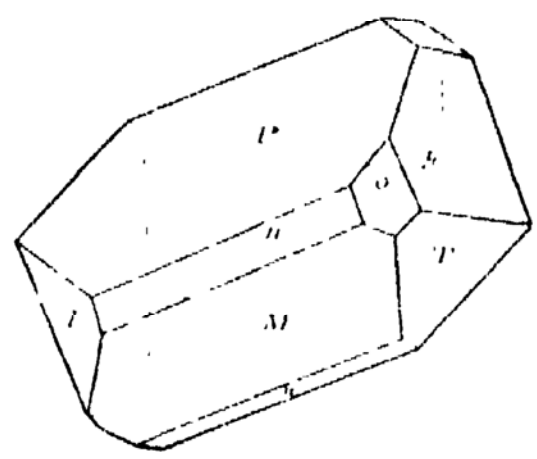


Fig. 132.

Fig. 131 is a crystal of common felspar or orthoclase, composed of the clinopinacoid $\infty P^{c}\infty(M)$, the prism $\infty P(T)$, the basal pinacoid $0P(P)$, and the hemidomes $2P^{c}\infty(y)$; to which, in fig. 132 of the same mineral, the hemipyramid $P(o)$ and the clinodome $2P^{c}\infty(n)$ are added.

VI. *Anorthic or Triclinic System.* This is the least regular system, and departs the most widely, indeed almost absolutely, from symmetry of form. The axes are all unequal, and inclined at angles none of which are right angles, so that, to determine any crystal, or series of forms, the proportion of the axes $a : b : c$, and also their angles or those of the inclination of the chief sections, must be known. As in the previous systems, one axis is chosen as the principal axis, and the two others distinguished as the macrodiagonal and brachydiagonal axes. In consequence of the oblique position of the principal sections, this system consists entirely of partial forms wholly independent of each other, and each composed only of two parallel faces. The complete pyramid is thus broken up into four distinct quarter-pyramids, and the prism into two hemiprisms. Each of these partial forms is thus nothing more than a pair of parallel planes, and the various forms consequently mere individual faces. This circumstance renders many triclinic crystals very unsymmetrical in appearance.

Triclinic pyramids (fig. 133) are bounded by eight triangles which lateral edges [illegible]. They are equal and parallel two and two to each other, each pair forming, as just stated, a tetartopyramid or open form, only limited by combination with other forms or, as we may suppose, by the chief sections. The prisms are again either vertical or inclined; the latter are named domes, and their section is always rhomboidal. In deriving the forms, the fundamental pyramid is placed upright with its brachydiagonal axis to the spectator, and the partial forms designated, the two upper by 'P and P', the two lower by ,P and P,, as in the figure. The further derivation now follows as in the right prismatic system, with the modifications already mentioned.

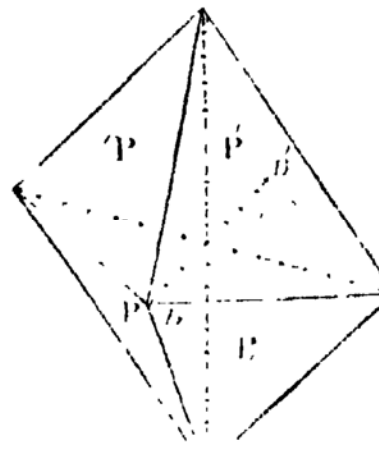


Fig. 133.

Some combinations of this system, as the series exhibited by most of the felspars, approach very near to the oblique prismatic system, whilst others, as cyanose and axinite, show great incon-

eteness and want of symmetry. In the latter case the determination of the forms is often difficult. In the oblique crystal (figs. 134, 135) *P* is the basal pinacoid 0P; *M* the brachydiagonal pinacoid $\infty\breve{P}\infty$; *r* the upper right pyramid P'; *l* the right hemiprism ∞l'; *T* the left hemiprism ∞'P; and *z* the hemidome 'P∞. Figs. 136 and 137 are crystals of axinite, the former from Dauphiné,

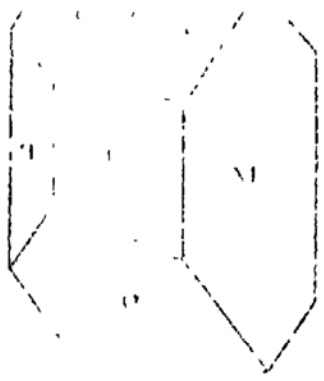


Fig. 134.

Fig. 135.

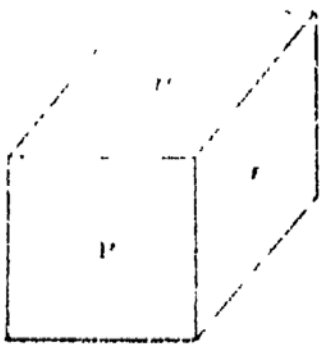


Fig. 136.

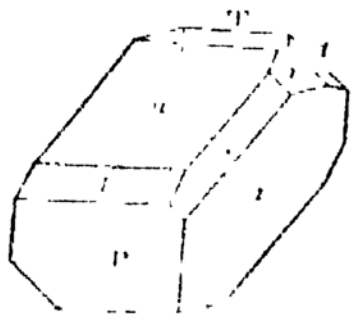


Fig. 137.

latter from Cornwall, of whose faces the following is the development: *r* the macropinacoid $\infty\breve{P}\infty$, *l* the left hemiprism 'P, *u* the left upper quarter-pyramid P, *f* the left upper quarter-pyramid 2P, *s* the left upper portion of the macropyramid P3, and *z* the hemidome 2'P∞.

The Measurement of the Angles of Crystals

The permanence of angular dimensions of crystals shows the importance of some accurate method of measuring their angles, that is the inclination of two faces to each other. Instruments for this purpose are called goniometers.

Two have been specially used for this purpose, the common or contact goniometer, invented by Carangeau, and the reflective goniometer of Wollaston. The former is simply two bars or rulers turning on a common centre, between which the crystal is opened until [illegible] and [illegible] rested on a graduated arc. [illegible] is then adjusted for many purposes, and for large crystals [illegible] goniometer is [illegible] smooth and even faces, but the faces may be very small, even of an inch or [illegible] small crystals are generally [illegible], far greater accuracy can be attained [illegible] goniometer is represented in fig. 138. It consists of a graduated circle *m n*, divided on its edge [illegible] most frequently into half-degrees, the minutes [illegible] estimated. This circle turns on an axis [illegible] by turning this the circle is moved [illegible] 180°, when moving in one direction, by [illegible] ment is intended to attach [illegible]. The two axes of motion [illegible] through it from *c*, so that [illegible] *f* to *z* can be turned without [illegible] required position; *f* is a [illegible] of *g*, a fourth axis, in the [illegible] all lies at *o*, to which the [illegible] crystal to be measured [illegible]. When about to be used, the [illegible] that its base horizontal [illegible] and opposite to a window [illegible] axis shall be parallel to [illegible] of the upper bar of the [illegible] west of the latter, a white [illegible] window, should then be [illegible] the observer places himself [illegible] bars, left hand. The crystal [illegible] wax, with the two faces [illegible] by the screws in its [illegible] lower distance, so that [illegible] bars of the window [illegible] for the lower bar or [illegible] rest or table parallel to [illegible] face adjust the crystal. [illegible] contact with the side *a* [illegible] held loosely by a piece [illegible] bent upwards, and the edge of union of the faces, including the angle to be measured, as nearly as possible in the line of *aa*. The eye being brought near to the first face of the crystal, the axes *aa* and *p* are turned till the image of the window is seen reflected in the face with the horizontal and vertical bars in their position. The axis *d* is then turned through a considerable angle (say 60°), and the image of the window again sought and brought into its proper place by turning the axis *f*, without moving *p*. When this is done that face is brought into its true position, normal to *d*, so that no motion of *d* can disarrange it. Hence the image of the window can now be sought in the second face and brought into its true position, with the horizontal bars seen horizontal, by moving the axes *d* and *a*. When this is done the crystal is properly "adjusted." The angle is measured in the following manner. Let a line [illegible] of the circle and vernier to coincide, and then turn the inner axis *a* or *c* and move the eye till the image of the upper bar of the window is reflected from the more distant face of the crystal coincides with the lower bar or horizontal line seen directly, keeping the eye in the same place, turn the other axis *f* till the reflected image of the upper bar in the other face in like manner coincides with the lower line, the angle of the two faces is then read off on the divided circle. As the angle measured is not directly that of the faces but of the rays of light reflected from them, or the difference between the angle wanted and 180°, the circle has the degrees numbered in the reverse direction, so as to give the angle without the trouble of subtracting the one from the other.

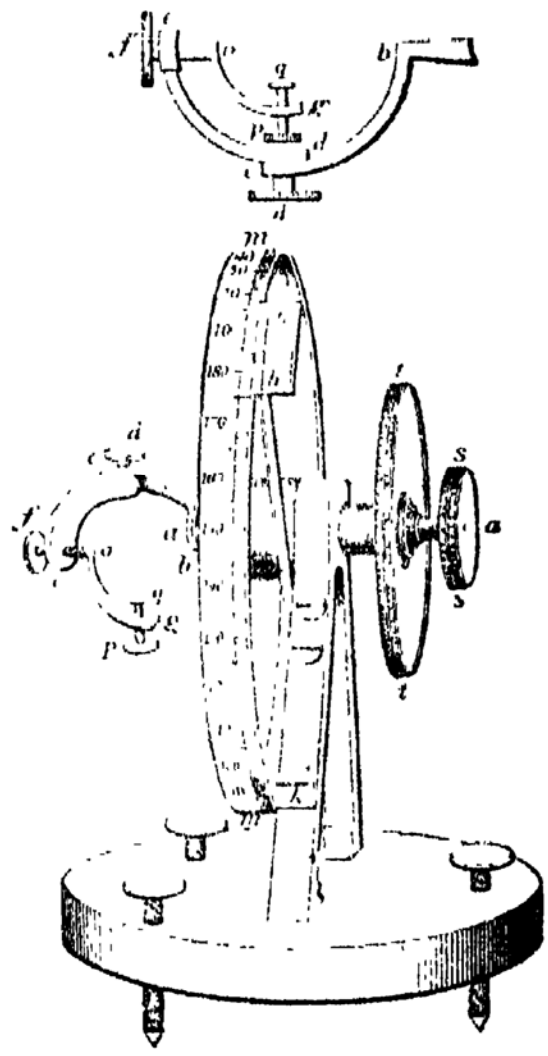


Fig. 138.

The apparatus figured is for adjusting the crystal, and is an improvement suggested by Naumann. In the original instrument the axis *a* was made to push in or out in a sheath, and had a small bent plate, bent at right angles, inserted in a cleft at *o*, to which the crystal was attached. The crystal was adjusted as formerly by moving the plate, or the axis *fa*, and by slight motion of the arm *z*, which bent at right angles nearly to *be* when used. A very marked improvement is to have a small mirror fixed on the stand below the crystal with its face parallel to the axis *aa*, and inclined at 45° to the window, when the lower line can be dispensed with, [illegible] instrument used for various other purposes of angular measurement. Many more perfect instruments have been introduced for the purpose of insuring greater accuracy; but the simple [illegible] trument is sufficient for all purposes of determinative mineralogy, and the error from the instrument will, in most cases, be less than the actual variations in the angles of the crystals.

Departure from Geometric Simplicity and Loss of Regularity in Crystals.

Such departures may be regulated by law, or may result from an undue operation of the force of accretion in certain directions.

1. *Regular Departures from Simplicity.*—There are three varieties of this: parallel groupings, twin forms, hemitrope [illegible].

Parallel Groupings. A plurality of individuals are here arranged either so that a line which joins their centres becomes a prolongation of one or other of their crystallographic axes, or so that their axes are parallel.

Fig. 20 shows the first, where cohesion sufficient for stability requires that the minute octahedra must mutually penetrate somewhat into each other. Fig. 139 shows the same in baryte. If we suppose octahedra united, the upper left-hand face of the one with the lower right hand face of the other, there would be parallelism of their axes. Re-entering angles would, in such cases, prove a plurality of individuals, but if a number of cubes were superimposed in similar position, no such angles would occur, an elongated square prism resulting; and such arrangements, if

repeated, are linear, or, with diminishing size in the individual, cicular.

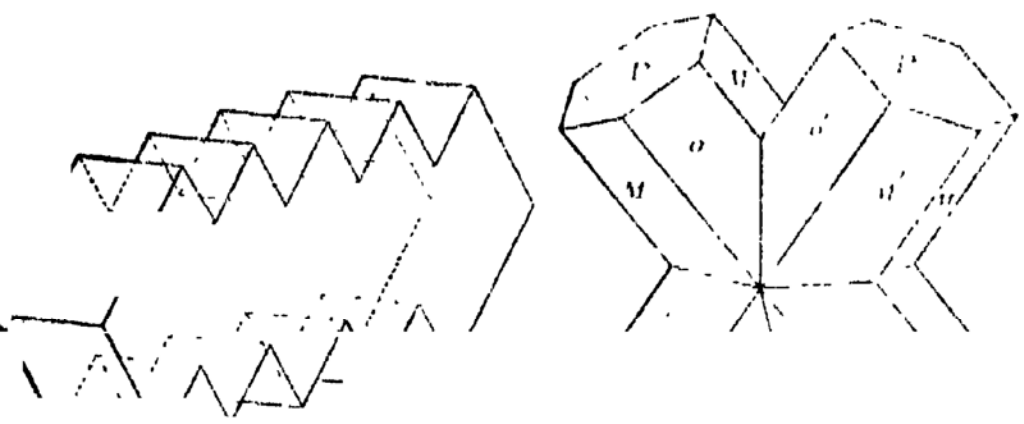


Fig. 139.

Twins and Hemitropes.—Though closely related termed under the operation of very similar laws, and to a certain extent passing into one another, there are not the In the first case a plurality of individuals must be pre ent, In the second this is not necessary In fig 140 two individuals evidently intersect one another, as figs. 141, 142 one individual may be supposed to have been bisected in a certain direction, and the two halves reattached, but in a position differing in some definite manner from their relative position before the separation

Fig. 141.

Fig. 142

There are four varieties of true twins, those of apposition, of intersection, of partial or completed interpenetration, and of incorporation.

The first is exemplified by spinel, as in fig. 143, the second by

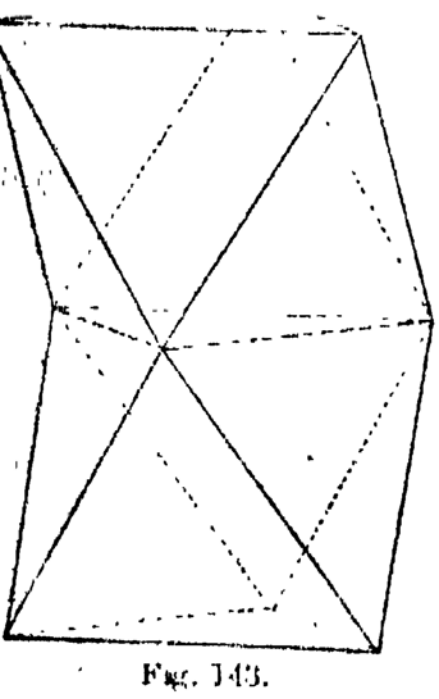


Fig. 143.

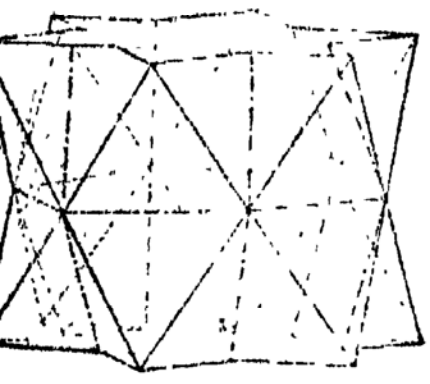


Fig. 145.

Fig. 144

Fig. 146.

staurolite, as in fig. 144; the third by calcite, as in fig. 146, and by blende, as in fig. 145, where the two individuals of fig. 143 may

be supposed to have been forced vertically into one another, and the fit made by quartz, as in fig 147.

The following are the laws of union of twins. 1. The face of union of twins, termed the "face of composition," must be either a plane which does occur in the mineral twinned, or which can occur in accordance with the fifth law of symmetry. A face

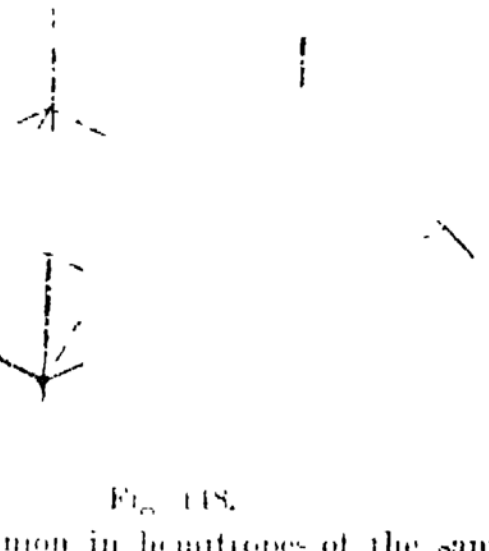


Fig. 148.

union in twins is also a face of union in hemitropes of the same mineral 2 From the above it results that the axes of the united crystals are either parallel (fig. 148) or inclined (fig. 149) The former generally occur among hemihedric forms and the crystals are combined in the exact position in which they would be derived from or would reproduce the primary holohedral form. The cases with enlargement occur both in holohedric and in hemihedric forms, and the two individuals are then placed in perfect symmetry, in accordance with

by having re-entering angles (fig. 150, 151), but sometimes the combined faces come to one plane, when the combination appears as a single individual (fig. 152, 153). The line of junction may then be imperceptible, or it may be marked by the same (fig. 154, 155) by one pe of the two fo

The formation of twin axial may be again repeated, forming groups of three, four, two When the faces of two crystals parallel to each other

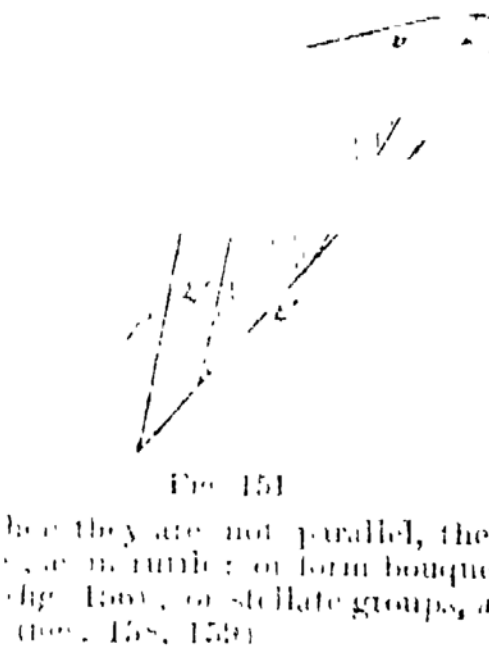


Fig. 151

rows of indeter may return into or rose-like group in calcite (fig. 2.

nt When they are not parallel, they re-circle, are in rumble; or form bouquet- ches (fig. 156), or stellate groups, a cross (figs. 158, 159)

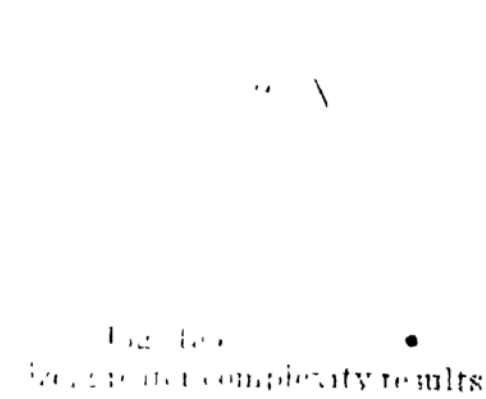


Fig. 152. Fig. 153

When the crystals are of different sizes the complexity results but a number of minute crystals are frequently arranged upon a larger at those points where the ends of the single large crystal would protrude. Occasionally a simple form is twinned with a more complex one, as in chabazite (fig. 160)

Hemitrope crystals we may imagine as having been formed from single crystal, which has been cut into two halves in a particular rection, and one half turned round 180° or 90°, or 60°. The ne about which the tion is supposed to take place is called he "axis of revolution." From the amount of turning usually being 180° [illegible] hemitrope. The position of the two

[illegible]

Fig. 157.

[illegible] halves in this case resemble that of an object and its image in a mirror, where either of them would represent the plane of reflection.

The following are the laws of hemitropes. The axis of revolution [illegible] possible crystallographic line, either an axis or a line perpendicular to an axis or a normal to a possible crystalline plane. The plane normal to the axis of revolution is called the twin plane, and is either an occurring or a possible face, and usually one of the more frequently occurring planes. [illegible]

Fig. 158.

[illegible] in relation to both halves of the crystal in them selves; consequently the part of hemitrope crystals are [illegible] which reference to the twin plane can be made in twinned crystals. The face of composition [illegible]

plane and the [illegible] position of the [illegible] angle to each other, the composition [illegible] parallel to the axis of revolution. But in the composition plane we have a disturbing influence [illegible] another, so that the plane of union is concealed or irregular. Still in these cases the axis and the plane of twinning retain a definite position, but the face of composition, being no longer defined, is [illegible] as a determinant.

Fig. 159.

Fig. 160.

There are three modes in which the composition may take place in hemitropes. These may be explained by dividing a crystal into halves, with the plane of division vertical, and then turning one of the halves round.

1. One of the halves may be inverted, as if by revolution through 180° on a horizontal axis *at right angles to the plane of section*, and the two faces again united by the surfaces which were separated. Here the surfaces of union are the original ones but the base of one of the halves has taken the place of its summit. Examples: selenite (fig. 161) and orthoclase.

2. One of the halves may be turned round through 180°, as if by revolution on a *horizontal axis, parallel to the plane of section*, and the two opposite and parallel to that of the plane of section an originally external face may then be applied to the other half. Here, not only has the base of one-half become a summit, but a lateral and external face of the original crystal has been thrust to its centre so as to become a face of internal union. Example: labradorite (fig. 162).

Fig. 161.

Fig. 162.

3. One of the halves may be turned round through 180°, as if by revolution on *a lateral axis*, parallel to the plane of section, the external face opposite and parallel to the plane of section becoming a face of union. Here, however, both the original summits retain their position as a summit. Example: orthoclase.

The last of the modes of composition may occur in each of the systems, but is not always apparent until disclosed by optical properties. The second is rare, and the third still more so.

In hemitrope crystals (besides frequently in true twins) the halves of the crystal are frequently reduced in thickness in the direction of the ordinary twin axis, and when there is a parallel repetition of hemitropes, which frequently occurs, they are often reduced to very thin plates, not the thickness of paper, giving to the surface of the aggregate a striated structure and appearance.

In the cubic system the faces of composition, both of twinning and of hemitrope revolution, are those of the cube, the dodecahedron, and the octahedron.

In the first case we have the axes of the two crystals necessarily in some cases parallel or, more correctly, falling into one, but, as in this system all the axes are alike, or all the cubic faces similar, composition may occur along or parallel to all alike, and double or triple twins occur. We have examples in twins of the pentagonal dodecahedron (fig. 163) made up by the interpenetration of a right

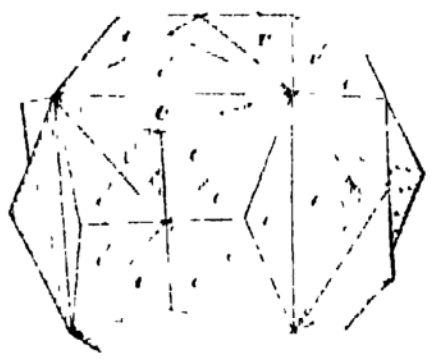


Fig. 163.

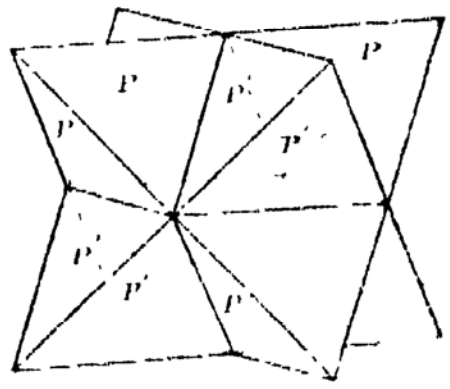


Fig. 164.

and a left (P and P'), and of the tetrahedron, as seen in pyrite and tabletz respectively. In virtue of the position required by law it will be seen that the position of the solid which is common to both intersecting crystals is in the twin of pyrite the four-faced cube, which is the holohedral form of the pentagonal dodecahedron, while in the case of the tabletz twin (fig. 164), the common portion is an octahedron, the holohedral form of the tetrahedron.

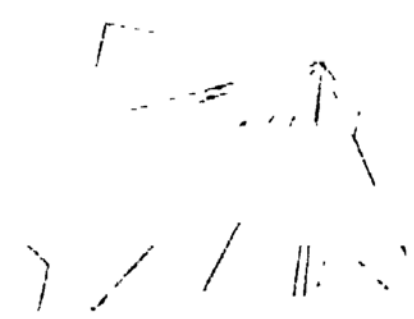


Fig. 165.

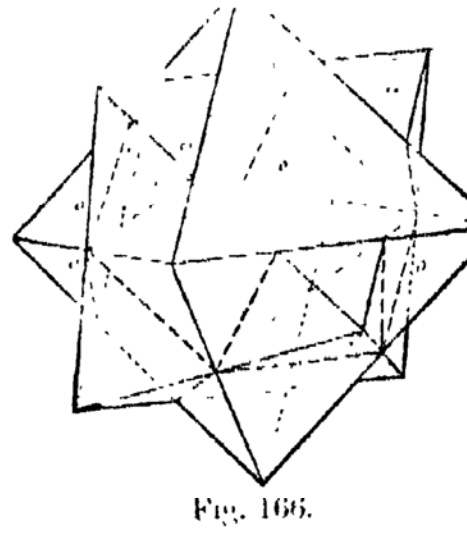


Fig. 166.

Twinning on an octahedral face is seen in the apposition twin spinel (fig. 133), the tetrahedral twin of blende (fig. 165), the interpenetrative octahedral twin of blende seen in fig. 166, and the intersecting cubes of fluor (fig. 167).

This is also the usual twin face for hemitropes of the cubic syste

is seen in fig. 168 of blende, where the two parts of the rhombic dodecahedron are united by it. Magnetite, spinel, and diamond

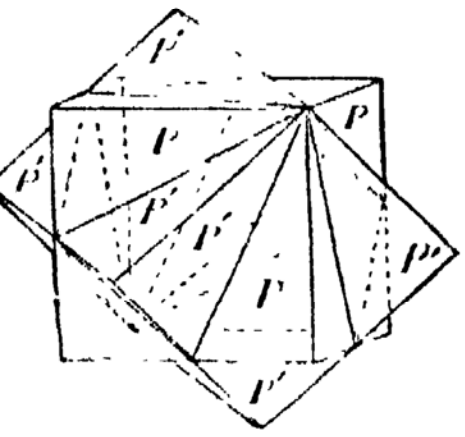


Fig. 167.

Fig. 168.

equently occur in octahedral hemitropes of the same composition g. 169).

This is also the face of composition for tetartohedral hemitropes ig. 170 is that of the diamond. Here six of the faces of the six-

Fig. 169.

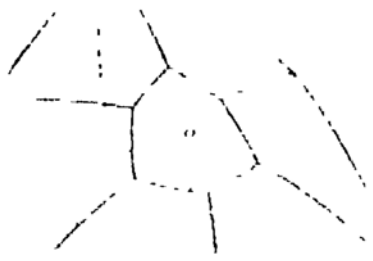


Fig. 170.

ded octahedron, with six faces diagonally opposite, form a low ouble six sided pyramid (a portion of an octahedral face truncating ach) through an 180° revolution of one set of the contained some mes shows both twins and hemitropes of the dodecahedron, of octahedral composition.

In the *tetragonal system*, twin crystals are very uncommon, but emitropes frequent. With parallel axes they very seldom occur, ut are seen in chalcopyrite. When the axes are inclined, the lane of union is usually one of the faces of the primary pyramid; nd, as these faces are all similar, composition may take place imultaneously parallel to all. Very complicated forms hence result, s seen in chalcopyrite and in cassiterite (fig. 171).

Fig. 171.

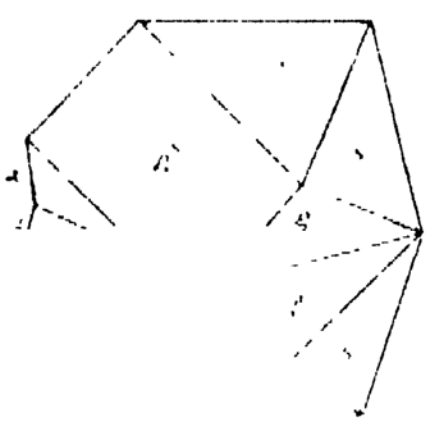


Fig. 172.

In cassiterite the plane of union is frequently one of the faces of the pyramid P∞, sometimes one of those faces that replace the polar edges of P (figs. 172, 173). From the bend the latter form is termed geniculated.

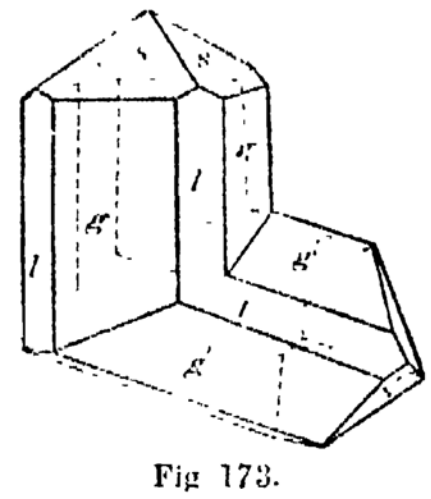


Fig. 173.

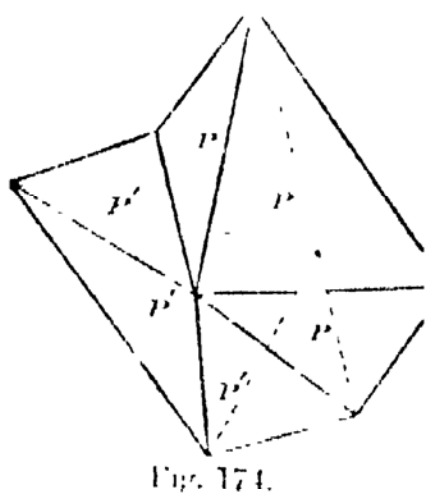


Fig. 174.

Hausmannite occurs in hemitropes of the primary P; and on the polar edges of this other twins are symmetrically repeated, a central individual appearing like a support to the others (figs. 174, 175).

In the *hexagonal system* twins are very common among the rhombohedral (the hemihedral) and the tetartohedral forms; while hemitropes prevail among the hexagonal or holohedral forms. The twins are generally formed by the interpenetration of two rhombohedrons, a + and a −, the vertical axis being the axis of composition; as in chabasite (fig. 176), cinnabar, levyne, calcite, &c. Sometimes six or more crystals, united parallel to the prismatic planes,

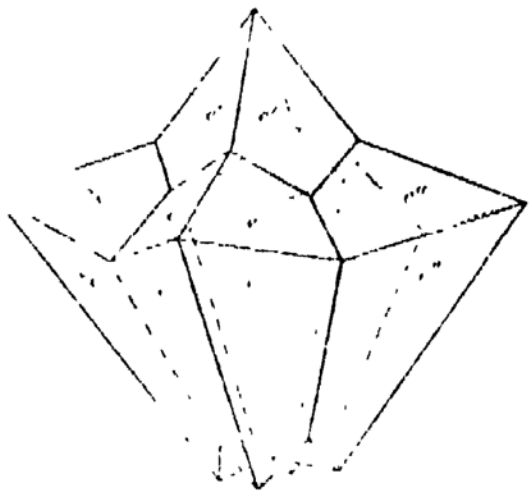


Fig. 175.

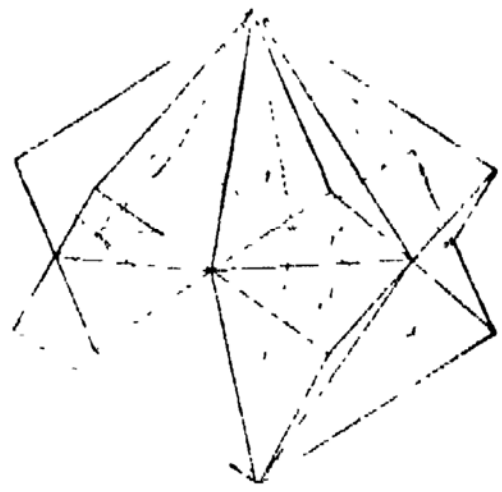


Fig. 176.

form rosettes, as in chabasite from Giant's Causeway. The almost endless stellate forms of crystals of snow are built up in this manner. Many of the most beautiful combinations to be seen among crystals result from this mode of arrangement.

Parallel grouping of hexagonal prisms also occurs, as in apatite (fig. 177).

Rock crystal in consequence of the tetartohedral character of its crystallization, exhibits twins in which the double hexagonal pyramid P may be said to be separated into two rhombohedrons. Parts of these, though geometrically similar, are physically distinct. In fig. 178 the two individuals have not entirely interpenetrated, and might be recorded as simply grown together with parallel axes, but in fig. 147 there is so complete an interpenetration that the composite character of the crystal is only evidenced through a difference in the character of the surfaces of the two halves, which are most irregularly disposed.

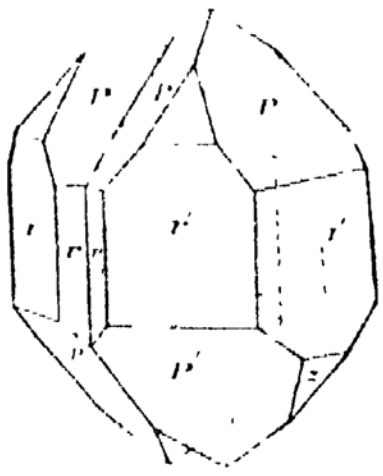


Fig. 178.

The hemitropes of this system often form regular crystals, when the two halves have been united by a plane parallel to the base, so as to appear like a simple crystal, as in fig. 179. Here each end shows the forms ∞R, −R, but the terminal faces appear in parallel instead of alternate position. Something of the same is seen in fig. 180, a hemitrope scalenohedron from Derbyshire. Hemitropes with the face of the primitive rhombohedron as the face of composition are also common, and they are sometimes joined by a face of −R; the two axes forming an angle of 77° 37′. Occasionally, a third individual is interposed in a lamellar form as in fig. 181, where the faces of the two outer parts are parallel. The pieces of isolated part. When the crystals occur in a face of the primary rhombohedron, they form an angle of 120° 0′ (supplement of 60°), recognized by the slight departure from a straight line in the reentering angles (figs. 182, 183).

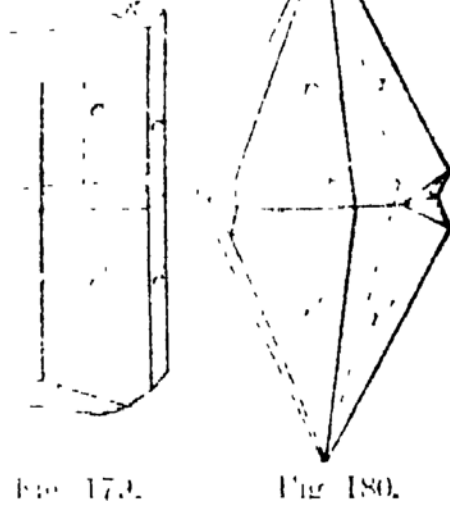


Fig. 179.

Fig. 180.

Fig. 181.

The faces of the hexagonal pyramid P are the faces of composition most commonly observed; other examples are figs. 142, 146, 148, and 149.

In the *orthorhombic system* twins are rare, with parallel axes are rare but with oblique axes common, the face of union being one of the faces of the prism ∞P. Twins of this kind are frequently in

ragonite, cerussite, witherite, and marmolite. In aragonite the crystals are partly in interpenetration, and partly merely in juxtaposition, as in fig. 191, where the individuals are formed by the

Fig. 191.

combination ∞P.∞P∞.0P, ∞P.∞P∞.P, ∞P.0P. In fig. 185 crystals of the same combination form a series with parallel planes of union, the inner members of which are often so shortened that they form

which appear

the twin

In fig. 186 four crystals each of the combination ∞P.2P∞, having two inclined planes for

one which

Fig. 186.

Fig. 187.

combination ∞P.∞P∞.0P, with

hexagonal crystals. Here

individuals

also common

nate combination ∞P, ∞P∞, 0P, combi

via face of the brachydiagonal hexan

may be seen to be 120 by a

chief axes, and the brachydiagonal

of the crystals meeting at

60°. The numerals, which are very freq

wanted, also form combinations with the

mbol ∞P∞.

In the *oblique prismatic* system twins o

are means of the great importance of

of penetration with parallel axis, but the

to M, to P

from the

Fig. 188.

Fig. 189.

of the two halves of the simple crystal represented in fig.

130 are in fig. 191 united so perfectly and symmetrically that the line of junction cannot be observed on the clinopinacoid. The two hemipyramids (s) (like - P7) in the gypsum crystal) form at one end of the crystal a re-entering, at the other a salient angle

Fig. 190.

Fig. 191.

Hornblende (fig. 192) and wolfram exhibit a similar appearance. This results in the imparting a pseudo-heteromorphism to certain oblique prismatic twins, which is well seen in the twins of sphene (figs. 195 and 589), and in exalting the character to the appearance of true hemimorphs, as seen in the twin of acmite (fig. 194). In other cases the individuals partially penetrate each other in the direction of the orthodiagonal. This mode of union is not uncommon in gypsum, and is very frequent in orthoclase. Two crystals

Fig. 192.

Fig. 193.

of the latter of the combination (∞P∞), ∞P, 0P, 2P∞, as in fig. 131, are often pushed into each other, as shown in fig. 195.

In the *anorthic system* twin formations are of great importance, e.g., as a mean of distinguishing the triclinic from the monoclinic species of felspar. In one variety the twin axis is the normal to the brachydiagonal chief section. But in the anorthic felspars this section is not perpendicular to the base, and consequently the two bases form on one side a re-entering, on the other a salient angle; whereas in the oblique prismatic felspars (where the brachydiagonal chief section corresponds to the clinodiagonal) no twin crystals can be produced in conformity to this law, and the two bases fall in one plane.

Fig. 194.

Fig. 195.

Albite and oligoclase very often exhibit such twins as in figs. 196, 197, where the very obtuse angles formed by the faces of 0P, or *P* and *M* (as well as those of ∞P∞, or *x* and *x'*), are a very characteristic appearance, marking out this mineral at once as a triclinic species. Usually the twin formation is repeated, three or more crystals being combined, when those in the centre are reduced to mere plates. When very numerous, the surfaces *P* and *x* are covered with fine striæ, often only perceptible with a microscope. A second law of twin formation is observed in triclinic felspars, particularly in albite and labradorite

is that the twin axis corresponds with that normal of the brachydiagonal which is situated in the plane of the base. In pericline, a variety of albite, these twins appear as in fig. 195, where the two crystals are united by a face of the basal pinacoid *P*, whilst the faces of the two brachypinacoids (*M*

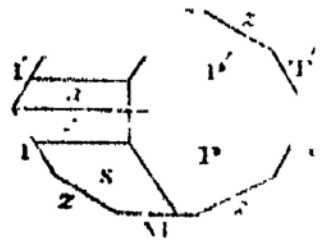


Fig. 196.

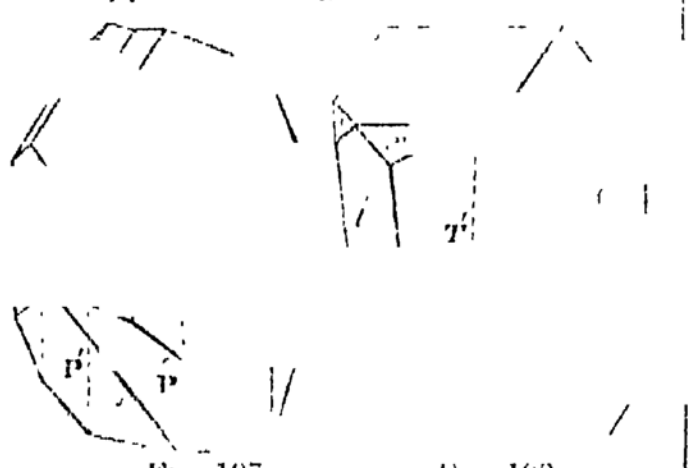


Fig. 197.

Fig. 198.

and *M'*) form edges with very obtuse angles (173° 22'), re-entering on the one side and salient on the other. These edges, or the line of junction between *M* and *M'*, are also parallel to the edges formed by these faces and the base, or those between *M* and *P*. In this case also the twins are occasionally several times repeated, when the faces appear covered by fine striæ.

Cause of the Formation of Twins and Hemitropes.—It has been shown above that the relative position of the molecules of a crystal is determined by a polarity in the molecules themselves. The polarity must exist along three lines which intersect in the centre of the molecules; and unlike poles must attract each other. It has been supposed that compound crystals result from a reversion of the original polarity of the molecules of a crystal, after it has attained a certain size. Heat and electricity, or minute tremor movements in strata, might occasion such reversal during the formation of a crystal, and this would suffice for the explanation of hemitropes, though not directly of geniculated crystals, and still less of intersecting twins. Twins have accordingly been divided into

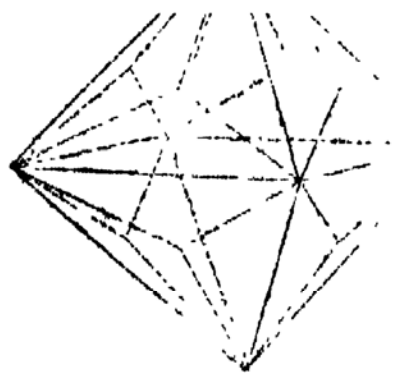


Fig. 199.

The first term is applied to the ordinarily occurring twins in which the component structures are supposed to have had their normal molecular, or to have been compound molecules, or to have been compound in structure from the first. In metagenetic twins, the crystals were at first simple, but afterwards, through some change in the matter returned before its mineral species finally induced it itself, it received new layers, or its extension *in a reversed position*

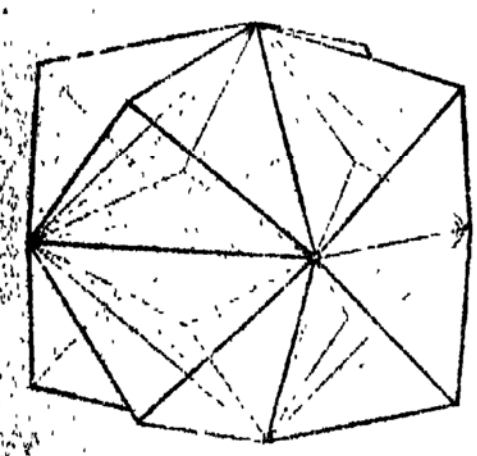


Fig. 200.

Fig. 202.

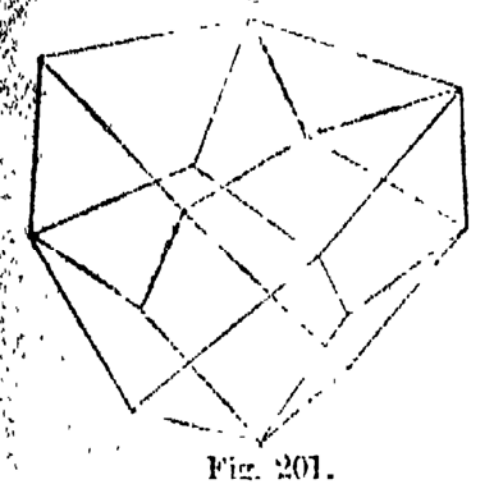


Fig. 201.

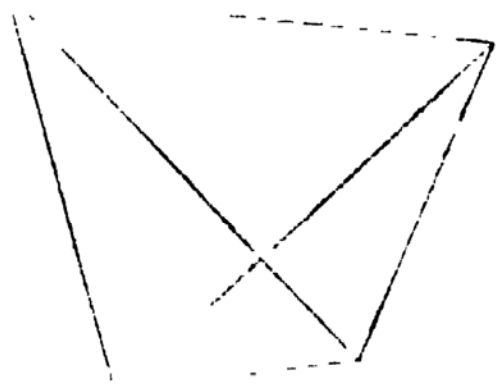


Fig. 203.

Rutile occurs in crystals like fig. 173, but with a bend at both extremities, instead of one only. Here the middle portion of the crystal is supposed to have attained a length of half an inch, and then it became geniculated simultaneously at both extremities; indeed, in this manner such geniculations are frequently repeated until the ends are bent into one another, and produce short hexagonal prisms with central depressions or even cavities. This repeated twinning which produces striation, as in calcite and the felspars, and the peculiar rippled structure of amethyst, are ascribed to a similar operation, acting in an oscillatory manner.

Certain intersecting twins in the cubic system may be explained simply through excessive or undue accretion of molecules along certain lines. At page 351 it was shown how the three-faced octahedron (fig. 39) was formed through an accretion of molecules upon the faces of the octahedron along a line joining the centres of its faces (those which connect the solid angles of the cube). It was also shown that when through the accretion two faces of the triakis octahedron (fig. 199), adjacent along the edge of the octahedron, rose into one plane the rhombic dodecahedron resulted. If now accretion still goes on along the same axes, so that the trihedral pyramid rises above the level of the dodecahedral planes, fig. 204 results. This is the twin of the three-faced tetrahedron (fig. 201).

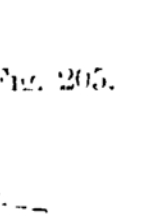


Fig. 204.

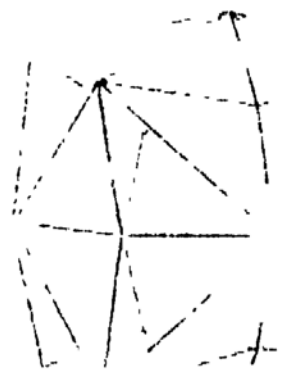


Fig. 205.

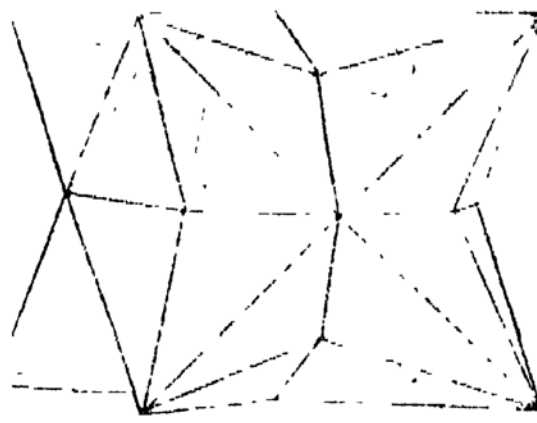


Fig. 207.

Fig. 206. Fig. 208.

If the accretion be still along the same axes, so that the inverted edges of the adjacent pyramid fall into the same line, this is the twin of the simple tetrahedron (fig. 201). Here accretion upon the faces of a complex holohedral form has produced a twin of a simple hemihedral form.

Again, starting from the three-faced octahedron (fig. 204) there is produced by the same process first fig. 205, the twin of the six-faced tetrahedron (fig. 206), and ultimately fig. 207, the twin of the three-faced tetrahedron (fig. 208).

2. Departure from Regularity or Normal Accretion in certain Directions. Distortion of Crystals.—The laws of crystallization should produce crystal forms of perfect symmetry; the laws, however, are subject, not only to the influence of other laws, but also frequently to disturbing influences which are subject to no law. Absolute symmetry, therefore, is very uncommon, crystals being generally more or less distorted and disguised through interference during their formation that either familiarity on the one hand or killed on the other is necessary for their recognition. The parameters of the angles may vary somewhat, even the colour may sometimes perplex. Hence it is necessary to be familiar with such departures from symmetry as some of the more common are here noticed.

In the cubic system a cube (fig. 209), lengthened or shortened along one axis, becomes a right square prism (fig. 209), and elongated in the direction of two axes changes to a rectangular prism (fig. 7). Cubes of pyrites, galena, fluor-spar, &c., are generally thus distorted. It is very unusual to find a cube crystal that is a true symmetrical cube. In some species the cube or octahedron (or other monometric form) is [illegible] of into a capilla-

rystal or needle, as happens in red copper and pyrites. Crystals acicular pyrites occur at the Newton Stewart lead-mine

An octahedron flattened parallel to two of its faces is reduced to tabular crystal (fig. 210). If lengthened in the same direction, takes the form fig. 211, or if is still further lengthened, to the blitération of two opposite octahedral faces or become an

Fig. 210.

Fig. 211. Fig. 212.

ents this prism lying on it acute edge (spinel, fluor magnetite) The dodecahedron when lengthened in the direction of the upright axis become a square prism with pyramidal summits (fig. 13); and when shortened along the same axis it is reduced to square octahedron with truncated basal angles (fig. 214). Bot

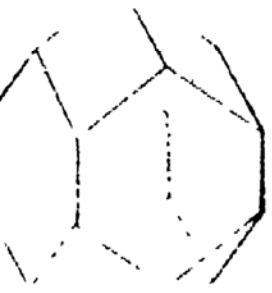


Fig. 213.

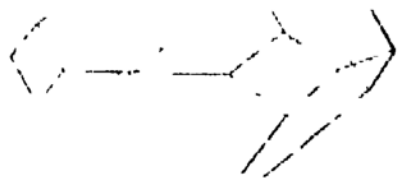


Fig. 214.

Fig. 215.

e forms are modifications of the square prism; the first mode distortion is common in garnet, rendering it liable to be con fused zircon, the second is seen in apophyllite, when it might be taken

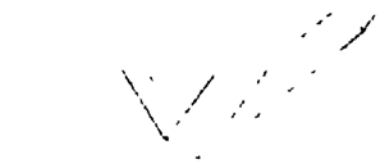


Fig. 217.

When first of these forms is flattened, as in fig. 215

When a dodecahedron again is lengthened along a diagonal of two opposite hexahedral angles, it becomes a six-sided prism with trihedral summits, and if shortened in the direction of the axis a rhombohedron which has its edges truncated

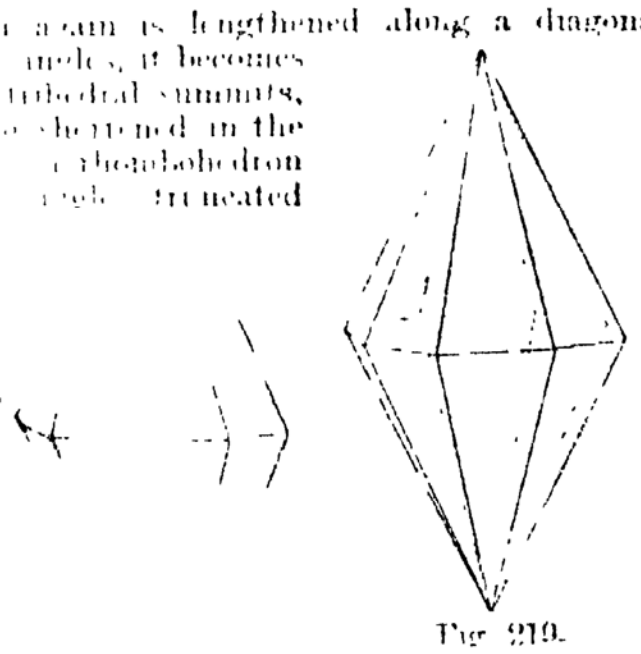


Fig. 219.

ase, a crystal of this form placed on one of its truncated summits could resemble the crystal of the latter, a hexagonal garnet would resemble calcite.

The trapezohedron is exceedingly subject to distortions which frequently disguise it until When elongated in the direction of the upright axis it becomes a double eight-sided pyramid with four-sided summits, fig. 218; a further elongation along the same axis would result in the obliteration of these summit faces, and in the production of a perfect double octagonal pyramid (fig. 219). The first of these distortions is exceedingly common in analcime and nos

Fig. 220.

Fig. 221.

uncommon in garnet, the latter rarely occurs in analcime. Lengthened along an octahedral axis it becomes fig. 220; shortened along the same it becomes fig. 221. Both are seen in analcime.

When the tetrakishexahedron is lengthened along a single octahedral axis it assumes the form of fig. 222; still further elongated with obliteration of one half of its planes, it becomes a scalene dodecahedron, resembling the "dog tooth" form of calcite (fig. 223). Fig. 224 is a hemihedron of this form, produced by shortening along an octahedral axis, with obliteration of all the planes which do not touch the poles of that axis.

In the case of modified crystals of this system the distortions are more complex. Fig. 225 represents a crystal of cinnamon stone from Aberdeenshire; it is a combination of the dodecahedron and the trapezohedron. Only four dodecahedral faces remain (*d*), and those of the trapezohedron (*n*) are of unequal size. It may be best understood by regarding it as fig. 218 with the four vertical faces of fig. 213, so that it combines the distortions of both of these figures.

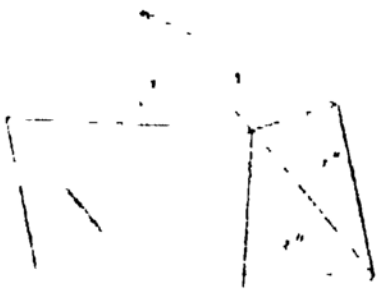


Fig. 224.

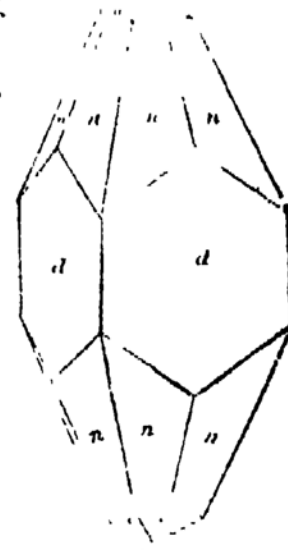


Fig. 225.

Crystals of diamond are very frequently distorted, though generally through curvatures of their faces.

Imperfections in the Surfaces of Crystals.

Of these the most important are striæ, caverns, and curvatures.

1. *Striated Surfaces.* The parallel furrows on the surfaces of crystals are called striæ, and such surfaces are said to be striated.

Each ridge on a striated surface is enclosed by two narrow planes. These planes often correspond in position to a secondary or to the primary planes of the crystal, and we may suppose these ridges to have been formed by repeated oscillation in the operation of those causes which gave rise, when acting uninterruptedly, to larger planes. By this means the surfaces of a crystal are marked in parallel lines with a succession of narrow planes, meeting at angles alternately re-entering and salient, and constituting the ridges referred to. This combination of different planes in the formation of a surface has been termed an oscillation of faces.

Cubes of pyrites are generally striated in such a way that the striæ on adjacent faces are at right angles to one another. These lines are parallel to the intersections of the primary faces with the planes of the pentagonal dodecahedron, which is the most common form of pyrites; and they have evidently resulted from an oscillation between the primary and this secondary form.

The rhombic dodecahedron is often striated parallel either with the

edges, or with the longer or the shorter diagonal of its faces. In the first case, seen in garnet (fig. 226), there is a passage into the six-faced octahedron; the second results from an oscillatory combination of the dodecahedron with the regular octahedron, as in magnetite; and the last with the cube, as in aplome.

Rhombohedrons of chabasite are often striated parallel to the

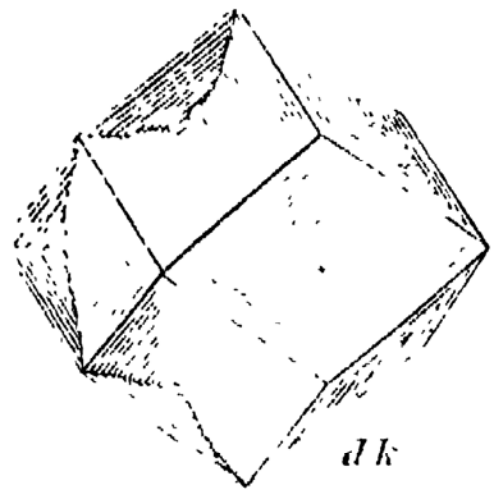


Fig. 226

terminal edges (fig. 227), indicating an oscillatory combination between the primary faces and a secondary plane which bevels these edges.

Striation of faces is more frequent in the rhombohedral system than in any of the others. Horizontal striæ are of almost invariable occurrence in the prismatic faces of quartz, whatever be the form of the crystal. The oscillation here has taken place between the pyramidal and the normal faces (figs. 228, 229, 230). During its growth there seems to have been a continued effort to complete the crystal by the assumption of the terminal planes, which effort was intermittently overcome by a preponderating one to continue the deposition of matter along its main axis. Quartz crystals, from these alternate efforts, often taper to a point, without having any regular pyramidal face.

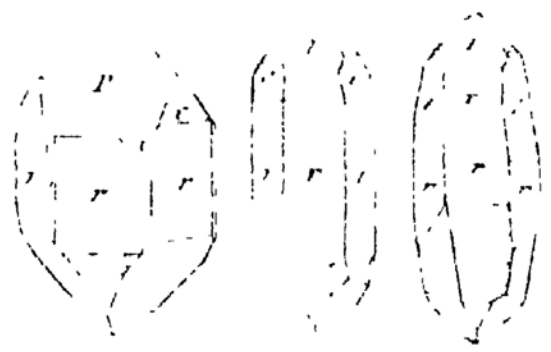


Fig. 228. Fig. 229. Fig. 230.

The lateral planes of prisms of tourmaline are very frequently convex, owing to oscillation between several lateral faces. In all such cases the interfacial angles cannot be determined, as they are lost in the rounding.

The striations on the lateral faces of foliated mineral are merely the edges of lamination. Examples: mica and gypsum.

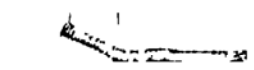
2. *Cavernous Crystals.* Crystals not unfrequently occur with a deep pyramidal depression occupying the place of each plane, as is often observed in common salt, galena (fig. 21) and sulphur. In the solution of crystals through atmospheric exposure, an approach to the same form is sometimes obtained, owing to the fact that the centres of the faces yield sooner than the edges and angles. Crystals of redruthite are often thus cavernous. Sometimes octahedrons occur with a triangular cavity, in place of each face (fig. 223). The same is met with in other forms.

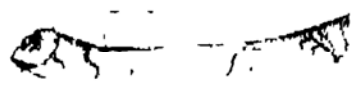
3. *Curved Surfaces.*—Curved surfaces sometimes result from the oscillatory combination already noticed. Others result from a curvature in the laminæ constituting the crystal. Crystals of diamond have convex faces, and are sometimes almost spherical. This mode of curvature, in which all the faces are equally convex, is less common than that in which a convex surface is opposite and parallel to a corresponding concave surface. Rhombohedrons of spathic iron and pearl spar are usually thus curved, as is shown in fig. 231. The saddle-shaped crystals of the same mineral (fig.

Fig. 231. Fig.

232) are remarkable instances of several reversed curvatures in the same face. A singular curvature is shown in fig. 233, of calcite. The conical crystals of brown zinc blende, and the lenticular and conical crystals of gypsum, are other examples. Crystals of quartz are sometimes curved and twisted. When this takes place in the left-handed and right-handed crystals, the twist is to the right or left according as the crystal is right or left handed.

The surfaces of crystals are frequently far from flat, on account of fracture, with dislocation of the several fragments, occasioned by motion in the enclosing rock, the material of which is forced, or may be transfused, into the rents. The tourmalines and beryls (fig. 234) which occur in granitic dykes are very subject to this, the fragments being often bent as well as displaced. A more or less momentaneous effort in the crystallization of two substances may produce a structure with the external form of one, the interior of which exhibits imbedded crystals of the other more or less perfect in their development. In pegmatite or graphic granite, rude crystals of feldspar contain skeleton forms of quartz, of which generally only one side of the prism and two of the pyramid occur, forming a roofed letterne. Similar hollow quartz forms occur imbedded in garnet, radiating from its centre (fig. 235), and touching the surface from protrusion, without distorting its form. Totally imbedded microscopic crystals, "microliths," are, as in the latter cases, chem-





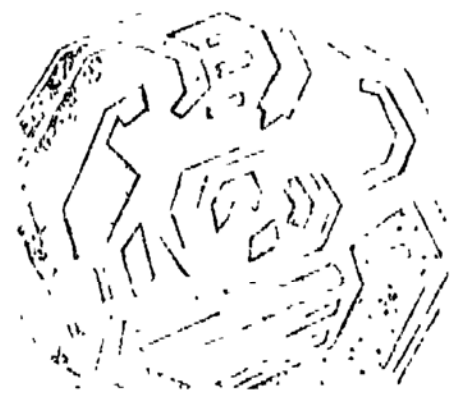


Fig. 234 1

cally non-assimilable. These are frequently arranged in layers in the including crystal, as in aventurine and leucite. When there is a certain amount of chemical resemblance there may occur definiteness in the arrangement, and if the enclosed substance crystallizes in a system different from that of the mineral which

includes it, the angles of the latter are more or less distorted. This is the case in "micropegmatite," where the intermixture of plagioclase feldspar causes one departure from the rectangularity of orthoclase. Foreign amorphous matter brought up on the faces as they grow to the surface of a crystal, decreases the power of that crystal to cohere, and forms a feeble cohesion. Even in the case of a good specimen of quartz there is an occasional shrivelled appearance on the crystal faces to which the foreign matter adheres, seeming to indicate that it has been to some extent under the influence of a polarity in attraction. Something of the same kind seems to have influenced the arrangement of the quartz grains caught up during the formation of the crystal of garnet shown in fig. 236. The perfect modelling of rock crystals is, however, but rarely interfered with by the almost countless substances which they contain.

Aggregation of Crystals

Crystalline aggregates, which pass into amorphous masses, may, in their more marked or perfect form, be referred to an imperfect twinning.

Crystals are often grouped in linear series, as in native copper and silver, and thus constitute lines, threads, or reticulations. In clustered crystals these adjoining each other are generally parallel in position, and are united by a plane parallel to one of the principal forms, or to planes of common occurrence. Senarmont mentions a union in galena

parallel to the octahedral faces, as common; and he also describes an instance where the union was parallel to the plane $3\breve{3}$.

The position of crystals on the supporting rock seem at first to be without [illegible] But by close inspection we detect even here the [illegible] harmony that governs the formation of the simple and compound crystal. The various relations assumed correspond to those of the more common kind of composition in twin crystals [illegible] of the irregularity produced in each on account of the unevenness of the surface on which it is set. In general, however, [illegible] with crystals a reflexion [illegible] with reflexions from the [illegible] showing that the crystals [illegible]

The [illegible] parallel to the positions of [illegible] crystals [illegible] In tourmaline, for example, [illegible] the more common position, that is, the [illegible] in the same direction, or nearly so. On the [illegible] in one direction more easily than in another, [illegible] direction is that of the perfect cleavage [illegible] the second less perfect cleavage of the [illegible] of the rock nearly at right angle to the [illegible] which third cleavage in the [illegible] the [illegible] to have [illegible] of gypsum to [illegible] to the third direction.

The [illegible] of crystals, more rarely [illegible] parallel position [illegible] different mineral [illegible] to the same [illegible] [illegible] to the [illegible] and [illegible] to those which [illegible] [illegible] Figure [illegible] of the [illegible] of anhydrite [illegible] [illegible] and [illegible] identically in the same [illegible] [illegible] of the latter [illegible] of the [illegible] of crystal [illegible] [illegible] are record of [illegible] [illegible] crystals of [illegible] and [illegible], of [illegible] and [illegible], or albite and orthoclase. [illegible] observed between crystals of rutile and specular iron, the crystals of rutile [illegible] the vertical axis to the direction of a lateral [illegible] of the [illegible].

A [illegible] connection with planes of [illegible] has been observed [illegible] covered with small crystals of quartz [illegible], with their pyramid-points [illegible] the [illegible] Where one mineral [illegible] another [illegible] of accretion will often [illegible] deposited in the same manner. [illegible] crystals of calcite which had been [illegible] by [illegible] crystals of arragonite, the [illegible] of the [illegible] [illegible] of the [illegible]

Irregularities of structure produced. Beside the regularities [illegible] crystals often [illegible] which [illegible] can be [illegible].

[illegible] [illegible] or spotted [illegible] [illegible] one after the other [illegible] [illegible] with [illegible] [illegible] [illegible]

econd in some varieties of specular iron, of the last in chalcedony, pal, and other species.

The above terms are indefinite, but of necessity, as there is very degree of fineness of structure in the mineral species, from erfectly impalpable, through all possible shades, to the coarsest granular. The term phanero-crystalline has been used for varieties n which the grains are distinct, and crypto-crystalline for those n which they are not discernible without the aid of a lens. Granular minerals, when easily crumbled in the fingers, are said to e friable.

The minute or crypto crystalline minerals form aggregates some what similar to the above. When globular or oolitic, the ndividual crystals often appear to radiate from a centre, or form concentric crusts. These are often globular or nodular, as in dolomite, and some what similar are the stalactites and stalagmites, or whatever mineral (especially rock-salt, calc spar, malachite, hematite, limonite) has been deposited from a fluid dropping down from some overhanging body, or some rent in the roof of a cavern. In this case there is generally found a long pendent cylinder or cone, the principal axis of which, generally hollow, is vertical, but the marginal parts are arranged at right angles to it, except where they curve round the termination of the tube, which is usually hemispherical.

By far the largest masses of the mineral kingdom have, however, been produced under conditions in which a free development of their form was excluded, and are termed amorphous. The rock masses, as with the greater portion of the minerals composing veins filling veins and dykes. The structure of these masses, on a small scale belongs to geology, but some varieties of the texture, even in hand specimens, may be noticed. The individuals of rock masses have seldom any regular form, but appear rounded or flattened, according to circumstances, and are frequently found interlocked in the process of formation. Even then, however, a certain regularity in the position of the parts is often observable, as in graphic granite, where the axes of the skeleton crystals of quartz are parallel. The rock is termed massive when the crystals of which it is composed are small, or granular when they are larger and more distinct. Sometimes the rock becomes slaty, breaking into thin plates; or concretionary, forming rounded masses, as if the result of the interposition of some foreign substance (water or vapour) which has rendered it porous, cellular, or vesicular, giving rise to drusy cavities. These cavities are often empty, but have occasionally been more or less filled by products of change in the rock. It is named amygdaloidal when the cavities are filled by a mineral in the form of an almond.

Changes of Crystalline Structure

"Pseudomorphs" are minerals which appear under a form of crystallization which does not belong to the species. They may be recognized either by their having no cleavage, which is most usual, or by their cleavage being altogether different in direction from that of the mineral imitated. Generally they have rounded angles, rough and dull surfaces, and when broken show a granular structure. The faces of the crystal, moreover, are often covered with minute crystals of a form different from that of the mineral imitated, but which is that belonging to the substance now present. Occasionally the resemblance to real crystals is so perfect, from the perfect polish of the faces, that they are distinguished with difficulty. They may be frequently found still undergoing change.

Pseudomorphs have been classed under four heads:

1. *Pseudomorphs by Alteration.* Formed by a gradual change of composition in a species. Of these there are two varieties: they may be pseudomorphous by loss of an ingredient or by addition of an ingredient; change of augite to steatite is an example of the first, and of galena into anglesite is one of the second.

2. *Pseudomorphs by Substitution.* Those formed by the replacement of a mineral which has been removed, or is gradually undergoing removal; *e.g.*, galena takes the form of pyromorphite.

3. *Pseudomorphs by Incrustation.* Those formed through the incrustation of a crystal, which may be subsequently dissolved away. Often the cavity is afterwards filled by infiltration, *e.g.*, change of fluor to quartz.

4. *Pseudomorphs by Paramorphism.* Those formed when a mineral passes from one dimorphous state to another; *e.g.*, change of aragonite to calcite.

These different kinds of change are not always distinguishable. In some cases a change may take place through alteration of the surface, and then, this process ceasing, the interior may be dissolved out, leaving a pseudomorph like one of incrustation; or a pseudomorph that appears to be a result of mere chemical alteration may be wholly due to substitution simply.

Again, changes of scapolite to a felspar and of augite to uralite (hornblende), have been considered by Scheerer examples of paramorphism,—scapolite being considered dimorphous with common felspar, and augite with hornblende. But, while such paramorphic changes undoubtedly take place with aragonite, their occurrence in these silicates—which are common associates in the same rock, and must have been formed under like circumstances—is hardly probable.

Where mineral bodies have taken the form of organisms, it is more a case of molecular replacement than of true pseudomorphism.

Paramorphism should be understood, however, to consist, not simply in alteration of crystal, but in every instance of change in mass of rock. Thus all serpentine, whether in mountain masses or in simple crystal, has been formed through a process of pseudomorphism or, in more general language, of metamorphism of some previous rock. The same is true of other massive rocks, as granular talcose and chlorite slates. The crystalline rocks often offer example of a change similar in nature. The graphite of these rocks is probably but a metamorph of some vegetable organism. Thus the subject of metamorphism, as it bears on all crystalline rocks, and that of pseudomorphism, are but branches of one system of phenomena, the geometry of both is the same, and a knowledge of each throws new light on the other.

The common change of peroxide of iron, from the loss of its water of the upper part of metallic lodes is produced by the [illegible] of the [illegible] of the process [illegible] protoxide [illegible] saturated after [illegible] trace of per[illegible] pyrites become [illegible] the same. Arseniates, vanadates, and arsenites of lead, &c., as well as carbonates and sulphates, are among the latter species, or those that occupy the upper part of metallic lodes, these are the result of alteration within those depths to which atmospheric agencies penetrate.

Pseudomorphs are always records of past existence, and in some cases they may be the only evidence we possess of such prior existence. Figs. 238, 239 are pseudomorphs of quartz or boracite after datholite, the measured angles of the crystal show that the imitated crystal was datholite, but that mineral does not now exist in any of either of these forms.

Fig. 238.

The process of pseudomorphism [illegible] of ores, lodes [illegible] a species of pseudomorphic [illegible] formation, and [illegible] a process [illegible] with the above remarks. External and internal [illegible] rather [illegible] mineral which [illegible] even the most [illegible] the different [illegible] fied mass [illegible] position [illegible] tinctness of the [illegible] Different from the original [illegible] portion [illegible] the [illegible] the [illegible] [illegible] been replaced [illegible] [illegible] towards the external [illegible] [illegible] [illegible] [illegible] pseudomorphic changes are also [illegible] [illegible] carbonates, bismuthite, and [illegible] often become very regular [illegible] detected account of the ligneous [illegible] perfectly observable [illegible] mineralized bodies, in which the [illegible] not their chemical nature [illegible] complete series may be often traced [illegible] through the variety of brown coal [illegible] opale

Causes and Character. The causes of [illegible] are the simple and most universal operation [illegible] process or general alteration to which [illegible] liable on account of the presence of [illegible] and carbonic [illegible] ment in the atmosphere, and the reactions [illegible] formed on adjacent ingredients [illegible] promoted by electrical currents or by heat, [illegible] the [illegible] of power of ordinary waters, cold or hot, or of [illegible] to reaction [illegible] in accordance with chemical principles [illegible] of the ingredients

di solved in these waters, or in mineral or sea waters, heated or at the ordinary temperature (4) the action of gases exhaling from the earth (5) change referable to volcanic action.

Ordinary water-formation acts well known, more or less of mineral matter. When water containing carbonic acid is passed through a finely-powdered or recently-ground minerals, it gives evidence of the presence of one or all of lime or magnesia; and some of the mineral even the softest even with the first drops. Perfectly pure water, free of them, will dissolve minute quantities of them, but more slowly. Rain-water, containing only about one-thousandth of its volume of carbonic acid, is capable of dissolving about one-fifth part per cent. of the whole mass. The lime, magnesia, and alkalies appear in the condition of carbonates, and the proportion from the state of carbonate to that of peroxide of iron is quite as great. The minerals of the most basic lime, and many of them readily yield to the action. Silica, however, is more readily than in carbonated water.

The above seems to two important points: (1) that ordinary water, free of acid, and filtering through the earth's crust are capable of dissolving and decomposing mineral and rock matter to a great extent, and (2) that the water thus impregnated with mineral matter is thereby fitted to act chemically upon, and alter, the water and thus transform them into other chemical forms. The water penetrates all rocks, as well as percolates through soil. Hence the action is universal, going on everywhere, and the result an universal deposit of lime, shell, coral, and animal remains, generally as a source of carbonate of lime, phosphate, and fluorides, and plant ashes contribute also potash and soda, and sometimes silica.

Carbonic acid is a constituent of the atmosphere, and is dissolved by the rain as they descend, hence the active decomposing agent present in all ordinary water, but it is also a result of different mineral changes. Sulphuric acid, along with vegetable matter, owes its origin to the decay of the vegetable matter, and the product carbonic acid and peroxide of iron. The quantity of iron and how it stands as to the proportion taken up in sulphuret of iron and that produce carbonic acid and peroxide of alphuret of iron. But it is obvious that the carbonic acid which has thus been eliminated must have been sufficient in quantity to make an atmosphere of carbonic acid equal in height to our present atmosphere. Again, decomposition of alphuret of iron, replacement of hydrogen, this by the combining action of the atmosphere forms sulphuric acid, and the sulphuric acid in its progress to the sea produces gypsum, and liberates carbonic acid. Sulphuric acid is also generated in the neighbourhood of volcanoes, and readily becomes sulphuric acid with the minerals. Moreover, thermal water, if aided by heat, will decompose lime-stone and liberate carbonic acid. Hence it is that there are extremely complex results from mineral parts mixed at different temperatures.

The dissolving and decomposing action of ordinary water is therefore general. The results also partake of the character of the rock in virtue of the composition of which it forms a part, and in accordance with the changes to which the rock is subject. Such changes and the various products to which they give rise have to be regarded as a type and criterion of what has occurred in former portions, periods, either of decay or of reformation from which have resulted wide-spread rock masses, and which have at one period time altered the surface-features of the earth. But the rich fields of palæontology, and of the processes which have gone to form these rock materials, are to become the sources from which to the student's department of geology can have a true conception, and be more living instead of a merely descriptive science.

Physical Properties of Minerals.

Characters Dependent on Light

There are few more interesting departments of science than the relations of mineral bodies to light, and the modification which it undergoes either when passing through them or when reflected from their surface. In this place, however, we only consider these phenomena so far as they present distinctive characters in the mineralogical examination of minerals, or furnish characters by which to distinguish one species from another.

Lustre. These characters admit of no precise or mathematical determination, they are of considerable value in mineralogy. One of the most important distinctions founded on them is that between minerals of metallic and non-metallic aspect or character. Transparency and opacity nearly coincide with this division, the metallic minerals being almost constantly opaque, the non-metallic more or less transparent. Minerals which are perfectly opaque, and show the peculiar brilliancy and opacity of surface of polished metals, are named metallic; those which possess these properties in an inferior degree are semi-metallic; and those without these properties are non-metallic.

Lustre has reference to either the intensity or the quality of the reflected light, considered as distinct from colour. Several degrees in intensity have been named: (1) splendent, when a mineral reflects light so perfectly as to be visible at a great distance, and lively and well-defined images are formed in its faces, as galena, specular iron, or calcite; (2) shining, when the reflected light is well, and only forms indistinct and cloudy images, as heavy spar or calcite; (3) glistening, when the reflected light is so feeble as not to be observable at a greater distance than an inch, length, and no longer forms an image, as talc; (4) glimmering, when the mineral held near the eye in full clear daylight presents only a number of such luminous points, as red hæmatite and granular limestone. When as in chalk or kaolin, the lustre is so feeble as to be indiscernible, the mineral is said to be dull.

In regard to the first or quality of the lustre, the following varieties are distinguished: (1) the metallic, seen in much perfection in native metals and their compounds with sulphur, and imperfectly on fine coal; (2) adamantine, found in beautiful perfection in the diamond, and in some varieties of blende and cerussite; the semi-adamantine metallic adamantine, as seen in wolfram and black jack; (3) vitreous or glassy, seen in rock crystal, or common calcite; the semi-vitreous to adamantine, in flint glass; sub-vitreous, seen in boracite, chabazite, &c.; (4) resinous, when the body appears as if covered with oil, as in amber, blende, and garnet; (5) waxy, as in wax opal and ozocerite; (6) pearly, like mother-of-pearl, seen in cyclite, talc, heulandite; (7) silky, the glimmering lustre seen on fine fibrous aggregates, like amianthus, fibrous gypsum, chrysotile, and fibrolite.

The surfaces and kinds of lustre are generally exhibited differently by multiple faces of the same crystal, but always similarly by like faces. The lateral faces of a right square prism may thus differ in lustre from that of a terminal face. Thus the lustre of the lateral face of apophyllite is vitreous, while that of the terminal, at right angles thereto, is pearly: chrysotile is silky when split along the fibres, dull when at right angles to them.

The surface of a cleavage plane, in foliated minerals, generally differs in lustre from the sides, and here again in some cases the latter are vitreous, while the former is pearly, as in heulandite.

As shown by Haidinger, only the vitreous, adamantine, and metallic lustres belong to faces perfectly smooth and pure. In the first, the index of refraction of the mineral is 1·3 to 1·8; in the second, 1·9 to 2·5; in the third, above 2·5. The pearly lustre is a result of reflexion from numberless lamellæ, or cleavage planes, within a clear-lustred mineral, and in hydrated minerals, as in the zeolites, it is the result of incipient change,—namely, a loss of water before exposure to the atmosphere.

Colour. This is a property which is of very inferior value. Minerals are so seldom, if ever, absolutely pure that very minute quantities of an intensely coloured impurity may impart colour to a substance inherently colourless, or overpower a feebler colour which may be its own. **Colour.**

Some few minerals have colour so strong or have a constitution so little susceptible of intermixture, that they retain almost unimpaired the colour special to them. Such a substance is pyrite: its brass-yellow colour may be heightened to gold-yellow by intermixture with copper sulphuret, or it may be slightly bleached by arsenic; but the nature of its composition does not admit of the infusion of ordinary colouring matters. The yellow of native gold, again, may be paled by impoverishment with the white of silver, down to the dull tint of electrum; but no foreign colouring matter can intrude itself into its crystals. Such substances as these, native metals, sulphurets, &c., have colours essential to them, dependent on their constitution, and to a great extent characteristic of the species.

A great number of minerals are colourless of themselves, and thus very liable to the influence of minute quantities of foreign tinctorial impurity. These are absolutely transparent and devoid of colour when in crystals, but white and opaque when reduced to powder, as ice and snow, calcite and chalk, rock crystal and sand. But such substances are generally coloured; "muddied" it would be called in the first case, though it is equally so with the others. Such false colour may be imparted in several ways. It may be (1) from their holding dissolved some colouring matter; (2) from mechanical mixture of colouring substances such as metallic oxides, or minute crystals ("endomorphs") of another mineral; or

3) from chemical replacement,—the substitution of a smaller or rger quantity of a coloured isomorphous ingredient.

As illustration of the first, silica, colourless in rock-crystal, has een found of almost every tint, due frequently to volatile hydrocar- ons which are dissipated by heat. Fluorite also, found of almost very shade of every colour, may possibly be to a certain extent eferred here.

Quartz, felspar, and calcite are often coloured accidentally by mbedded layers of foreign "inclusions," or by "pseudomorphous" These are mechanically mixed, so far as revealed, then resence in a structure of different and non-miscible chemical omposition but crystallographically arranged. The colour may ne lines of interrupted or intermittent growth, or, in the case of udomorphs, the axial positions of the minute structure of the crystals lie in one plane, or in the same set of planes.

As an instance of colours introduced through chemical eplacement, calcite may be cited. Carbonate of lime is sometimes a portion of this be replaced by carbonate of magnesia, and a rtain amount of pearly opacity, if by carbonate of manganese d a pink tinge; if by carbonate of iron, of yellow, varying ncreased through oxygen absorption and "weathering" to brown nt, and ultimately to a dark brown.

Sulphuret of zinc, chemically white, and hence the palest trans- arent may, through metallic substitution, be found almost all nts of yellow, orange, brown, and black. Again, hornblende, ugite, and garnet, silicates, which in their purest state of transpa- te, tremolite, and water garnet are colourless, may assume green, rown, red, and black tints from the accumulation of other metallic bstances.

Hence it would appear that a very advanced practical knowledge of the subject is necessary to enable us to record ourselves the information which is to be derived from this external nature.

The accidentally coloured minerals sometimes present two or ore colours or tints, even in a single crystal. Very remarkable xamples occurring in fluor spar, apatite, sapphire, smoky quartz, tourmaline, and cyanite. The most still more common are compound inerals, on which the colours are variously arranged in points, ngles, clouds, veins, stripes, bands, or in broader and ramifying ms. Some minerals again change their colour from exposure to ght, the air, or damp. Then either the surface alone is affected "tarnished," and appears covered as with a thin film producing some minerals, as silver and arsenic, only one colour, in hers, as chalcopyrite, hæmatite, bismuth, stibine and anthracite, arious or iridescent hues, when they are said to have a ravonine lustre. Or occasionally the change pervades the whole ineral, the colour either becoming paler or disappearing, as in ysoprase and rose-quartz, or becoming darker, as in brown ar, siderite, and rhodonite. In a few minerals complete change f colour takes place, as in heterosite and in the chlorophæite of n Western Isles of Scotland, which, on exposure for a few hours, sses from a transparent yellow green to black. These alterations generally connected with some chemical or physical change, he tarnished colours sometimes only appear on certain faces of a rystal belonging to a peculiar form. Thus a crystal of copper yrites (like fig. 89) has one face P free from tarnish, the faces d e, close to P, dark blue; the remainder of the first violet, and hen, close to P, gold-yellow.

Some crystalline minerals exhibit in certain directions a very vely play or change of colours from reflected light. Thus we have en many various hues on the cleavage planes of labradorite, and eems produced by a multitude of very thin quadrangular pores, terposed in the mineral, like minute parallel lamina. On the eavage planes of hypersthene it appears copper-red, and is easoned by similar pores, or by numerous small brown or black amine of some foreign substance interposed in a parallel position etween the planes of the hypersthene. The chatoyant or changeable olours of the sun-stone arise from scales of hæmatite, and partly ater- osed, and that of avanturine from scales of mica. The play of olour in the noble opal seems to be produced very nearly in the same anner as that in the labradorite. A similar opalescence is seen certain minerals when cut in particular forms. In the sapphire, it hemispherically over the chief axis, it appears like a star with x rays, in garnet it shows four rays, in certain varieties of chryso- eryl and of adularia it has a blue hue, and it is also very remarkable in the cat's-eye variety of quartz. Iridescence often arises from ery fine fissures, producing semicircular arches of prismatic tints, hich, like the colours of thin plates in general are referred to the nterference of light.

Streak. This name is applied to the appearance and he colour of the line or furrow produced in minerals by *rowing the edge of a hard tempered knife or file along* heir surface, or to the stain obtained by rubbing a soft nineral on such a substance as paper or porcelain. Taken long with the hardness, which may to a certain extent be determined by the same operation, it is one of the most valuable tests which we possess.

The furrow may be lustrous or it may be dull. Powder or splinters may lie along its course, or a still adherent ridge may have been merely rolled over. The furrow and the powder may each be possessed of colour, though such may not be distinguishable in the mineral, or may have a colour quite different from that of the mineral. Three illustrations of the metallic lustre of the test may suffice. Argentiferous gold, chalcopyrite, and pyrite, differing immensely in value, may readily be mistaken for each other. The knife, when drawn along the surface of the first, finds much to cut upon adhering ridge, and leaves a bright streak of the same colour as the specimen. When drawn along the crystallized surface it cuts through covered with cohesive powder which when rubbed on paper or the hand is greenish-yellow. When drawn along the third it has no effect, as pyrite is harder than the knife. Pitchblende, hæmatite, and limonite all occur in black, obscure, tuberose forms, and have all been termed "black hematite." There exists also a great difference in the value. The knife makes little impression on pitchblende but leaves a blue bituminous line, it makes a blood-red line on hæmatite, and a rich ochre-yellow on limonite. Graphite and molybdenite both very tallic in their crystalline plates, both occur in the same scales, both have a grey-blue colour and a brilliant metallic lustre, both turn the hand or paper, the streak of the first best on rough paper is black tending to blue, that of the latter green-ish. Rough porcelain is the best material for determining the streak of soft minerals.

Diaphaneity. Minerals, and even different specimens of the same species, vary much in this quality. Some transmit so much light that small objects can be clearly seen, or letters read, when placed behind them, such are named trans-parent. They are semi-trans-parent when the object is seen only dimly, as through a cloud, and trans-lucent when the light that passes through is so broken that the form of the object can be no longer discerned, some minerals are only thus translucent on the thinnest edges. Others transmit no light, and are named opaque.

Refraction. It has already been mentioned that most crystals—all, in fact, except those of the cubical system—exhibit the phenomena of double refraction. For a general explanation of these phenomena the reader is referred to Light, vol. xv. p. 609 *sq.*

The direction in which there is no double refraction is named the optic axis of the crystal, sometimes (happily the axis of double refraction. Now in certain minerals it is found that there is only one direction with this property, whereas in others there are two such directions, and they have in consequence been divided into uniaxal and biaxal. To the former belong all crystals of the tetragonal and hexagonal systems, to the latter all those of the other three systems. In the former the optic axis coincides with or is parallel to the crystallographic axis. In one uniaxal crystals the index of refraction for the extraordinary ray is greater than for the ordinary ray, and in others it is smaller. According as it is greater or less they are said to have positive (attractive) or negative (repulsive) double refraction.

Quartz is an example of the former, the index of refraction, according to Main-hem for O being 1.5471, for E 1.5582; calc-spar of the latter, the index of O being 1.6543, that of E 1.4833. The index of E is in both cases tabulated at the incandescence.

It should be observed that the optic axes are not single lines, but directions parallel to a line, perhaps through every part of the crystal. It is also important to remark that this property divides crystals into three great groups—the cubic, with single refraction, the tetragonal and hexagonal, with double refraction, and uniaxal, those of the other three systems, also double, but biaxal. These properties are therefore of the greatest use in determining the system to which a mineral belongs.

Polarization. Intimately connected with the property of that of the polarization of light, which affords an easier means of determining mineralogical characters than the direct study of double refraction. For the elements of this subject see Light, vol. xv. p. 611 *sq.*

While a consideration of the optic axes enabled us merely to arrange the systems of crystallization in three groups, the phenomena of polarization not only bear out a further subdivision of the whole into the above six systems, but disclose, in many cases, phenomena marked, special to individual species. The optical consideration of these phenomena enables us to fix three directions at

ght angles to one another called the axes of optical asticity such that the effect of the crystal on the minous vibrations the elastic ether is a maximum in ne of these directions, a minimum in a second, and a aximum in the third. The length of these axes is the measure of the action. In certain cases the directions of the axes of optical elasticity is different o light of the different colours.

the principal sections corresponding to the crystallographic axes, n length, enabling us to class all crystals as

of the cubic system. Here the three axes of equal. The most simple of the rhombohedral system, in which the three axes are equal to one another; the ed by two equal axes perpendicular to the crystallographic axis, the third axis coinciding with the axis.

of the next principal system. The direction of the of optical elasticity coincide with the crystallographic , taken parallel to the diagonals of the base of the rhombo lso parallel to the vertical axes of the primitive prism parallel pair of faces.

Crystals of the oblique prismatic system. Only one of the of optical elasticity coincides with the crystallographic horizontal axes or the inclined horizontal axes of the mmon base, the direction of the two other not having any ndent relation, *a priori*, with the inclined or diagonal inclined s of the base, and with the vertical axis or vertical edges of primitive right prism.

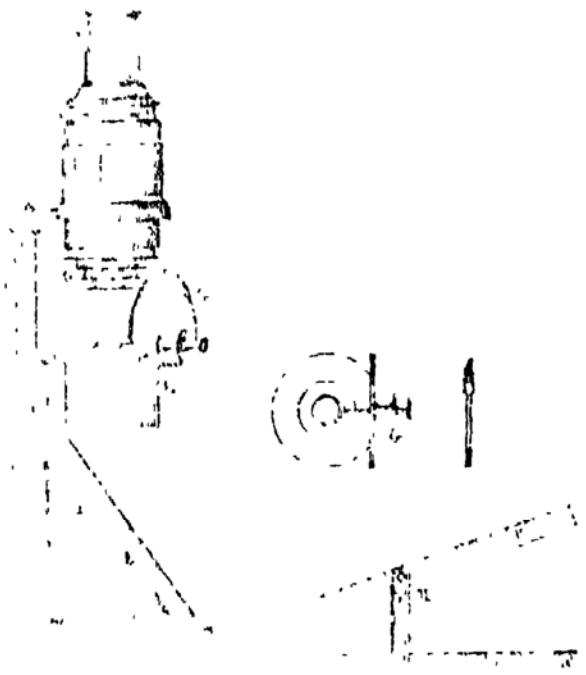
Crystals of the triclinic system. The three axes of optical city have no relation that can be referred *a priori* to the stallographic axes, whatever position may be assigned to these relation to the primitive edges.

In crystals belonging to the last three systems the three axes of city are unequal.

The axes of elasticity are in general such that a crystallographic crystal in the direction of any one of them is divided to two, which follow that direction with different velocities pending on the lengths of the other two axes. For any other tion there will be several also corresponding to different locities; but their rates will now depend in a more complex anner on all three axes. In two directions, and only in two, axes are all unequal, the retardation becomes unity, or the rays not vided. These directions are the optic

The displacement of the axes of elasticity for light of different ours—already mentioned—takes place to two different degrees in crystals of the monometric system and for all directions in the dimetric, hombohedral, oblique, and triclinic systems. In the other systems it does not

It is easier to follow the distinctive features of the different systems until we proceed to consider the other phenomena which they display, when examined in a beam of polarized light. Various instruments have been devised for the purpose, and of the



Apparatus of Dr Brewster

heading also we must refer for the phenomena of circular polarization.

Double Refraction and Polarization of Composite Crystals. In Optic all the crystallized bodies whose action upon light we have been proper considering, the phenomena are identical in all parallel directions, ties of the smallest fragment having the same property as the largest, compos from whatever part of the crystal it is taken. In the mineral crystal world, however, and among the products of artificial crystallization, there occur crystals which are composed of several individual crystals whose axes are not parallel. These crystals sometimes present regular symmetrical forms that mineralogists have long regarded as simple forms, and it is probable that they were so viewed if they had not been subjected to the scrutiny of polarized

Fig. 241.

A remarkable case has been observed in the crystals of Brazilian topaz, and apophyllite of potash, which appeared to be a simple crystal, were found to be tessellated, consisting of crystals of potash combined in their principal axes parallel. When

Fig. 242.

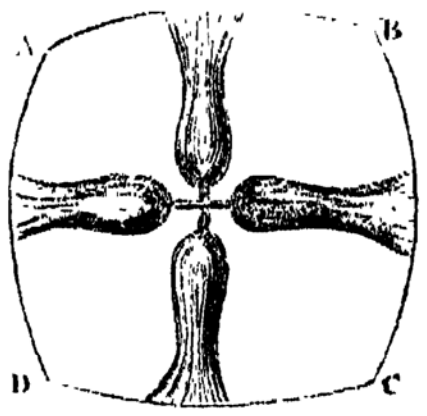


Fig. 243.

a system of biaxal crystals, at a distance from the eye, instead of the elliptical appearance shown in fig. 241, each is rectangular, having the same tint.

A crystal of this class of minerals is the tessellated examination of this body by polarized light is For the results the reader is referred to his paper *Transactions*, vol. ix. p. 328.

are representations of the figure produced in an internal slice of the barrel or cylindrical

apophyllite from Kudlisaet, in Disco Island. The figures are from different specimens. The shaded part of them has only one axis of double refraction while the four sectors have two axes. The mechanical structure of the clear plates to double the optical figure even after the plates are

minerals sulphate beulan nacrite, and many others, ularly complex in struc

Iron with Planes of Double Meteoric iron, a mineral among the cubical crys is found by Brewster to be on its action upon light, and to act

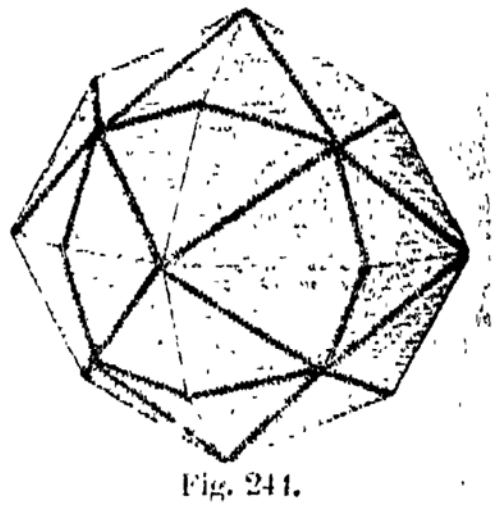


Fig. 244.

perties, or state to which the double refraction, structure was related in the same manner as it is in one or two of the other minerals. It crystallizes most commonly in the form of the icositetrahedron. If we suppose a complete crystal of it to be exposed to polarized light, it will give the figure shown in fig. 211, where the dark shaded lines represent those in which there is neither double refraction nor polarization, the rays refracted and the tints commencing at the planes of cleavage having their maximum in the centre of the space enclosed by three of the dark lines. When light is transmitted through any pair of the four planes which are adjacent to any of the three axes of the crystal it is doubly refracted, the least refracted image being the extraordinary one, and consequently the double refraction negative in relation to the axes to which the doubly refracted ray is perpendicular. If we suppose the crystal to have the form of a

Fig. 245.

cube, the planes of double refraction will be, as in fig. 215, a plane passing through the two diagonals of each face of the cube.

The tints vary as the square of the distance from the nearest plane of double refraction.

Pleochroism.—Closely connected with double refraction is that property of transparent minerals named pleochroism (of many colours), in consequence of which they exhibit distinct colours when viewed by transmitted light in different directions. Crystals of the cubic system do not show this property, whilst in those of the other systems it appears in more or less perfection, in tetragonal and hexagonal minerals as dichroism (two colours), in rhombic and clinic systems as trichroism (three colours). In most cases these changes of colour are not very decided, and appear rather as different tints or shades than as distinct colours. The most remarkable of dichromatic minerals are the magnesian mica from Vesuvius, the tourmaline, and ripidolite; of trichromatic, iolite and andalusite from Brazil, diaspore from Schemnitz, and [illegible] nite.

In a specimen of yellow Iceland spar [illegible] of an orange-yellow colour, while the ordinary image is yellowish white. Along the axis of double refraction the colours of the two pencils is exactly the same, and the difference [illegible] with the inclination of the refracted ray to the axis. [illegible] the invariable law of the pleochroism produced [illegible]. Sir John Herschel found several [illegible] to have a brownish colour along the axis, and it might [illegible] to be yellow green. There can be little doubt that this property [illegible] found in every crystal of sufficient refraction. Even in the crystals [illegible], a slight inequality in the intensity of the two images may be observed; and when it is distinctly coloured the difference of intensity is very easily seen, even when the two colours are not of a different kind.

The phenomena of dichroism are best seen in [illegible] with two axes of double refraction, and are well exhibited [illegible] mineral which crystallizes in six- or twelve-sided prisms are of a deep blue colour when [illegible] to the axis, and a yellowish brown colour when viewed [illegible] to it.

If *abcd* (fig. 246) be a section of the prism [illegible] parallel to the axis of the prism, the transmitted light will be blue through the faces *ab* and *dc*, and yellowish brown through *ad*, *bc*, and in every direction perpendicular to the axis of the prism. If we grind down the angles *a*, *c*, *b*, *d*, so as to replace them with faces *mn*, *m'n'* and *op*, *o'p'*, inclined 31° 41′ to *e* or to the axis of the prism, then, if the plane *abcd* passes through the optic axes, we [illegible] observe, by transmitting polarized light through the crystal in the directions *ae*, *bd*, and [illegible] quently analysing it, a system of rings round each of these axes. The system will exhibit the individual rings very plainly if the crystal is thin; but if it is thick, we shall observe, when the plane *abcd* is perpendicular to the plane of primitive polarization, some branches of blue and white light diverging in the form of a cross from the centre of the system of rings, or the poles of no polarization, as shown at *p* and *p'* (fig. 247), where the shaded branches represent the blue ones. The summits of the blue masses are tipped with purple, and are separated by whitish light in some specimens and yellowish light in others. The white light becomes more blue from *p* and *p'* to *a*, where it is quite blue, and more yellow from *p* and *p'* to *c* and *d*, where it is completely yellow. When the plane *abcd* is in the plane of primitive polarization the poles are marked by spots of white light but everywhere else the light is a deep blue.

Fig. 247.

In the plane *cadb* (fig. 247) the mineral, when we look through it by common light, exhibits no other colour but yellow, mixed with a small quantity of blue, polarized in an opposite plane. The ordinary image at *c* and *d* is yellowish brown, and the extraordinary image faint blue, the former receiving some blue rays and the latter some yellow ones from *c* and *d* to *a* and *b*, where the difference of colour is still well-marked. The yellow image becomes tainted from *a* and *b* to *p* and *p'*, till it changes into blue, and the faint blue image is strengthened by other blue rays, till the intensity of the two blue images is nearly equal. As the incident ray advances from *a* and *b* to *p* and *p'*, the faint blue image becomes more intense, and the yellow one, receiving an accession of blue rays, becomes of a bluish white colour. The ordinary image is whitish from *p* and *p'* to *a* and the extraordinary is deep blue, but the whiteness gradually diminishes towards *a*, when they are both almost equally blue.

The principal axis of double refraction in rubies is negative. The [illegible] purple tinge and the least refracted one [illegible]

[illegible] used to the determination of [illegible] crystallizing in the [illegible] with the exception [illegible]

[illegible] corundum, including ruby and sapphire, tourmaline, beryl, absorbing a greater degree of ordinary ray [illegible] beryl, apatite, and some nephylites, while [illegible] as prism, red quartz, sulphate of lime, nephylite, absorb in a greater degree the extraordinary [illegible] but found also that certain crystals [illegible] transmit [illegible] without [illegible]

[illegible] colour of [illegible] limit, and [illegible] Hardness does [illegible] relation of [illegible] embodiment of [illegible]

[illegible] transmit [illegible] lowest [illegible] [illegible] 28, [illegible] [illegible] shade by two [illegible]

[illegible] to red with [illegible] metallic [illegible], which [illegible] [illegible] and respond [illegible] holes about the fifteenth of an [illegible] width at the other. The lens [illegible] a focal distance which [illegible] object holes about half an inch from the square hole.

On looking through the lens and presenting [illegible] of the square hole at [illegible] on put together [illegible] at [illegible] on the other, [illegible] image polarized in the plane which [illegible] of the prism, that of the other in [illegible] plane of the longer diagonal. When a plate [illegible] [illegible] focal distance and examined by [illegible] [illegible], then, on the turning of the instrument [illegible], the polarizing [illegible] plane coincidence with those of the eye [illegible] the two images opening will [illegible] colour of the [illegible] which the light [illegible] by the crystal [illegible] complementary [illegible]. The [illegible] through the crystal [illegible] two colours [illegible] more obvious.

Phosphorescence.—The [illegible] [illegible] partial [illegible] material [illegible] without combustion or [illegible]

no mineral pho-phoresces readily when the discharge passes through it; it generally phosphoresces with a different colour after it has been thus excited.

Fluorescence is the property whereby rays of light of a refrangibility higher than those ordinarily seen by the human eye are rendered visible. The substance when placed in the violet end of the spectrum, and carried beyond it into the dark, is seen to become luminous through the agency of the rays of extreme refrangibility. This property is well marked in the variety of fluorite which is pale [illegible] when transmitted light, and deep purple by reflected light. Uranite and some petroleums also exhibit the property.

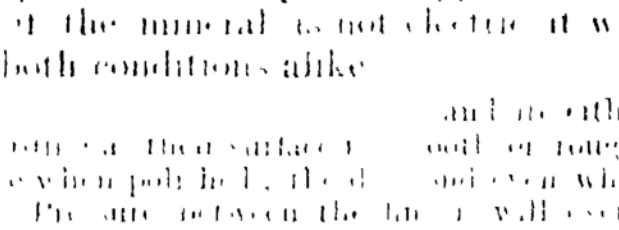
Electric, Magnetic, and Thermic Properties.

Electricity. Friction, pressure, and heat may all excite electricity in mineral. To observe the property delicately the specimen is required, formed of a light needle terminating at both ends in small balls, and suspended horizontally on a fine pivot by an agate cup. Such an instrument, if the mineral be electrified negatively by touching it with a stick of sealing-wax excited by rubbing, or positively by merely bringing the wax so near as to attract the needle. When the instrument is in this state, the mineral, if also rendered electric by heat or friction, will attract or repel the needle according as it has acquired electricity of an opposite or of a similar kind. But if the mineral is not electric, it will attract the needle in both conditions alike.

Most [illegible] and to either [illegible] negative according to their surfaces [illegible] cool or rough. [illegible] one point when polished, the [illegible] and even when [illegible] positive. The [illegible] between the [illegible] will excite [illegible] positive electricity in pieces of [illegible] from parent-stone [illegible] by [illegible]. Fluor, arragonite, fluor-spar, carbonate of lead, quartz, and other minerals show this property, but in a more feeble degree; some [illegible] remain excited much longer than others, [illegible] for a very long time. Heat or change [illegible] to many crystals, [illegible] so much that [illegible] crystal [illegible] fluor per diamond, [illegible] [illegible] [illegible] electricity of the two electric [illegible] opposite parts of a crystal which are named electric poles. Each pole alternately positive and negative, the one when the mineral is being [illegible] the other when it is cooling. Under [illegible] treatment of this kind [illegible] peculiarly noteworthy.

A [illegible] of [illegible] this polar-electric mineral [illegible] named [illegible] for the [illegible] crystal form. Tourmaline, calamine, and [illegible] acquire [illegible] the [illegible] thus [illegible]. Its polarities [illegible] when the temperature is [illegible], and [illegible] exhibited when it [illegible] to decline, and when the heat is [illegible] they [illegible].

Rose and Rath name one of the poles the analogous electric pole, and the other the antilogous electric pole. The former becomes positive while the crystal is heating, and negative while cooling, the latter negative while heating, and positive while cooling. Tourmaline at 30° C. electrical polarity not [illegible] to 100°, as long as the [illegible] to rise; if the temperature remained



stationary an instant, the polarity disappears [illegible] shortly manifested itself [illegible], when the temperature [illegible] to decline [illegible] but one end of the crystal was heated the crystal was unpolarized, but when two ends were unequally heated each acquired an electrical state independent of the other. In tourmaline the extremities of the prism are dissimilarly modified, and that end which presents the greater number of planes is the antilogous pole, or, if the number of planes is the same, the secondary rhombohedrons of the antilogous pole have (one or more of them) longer vertical axes than those of the analogous pole. Fig. 249 (tourmaline) is the antilogous pole (negative under increasing heat), and fig. 250 the analogous pole. The pyramid of the analogous end is more flattened by its facets than that of the antilogous end; thus e^3 and d^3 of the antilogous end are more acuminating than e^1 and d^1 of the analogous end. The same is the case with the other two crystals (figs. 251, 252).

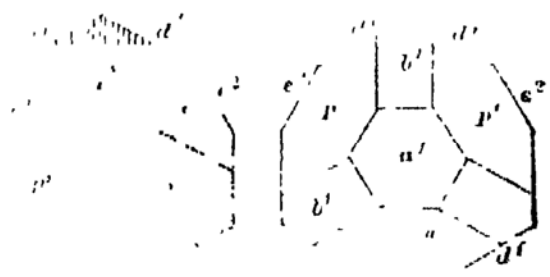


Fig. 251.

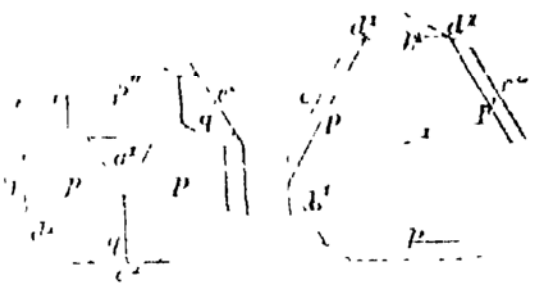


Fig. 252.

Pyro-electricity has been observed in the following substances: tourmaline, topaz, arsenic, boracite, scolezite, prehnite, electric calamine, sphene, chrysoberyl, heavy spar, and crystallized [illegible].

Pyro-electricity is of two kinds, either [illegible] polar or centrally polar. In the former the extremities are opposite poles. In the latter two sets of a prism are of the same name, and the opposite pole to each is intermediate between the two.

The examples of the first kind are tourmaline, calamine, and scolezite, which are uniaxal, axinite, binaxal; boracite and rhodizite, with four axes. Calamine, like tourmaline, has the sharper extremity the antilogous end, and the more flattened the analogous. Compound crystals from Altenberg have both ends analogous, and the portion which lies between the twin antilogous electric, the pyro-electric axis corresponds with the vertical axis of the prism, as in tourmaline. Boracite, which crystallizes in cubic forms, with the opposite angles differently modified, has pyro-electric axes corresponding to the four octahedral axes. In figs. [illegible] this species, the plane which has its angles modified by e^1 is the antilogous pole, and that with the

Fig. 253.

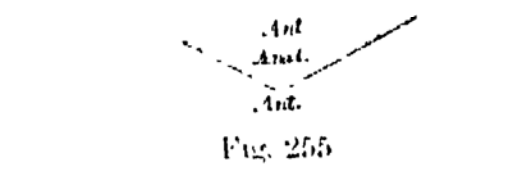


Fig. 255

[illegible] connected at [illegible] the analogous pole; and, generally, the antilogous pole has either one numerous or larger facets. Rhodizite resembles boracite in its pyro-electricity.

The [illegible] in which pyro-electricity of the second kind has been observed are prehnite and topaz. If fig. 251 represent a tabular crystal of prehnite, the poles will be situated as marked, the analogous being central, and the antilogous at either extremity of the shorter diagonal of the rhombic prism. Topaz has in a similar manner a central analogous pole, and an antilogous at either extremity of the shorter diagonal. In some instances there is a separate set of similar poles near one or the other angle, as in fig. 255; this must be due to the crystals being of a composite nature.

Magnetism. This property is very characteristic of the few minerals in which it occurs,—chiefly ores of iron or nickel. Some magnetic iron ores possess polar magnetism, or are natural magnets; while the common varieties of magnetite, meteoric iron, magnetic pyrites, precious garnet, and other minerals, are simply magnetic. Most minerals are only attracted by the magnet, but do not themselves attract iron.

Minerals, as other substances, have also been divided into magnetic and diamagnetic. See MAGNETISM.

The ordinary mode of testing whether a mineral is magnetic or not is to bring it near a pole of a delicately suspended magnetic

edle, and observe whether it causes it to vibrat . Another mode to apply a strong magnet to the mineral in powder. Th are sufficient for the mineralogist. Delesse has experimented extensively upon the magnetic force of minerals, and has determined the relative amount for numerous species. Calling the force for tyrian steel 100, the following are some of his results:

Native platinum	
Magnetic iron ore	
Franklinite from the United States	
Chromic iron	
Spinel (pleonaste), from Monzoni Tyrol	
Titanic iron (sometimes not attracted)	
Specular iron, sometimes not attracted	
Graphite	
Specular iron (oligist), the brighter	
Hæmatites	
Vivianite	
Columbite of Bodenmais and Haddam	
Ilvaite	
Chrysolite (quartz, dolerite, basalt, lava)	
	(varies feebly in	
Labradorite	an antique green	
Hornblende		

Crystallomagnetic Action. The [illegible] ar alluded to belongs to the [illegible] ry-talline form. There is also a kind of p elated to the crystalline or optic axes [illegible] ry ful of cyanite, suspended between [illegible] orth, by the magnetic power of [illegible] rne compass needle, from which [illegible] e obtained; and the line of direction [illegible] optic axes. Other crystals which [illegible] take a transverse or equatorial position. Th [illegible] diamagnetic crystals.

Conducting for Heat. Senarmont found [illegible] ducting power of colours and of crystals [illegible] ystem is equal in all direction, but that [illegible] different directions in crystals belonging to all the other systems, exhibiting character analogous to [illegible] from their double refraction, conformable with the [illegible] axes of the crystal, and referable, as in the latter case, to axes of elasticity, or unequal compression of the molecules.

The fundamental fact is easily shown by taking [illegible] of rock crystal, one cut transverse to the axis and [illegible] Through the centre of each plate a small hole is drilled for the reception of a platinum wire, which by insertion into the hole [illegible] the plate. The other end of the wire to be heated, and the rate of the conduction of the heat rendered visible by the amount of a flow coating of beeswax, with which the plate has been previously coated, which is melted round the central hole. It will be seen that in the transverse slice the wax is melted in a circular form, while in the longitudinal slice the form is elliptical (fig. 256). The conduction is equal in all directions as regards the transverse axes of the hexagonal prism, but more rapid in one direction in the longitudinal slice, and that direction is the line of its optic axis. In the case of quartz the two diameters of the ellipse are as 1000 to 1312.

Fig. 256.

If the regular disposition of the molecules of amorphous bodies be interfered with by unequal tension or compression, the regularity of their power of conducting heat is destroyed, and they also show elliptical forms of melted wax, and the shorter axis of the ellipse is in the line of pressure or undue packing of the molecules. The heat thus does not travel so fast in this direction, partly because it is spent in the heating up of the greater number of molecules. Hence we might conclude that along the main axis of quartz a smaller number of molecules are packed in an equal space than along the transverse. The following are the more important of Senarmont's results:

1. Crystals of the tetragonal and rhombohedral systems have one axis of conductivity which is either greater or smaller than the others, and this axis coincides with the main crystallographic axis. The isothermal surfaces are ellipses which lie in the line of this axis, and these ellipses may be either elongated or flattened in the direction of this line.

2. In crystals of the right prismatic system the isothermal surfaces have three unequal axes, which coincide with crystallographic axes drawn parallel to the edges of the rectangular prism.

3. In crystals of the oblique rhombic system the isothermal surface have three unequal axes, one of which coincides, with [illegible] horizontal diagonal of the base, while the other two have directions which are not referable to any law.

4. In crystals of the anorthic system the isothermal surfaces have three unequal axes, all with indeterminate [illegible] relation.

In crystals of a single axis there appears to exist no constant relation between the axes of optic elasticity, whether maximum, minimum, and the axis of the greatest or of the least calorific conductability. Thus, of the minerals examined by Senarmont, quartz, [illegible], chabasite, [illegible], and calcite have all their greatest axes of calorific conductability parallel to the optic axis, whereas, beryl, tourmaline, and corundum, optically negative, have on the contrary their smallest axes of calorific conductability parallel to the optic axis.

In crystals belonging to the oblique rhombic system [illegible] coincidence between the thermal axes and the axes of elasticity. Descloizeaux has noted for the latter [illegible] of [illegible].

Dilatation by Heat. In crystals of the [illegible] system, where the molecules are arranged unequally as regards their axes, the amount of their dilatation when heated is unequal, and the direction of their axes [illegible]. Our knowledge of the [illegible]

[illegible] crystals of [illegible] variation [illegible] equal [illegible] tion is dimunished with the increase [illegible] negative double refraction, and [illegible] positive. According to Descloizeaux the same is true of [illegible]. The dilatation of each [illegible] according to [illegible] permanent [illegible].

Kopp has shown that in the carbonate of lime, magnesia, manganese, and zinc, which are [illegible] the angles of the crystals, the vertical axis [illegible] the lateral. And since heat diminishes the density, and therefore increases the volume, the axis should be lengthened by an increase of temperature, as is true. The [illegible] has determined by calculation that the change of angle from 74° to 90° should be 7′ [illegible].

Although in the greater number of cases the variations are small [illegible] to be accurately measurable, yet they may be sufficient to establish [illegible] between substances which have identical geometric form while belonging to different systems of crystallization. The angle of cleavage or direction might at a certain temperature be 90°, and so remain with a rise, but that an [illegible] rhombohedron change when [illegible] the temperature altered, while the angle of a true monometric cube is constant at all temperatures. The [illegible] direction in many [illegible] not from heating [illegible] accompanied by changes in optical properties. In a monometric crystal where the principal axes [illegible] unequally, the change affects the amount of [illegible] of the axes. The amount of alteration in a certain [illegible] determined, is extraordinary. At the ordinary temperature [illegible] of the divergence of the optic axes which [illegible] symmetry is about 90° for red light; when heated to [illegible] diminished to 0, and for the moment the crystal appears uniaxal. When more highly heated, the [illegible] diverge in a plane at right angles to the original one, [illegible] change take place in reverse order. In beryl and [illegible] the alteration in the angle of the optic axes or divergence when heated.

Characters depending on Cohesion.

These characters are of five kinds: (1) hardness, (2) tenacity, (3) elasticity, (4) cleavage, (5) fracture. All may be considered as related to the power of resisting attempts to separate one part from another.

1. *Hardness.*—A harder body is distinguished from a softer, either by attempting to scratch the one with the other, or by trying each with a file. Each of these methods is used by the mineralogist in determining the hardness of the species, though the latter is in most cases to be preferred. Both methods should be employed when practicable.

Certain varieties of some mineral give a low hardness under the file, owing either to impurities or imperfect aggregation of the particles, while they scratch another mineral upon which a file would have no effect, showing that the particles of the first are hard, though loosely aggregated. Chiastolite, spinel, and sapphire are common examples of this. When the mineral is too hard to be impressed by a file, the peculiarity of the grating sound will suffice for the practised ear.

Mohs introduced a scale of hardness, consisting of ten minerals, which gradually increase in hardness from 1 to 10. The intervals between 2 and 3 and 5 and 6 are larger than the others. Breithaupt has therefore introduced another degree of hardness between each of the above, and thus his scale consists of twelve minerals.

The scale is as follows:

1. Talc, common laminated light green variety.
2. Gypsum, a crystallized variety.
2·5 Mica (muscovite).
3. Calcite, transparent variety.
4. Fluor-spar, crystalline variety.
5. Apatite, transparent variety.
5·5 Scapolite, crystalline variety.
6. Felspar (orthoclase), white cleavable variety.
7. Quartz, transparent.
8. Topaz, transparent.
9. Sapphire, cleavable varieties.
10. Diamond.

If the file abrades the mineral under trial with the same ease as No. 4, and produces an equal depth of abrasion with the same force, its hardness is said to be 4; if with more facility than 4 but less than 5, the hardness may be 4½ or 4¼, written in decimals 4·5 or 4·25. Several successive trials should be made to obtain certain results.

The use of the file is acquired with very little experience, usually a single trial is sufficient. Care must be taken to apply the file to edges of equal obtuseness. That part also of the specimen should be selected which has not been altered by exposure, and has the highest degree of transparency and compactness of structure. The one size for determination should be rather heavy, and the file should be passed three or four times over the specimen.

Where the scale of hardness is wanting, or a more thorough determination is sought, the following experiments may serve:

Every mineral that is scratched by the finger nail has H. 2 or less. Mineral that scratch copper have H. 3 or more. Polished white iron has H. 4·5. Window-glass has H. 5 to 5·5. Steel wire or file has H. 6 to 7; hence every mineral that will cut or scratch window-glass, or good penknife blades H. less than 6. Flint has H. 7, and will scratch about eleven minerals, including the precious-stones or corundum family.

Many minerals present different degrees of hardness on different faces, examples of which we mention cyanite and mica. These faces belong to the unequilateral primary forms, and like the similar differences of colour, lustre, &c., finds a ready explanation in the theory of their formation: unlike faces are the result of the action of cohesive forces along unlike axes.

The difference of hardness parallel to unlike axes may be perceived in nearly all cases where the methods of trial are sufficiently delicate. Haüy even observed that the cleavage face of a crystal of calc-spar divided it into zones from the other faces; and even in a monoclinate crystal of gypsum it has been found that the faces of the cube and octahedron are specifically alike in this respect.

2. *Tenacity.*—Solid bodies are said to be brittle, sectile, malleable, flexible, or elastic.

1. *Brittle*, when portions are detached in powder or grains on attempting to cut it; as fluor-spar, &c.

2. *Sectile*, when pieces may be cut off with a knife without falling to powder, but still the mineral pulverizes under the hammer; as hornblende, gypsum.

3. *Malleable*, when slices may be cut off, and these slices flatten out under a hammer; as native gold, native copper.

4. *Flexible*, when the mineral will bend and remain bent after the bending force is removed; as gypsum, graphite, talc.

5. *Elastic*, when after being bent it will spring back to its original position; as mica.

A liquid is said to be *viscous* when, on pouring it, the drops lengthen and appear ropy; as petroleum.

3. *Elasticity.*—Investigations on this property have not to any extent been entered upon. The unequal elasticity of unlike faces of crystals has been shown by Savart in his acoustic investigations, and he was able to distinguish the rhombohedral from the other faces in the pyramid of quartz crystals: he also showed that the figures formed upon vibrating plates of crystals were directly connected with their optic axes. Milne, by measuring the amount of recoil of a sphere of calcite when struck at different points by another of rock crystal, found that the elasticity, as thus measured, was greatest along the line of the optic axis, and least in directions at right angles to it. He also found that points which lay intermediate between the main and the transverse axes were most indented by the blows. This goes to show that, although there may be fewest molecules arranged along the lines of the transverse axes, yet cohesion operates with greater intensity along these than in intermediate directions. Elastic

When the tenacity of a mineral is overcome by an overwhelming amount of traction, or its elasticity by a sudden shock, its parts are separated, either in flat and continuous surfaces, or in surfaces which are irregular in the extreme. The first of these modes is termed cleavage, the second fracture. In those substances in which cleavage exists it is found that the planes or directions along which it takes place lie in certain strictly definite positions to one another and to the axes of the crystal. They show not the smallest tendency to a transition or gradual passage into the other directions of greater coherence.

4. *Cleavage.*—The number of these parallel cleavage-planes is altogether indefinite, so that the only limit that can be assigned to the divisibility of some minerals, as gypsum and mica, arises from the coarseness of our instruments. These minima of coherence, or cleavage-planes, are always parallel to some face of the crystal; and similar equal minima occur parallel to every other face of the same form. Hence they are always equal in number to the faces of the form, and the figures produced by cleavage agree in every point with true crystals, except that they are artificial. They are thus most simply and conveniently described by the same terms and signs as the faces of crystals. Cleavage

Some minerals cleave in several directions parallel to the faces of different forms, but the cleavage is generally more easily obtained and more perfect in one direction than in the others. This complex cleavage is well seen in calc-spar and fluor-spar, and very remarkably in zinc blende, where it takes place in no less than six directions. As in each of these the division may be indefinitely continued, it is clear that no lamellar structure in any proper sense can be assigned to the mineral. All that can be affirmed is that contiguous atoms have less coherence along a direction normal to these planes than in other directions. When cleavage takes place in three directions, it of course produces a perfect crystal form, from which the system of crystallization and angular dimensions of the species may be determined, it is thus often of very great importance.

The common cleavage in the different systems is as follows, those of most frequent occurrence being in italics:—(1) In the cubic system, *Octahedral*, O, along the faces of the octahedron; *Hexahedral*, ∞O∞, along those of the cube; and Dodecahedral, ∞O. (2) In the tetragonal system, Pyramidal, P, or 2P∞; *Prismatic*, ∞P, or ∞P∞; or *Basal*, 0P. (3) In the hexagonal system with holohedral forms, Pyramidal, P, or P2; *Prismatic*, ∞P, or ∞P∞; or *Basal*, 0P; with rhombohedral forms, *Rhombohedral*, R; Prismatic, ∞R; or *Basal*, 0R. (4) In the right prismatic system, Pyramidal, P; *Prismatic*, ∞P; Macrodomatic or Brachydomatic, P̄∞ or P̄∞; *Basal*, 0P; Macrodiagonal, ∞P̄∞; or *Brachydiagonal*, ∞P̄∞. (5) In the oblique prismatic system, Hemipyramidal, P, or −P; *Prismatic*, ∞P; Clinodomatic, P^c∞; Hemidomatic, P^o∞ or −P^o∞; *Basal*, 0P; Orthodiagonal, ∞P^o∞; or *Clinodiagonal*, ∞P^c∞. (6) In the

anorthic system, Hemiprismatic, $\infty P'$, or ∞P; Hemidomatic either along the macrodome or the brachydome; *Basal*, 0P; Macrodiagonal, $\infty \breve{P} \infty$; or *Brachydiagonal*, $\infty \breve{P} \infty$.

In some minerals, as mica and gypsum, the cleavage is readily procured; these may be held in the hand and divided by a knife. Others only cleave with more or less difficulty; these must be placed on a firm support resting on lead, folded paper, or cloth, and a sharp blow struck on a chisel applied in a proper direction. This may often be ascertained by examining the specimen in a strong light. Sometimes it is necessary to subject them to extreme compression in a vice. Some of the hardest substances have not only a perfect but a facile cleavage, as cuclase, topaz, and diamond; many of the softest species have none. The planes produced also vary much in their degree of perfection, being highly perfect in some, as mica and calc-spar, and imperfect in others, as garnet and quartz. In a very few crystalline minerals cleavage-planes can hardly be said to exist. Cleavage must be carefully distinguished from the planes of union in twin crystals, and the division planes of laminar minerals.

5. *Fracture.*—This is the irregular manner in which substances may be broken. Even mineral possessed of cleavage may be fractured in other directions, but in amorphous bodies fracture alone occurs. The following varieties of fracture occur, and are highly characteristic.

1. *Conchoidal*, almost typical of amorphous bodies, but occasionally seen in crystals,—rounded cavities, more or less deep. The name is taken from the resemblance to the successive lines of interrupted growth in a bivalve shell. Seen in flint, obsidian, asphalt. In calcite the direction of this fracture is intermediate to the planes of the mineral's cleavage.

2. *Even*, when the surface of fracture is smooth and free from inequalities.

3. *Rough*, when the surface of fracture is rugged, with numerous small elevations and depressions.

4. *Splintery*, when covered with small wedge-shaped splinters.

5. *Hackly*, when the elevations are sharp, jaggedly bent, or jagged, as broken iron.

6. *Earthy*, when it shows only fine dust.

Taste, Odour, Touch

Taste belongs only to soluble mineral. The different kinds adopted for reference are as follows:

1. ***Astringent***, the taste of blue vitriol.
2. ***Sweetish astringent***, taste of alum.
3. ***Saline***, taste of common salt.
4. ***Alkaline***, taste of soda.
5. ***Cooling***, taste of saltpetre.
6. ***Bitter***, taste of epsom salts.
7. ***Sour***, taste of sulphuric acid.
8. ***Pungent***, taste of sal ammoniac.
9. ***Metallic***, taste of zinc sulphate.

Odour.—Excepting a few gaseous and soluble species, minerals in the dry unchanged state do not give off odour. By friction, moistening with the breath, and the elimination of some volatile ingredient by heat or acids, odours are sometimes obtained which are thus designated.—

1. *Alliaceous*, the odour of garlic. Friction of arsenical iron elicits this odour; it may also be obtained from any of the arsenical ores or salts by means of heat.

2. *Horse-radish odour*, the odour of decaying horse-radish. This odour is strongly perceived when the ores of selenium are heated.

3. *Sulphurous.* Friction will elicit this odour from pyrites, and heat from many sulphurets.

4. *Bituminous*, the odour of bitumen.

5. *Fetid.* the odour of sulphuretted hydrogen or rotten eggs. It is elicited by friction from some varieties of quartz and limestone.

6. *Argillaceous*, the odour of moistened clay. It is obtained from serpentine and some allied minerals after moistening them with the breath; others, as pyrargillite, afford it when heated.

7. *Empyreumatic* or *ozonic.* Quartz, when two portions strike one another.

Touch.—Some minerals are distinguished by a greasy feeling, as talc; others feel smooth, as celedonite; others meagre, like clay; others cold. This last character distinguishes true gems from their imitations in glass. Some, in virtue of their hygroscopic nature, adhere to the tongue.

Chemical Properties of Minerals.

Influence of Chemical Composition on the External Characters of Minerals.—That the characters of a compound must to a certain extent depend on those of its component elements seems, as a general proposition, to admit of no doubt. Hence it might be supposed possible from a knowledge of the composition of a mineral to draw conclusions in reference to its form and its other properties; but practically this has not yet been effected.

The distinction between the mineralizing and mineralizable or the forming and formed elements lies at the foundation of all such inquiries. Certain elements in a compound apparently exert more than an equal share of influence in determining its physical properties. Thus the more important non-metallic elements, as oxygen, sulphur, chlorine, fluorine, are remarkable for the influence they exert on the character of the compound. The sulphurets, for example, have more similarity among themselves than the various compounds of one and the same metal with the non-metallic bodies. Still more generally it would appear that the electro-negative element in the compound is the most influential, or exerts the greatest degree of active forming power. After the non-metallic elements the brittle, easily fusible metals rank next in power, then the ductile ignoble metals, then the noble metals, then the brittle, difficultly fusible, and, last of all, the metals of the earths and alkalies.

Generally each chemical substance crystallizes only in one form or series of forms. Some substances, however, show dimorphism, or crystallize in two forms, and thus any compound of two or more metals. Thus sulphur, which in nature usually crystallizes in the right prismatic system, when melted forms oblique prismatic crystals. Carbon in one form is the diamond, in another graphite, carbonate of lime appears as calc-spar, as arragonite; the bisulphuret of iron as pyrite and as marcasite. An example of trimorphism occurs in titanic acid, forming the distinct species anatase, rutile, and brookite. It is remarkable that of dimorphic minerals one form is almost always right prismatic, thus:

Isomorphic Pairs	
Cyanite, anorthic	Staurotide, Andalusite
Calc-spar, hexagonal	Arragonite
Sussexite, do	Kobellite
Rutile, Anatase, pyramidal	Brookite.
Prehnite, right prismatic	Pectolite
Cuprite, cubic	Chalcotrichite
Senarmontite, cubic	Valentinite
Pyrite, do	Marcasite
Rammelsbergite, do	Chloanthite.
Argentite, do	Acanthite
Ferrocyanate, oblique prismatic	Dichroite
Sulphur, do	Sulphur

Even the temperature at which a substance crystallizes influences its forms, and so far its composition, as seen in the case of Glauber salt, natron, and borax.

Isomorphism. Still more important is the doctrine of isomorphism, designating the fact that two or more simple or compound substances crystallize in one and the same form, or often in forms which, though not identical, yet approximate very closely. The similarity of form is generally combined with a similarity in other physical and mechanical properties. Among minerals that crystallize in the tesseral system, isomorphism is of course common and perfect, there being no diversity in the dimensions of the primary form; but for this very reason it is generally of less interest. It is of more importance among crystals of the other systems, the various series of which are separated from each other by differences in the proportion of the primary form. In these perfect identity is seldom observed, but only very great similarity.

The more important isomorphic substances are either simple substances, as (1) fluorine and chlorine, (2) sulphur and selenium, (3) arsenic, antimony, (4) cobalt, iron, nickel, (5) copper, silver, mercury, gold (?), or combinations with oxygen, as (6) lime, magnesia, and the protoxides of iron, manganese, nickel, (7) sesquioxides, as of iron, manganese, chromium, and titanium, (8) phosphoric acid, vanadic acid, arsenic acid, (9) sulphuric, selenic, chromic acids, or combinations with sulphur, as (10) sulphuret of iron and of zinc; (11) sulphuret of antimony and of arsenic, (12) sulphuret of lead, of copper, and of silver. These are sometimes named vicarious from the singular property that in chemical compounds they can mutually replace each other in definite proportions, and very often without producing any important change in the form or other physical properties. But there are numerous instances among the silicates where the mutual replacement of the isomorphic

bodies, especially when the oxides of the heavy metals come in the room of the earths and alkalies, and influence on the external appearance, particularly as regards colour, specific gravity, and fusibility. The varieties of hornblende, augite, and mica which contain the rarer elements are remarkable for the beauty of their crystals, which are sometimes enormously developed. Without the presence of these elements, the oxides of iron and manganese would have [illegible] the colour, would have

In the chemical formulæ, barred letters represent two equivalents of the element, and a dot over the symbol indicates the combination with three times its quantity of oxygen, as the terms are explained.

In the symbolic notation the several faces of crystals are separated by commas, and the constituent members of combination by colons. The letters on the faces of the figures are for the most part those adopted by Miller. In these combinations the crystallographic form which is typical of the mineral is placed first:

SIMPLE SUBSTANCES

1. Sulphur Group.

[illegible] Rhombohedral. Cleavage perfect [illegible], middle edge 144° 12′, basal P on P 101° 56′, oP on oP 120°. Usually granular, and also stalactitic or compact, and pulverulent. Cleavage basal and P. H. 1·5 to 2·5. G. 2·5. Fracture conchoidal or [illegible] Colour pale wax-yellow, passing into red, brown, or green. Yellow on the closed tube. Fuses at a temperature of 226° C. (439° F.), and burns with a pale blue flame. Soluble in carbon disulphide. Crystallized sulphur, and that precipitated from solution of chromium, and yellow sulphuret of antimony. Found chiefly in [illegible] formations. Fine crystals in Sicily, with celestine, gypsum, &c. Also in Switzerland, Greenland, Iceland, [illegible] in Solfatara near Naples, from [illegible], from sulphuret of zinc in New York, and in coal-beds, limestone, and pyrites at several localities.

Fig. 257.

(2) Selenium, Se.

Lead-grey but reddish brown by transmitted yellow. B.B. burns with blue flame and odour of sulphurous acid, and fuses with the sulphurous. Found in the crater of Volcano in the Lipary Islands, and Kilauea in Hawaii.

3. SULPHIDES.

H. 2·5. G. 6·1. Precisely black to lead-grey: thin splinters translucent and red. From Cuebras in Mexico.

4. Tetradymite, Te.

Rhombohedral. [illegible] 50′. In minute hexagonal prisms, with basal cleavage, and also massive and granular. Cl. lateral perfect. H. 2 to 2·5. G. 6·1 to 6·3. Tin-white; [illegible] Composition with a little gold and iron. Occurs at [illegible] Transylvania, and in several mines in Boulder county, Colorado, where 25 lbs. weight have been obtained [illegible].

Fig. 258.

Rhombohedral: R on R 105° 5′ (fig. 258). Usually in botryoidal investing masses composed of numberless layers. The structure is sometimes [illegible] granular. H. 3·5; G. 5·7 to 5·95. Cl. basal. Colour black, and dull, but when fresh broken very [illegible] and [illegible] white. Fracture uneven. When rubbed or heated gives out a garlic-like odour. B.B. volatile with formation of white fumes. Composition with some antimony, and traces of iron, silver, and gold. Andreasberg in the Harz, Annaberg, Schneeberg, Freiberg, Joachimsthal, Allemont (Dauphiné), Kongsberg (Norway), the Altai, Chili, Pebble mine (Dunbridge, Tyndrum (Perthshire).

6. Antimony, Sb.

Rhombohedral; R on R 87° 35′, but rarely crystallized, generally in foliated or granular masses. Cl. basal. H. 3. G. 6·6 to 6·8. Tin-white, with a yellowish tarnish. Brittle and sectile. B.B. easily fusible, volatilizes, and on charcoal leaves a white deposit, burning with a pale flame. Found at Andreasberg, Przibram (Bohemia), Sala (Sweden), Allemont, Southham in East Canada, and Borneo.

7. Allemontite, $SbAs_2$.

Hexagonal, spheroidal, reniform, and investing. H. = 3·5; G. = 6·1 to 6·2. Lustre, when fresh metallic. Tin-white to lead-grey, but with a blue or brown tarnish. B.B. strong odour of garlic, with [illegible] of oxide of antimony. Composition: antimony 37·85, arsenic 62·15. Almost always in curved foliated lamina. Occurs at Allemont, Przibram, Schladming; in Styria, Andreasberg.

8. Bismuth, Bi.

Rhombohedral, R on R 87° 40′. Crystals, R, 0R, generally distorted and reticulated, pearl-like twins, or arborescent; also disseminated and granular. Cl. basal perfect. H. 2·5; G. = 9·6 to 9·8. Brittle and sectile. Reddish white, often tarnished grey, brown, or blue. F.B. easily fusible, even in candle flame. Volatilizes on charcoal, leaving a yellow crust. Sol. in n. acid; solution precipitated when thrown into water. Occurs in gneiss and clay-slate in veins and disseminated, along with ores of cobalt, silver, lead, and zinc. Alston Moor, Cumberland, Devonshire, and Cornwall. Schneeberg, Marienberg, Joachimsthal, Biebe, Modum (Norway), Falun (Sweden), Bolivia.

9. Tetradymite, Bi_2Te_3.

Bismuth glance, Schirmm 18. Virginia, Dahlonega in Georgia, Montana. A variety with 7 per cent. of selenium and H. = 2 also occurs.

10. Tetradymite, Bi_2Te_2S.

Rhombohedral; 3R 68° 10′. Almost always twins of 3R and 0R, with the faces of 0R at 93°. Cl. basal, perfect. Sectile, and thin lamina flexible. H. = 1 to 2; G. = 7·2 to 7·5. Steel-grey. By rubbing, yielding a grain of metal which ultimately volatilizes. Some massive. Composition: 59·6 bismuth, 35·9 tellurium, and 4·5 sulphur. Schemnitz.

11. Weibullite, $Bi(Te_3S)$.

Hexagonal. Cl. basal. H. = 1 to 2; G. = 8·14. High lustre. Steel grey. C.c.: bismuth 61·15, tellurium 29·74, sulphur 2·33, silver 2·07. Deutsch-Pilsen in Hungary.

12. Joseite, $Bi_3Te_2(SSe)_2$.

Hexagonal. Cl. basal. G. = 7·93. Colour grey black to steel-grey. Brittle. C.c.: tellurium 15·93, sulphur 3·15, selenium 1·48, bismuth 79·15. San José (Brazil). A Cumberland variety yielded tellurium 6·73, sulphur 6·13, bismuth 84·33, corresponding to $Bi_4(TeS_4)$.

13. Diamond, C.

Var. 1. *Crystallized.*—Cubic; very frequently hemihedral. Crystals most generally with curved faces. Twins common on octahedral face; hemitropes also common (see fig. 170, 204, 207). Crystals vary remarkably in appearance, each [illegible] Cl. octahedral. H. 10; G. = 3·5 to 3·6. Transparent or translucent when of dark colour. Refracts light treely. The black plane diamonds reflect all the light which strikes them at an angle exceeding 21° 13′, and hence comes their peculiar brilliancy. Has adamantine lustre. Colourless, but often tinged with brown,—more rarely yellow, pink, blue, green, and black, the last named being the rarest. Disperses light lavishly, and brilliant flashes of all the colours of the spectrum. Becomes negatively electric by friction. B.B. infusible, but burns away

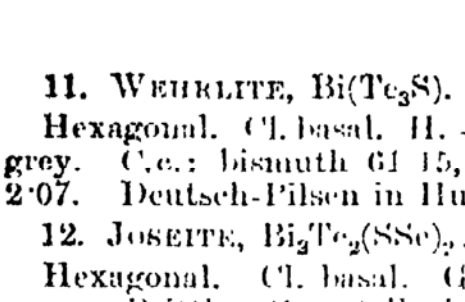


Fig. 259.

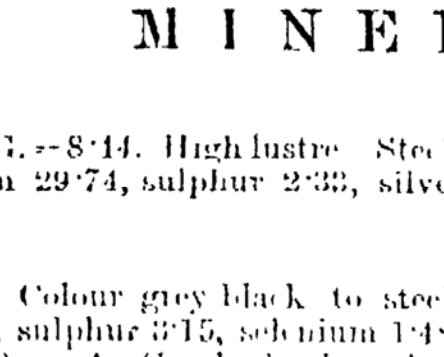


Fig.

acid in oxygen gas. When air is excluded it can be heated at the temperature of melting cast iron, but at that of melting malleable iron is changed into a black coke, or, if air is admitted, into graphite. Insoluble in all acids and alkalies. C.c.: carbon with traces of silica and earths. Geologic formation apparently a limonitic flexible quartz rock called itacolumite, which occurs in Brazil, the Urals, Georgia, and North Carolina, in the vicinity of places where diamonds have been found. Minute crystals have been found in xanthophyllite, and in talc slate and serpentine on the Schischimskian hills near Zlatoust (Russia). They have also been obtained in Brazil imbedded in a conglomerate composed of much worn pebbles of quartz, chalcedony, and gold, cemented by limonite or

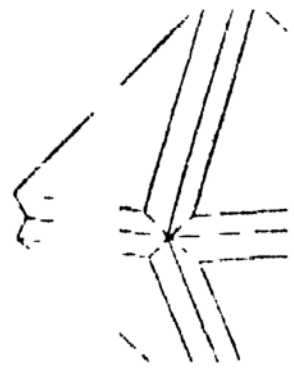


Fig. 261

Fig. 262.

ferruginous clay. In South Africa they are imbedded in [illegible] clay. Diamonds were formerly obtained in India, at Panna, Raolconda, and Golconda. So few are now obtained here that the mines are let for £1 a year. From these mines were obtained not only the Kohinoor, which was possibly the same as the great diamond mentioned by Tavernier as having been seen by him in the possession of the Great Mogul, which weighed 280 carats, but the Regent, of 136 carats (which, not only from its size, but from the perfection of its form, is very much the finest diamond known), the Nizam, an uncut diamond of 340 carats, and the Orlow rose cut, 193 carats. More lately diamonds were found in great quantity in the neighbourhood of Rio Janeiro in Brazil; they occur in two different deposits: the one called "gurgulho" consists of broken quartz covered by a bed of sand; the other, "cascalho," consists of rolled quartz pebbles united by ferruginous clay: both rest on talcose clays, which are the debris from talcose rocks. The first deposit affords the finest diamonds, and both contain gold, platinum, magnetite, and rutile. A dodecahedral diamond of 257 carats was lately found at Bogagem in this district; this was reduced by cutting to an oblong brilliant of 129 carats, a [illegible] the second most valuable diamond,—the Kohinoor, now re[illegible] to an imperfectly circular brilliant of 102 carats, occupying third place. The two coloured diamonds most worthy of [illegible] are a green diamond in the Dresden collection weighing 51 c[illegible] which is a little deeper in tint than a beryl, and a blue dia[illegible] in the Hope collection, of 44 carats, a highly coloured [illegible] sapphire, which it is by some considered to be. Diamonds [illegible] lately been found in very fe[illegible] e of great [illegible] north of the Cape of Good Hope; these for th[illegible] most part [illegible] yellow colour and of very inferior value. Wh[illegible] a Brazilian [illegible] brilliant of one carat is worth from £30 to [illegible], the va[illegible] the finest brilliants from the Cape is only from [illegible] to £4, and [illegible] of the yellow diamonds is from £2 to £[illegible]. Apart fro[illegible] employment as an ornamental stone, the diamon[illegible] has in nat[illegible] value from it being utilized for cutting [illegible] an[illegible] grinding [illegible] polishing other gems. Of late years it ha[illegible] has had [illegible] application to [illegible] been employed for the drilling of [illegible] can now be [illegible] operation, and in the boring of artesian well[illegible] in the [illegible] tion has resulted from the latest methods of w[illegible] by the [illegible] that the lustre of the African diamonds, a[illegible] to [illegible] of their endurance, is certainly not [illegible] to that of the Brazilian [illegible]. So much is this recognized that while the best [illegible] minute crystal, of the latter commands a price of 50 per carat, [illegible] African can be got for about £1. The circumstance that [illegible] African diamond [illegible] ornament that even the best of the Brazilian [illegible] some of them to fall in price. Such diamonds, generally octahe[illegible] may be recognized by a peculiar watery lustre, they are called [illegible] diamonds. The above facts give some ground for the supposi[illegible] that there may be a distinct difference between the two varieties, pos[illegible] that both may contain small, but different, quantities of foreign [illegible]. The circumstances under which diamonds have been formed [illegible] altogether unknown. The fact of their being changed into a [illegible] of coke at a very high temperature is an argument against [illegible] having been produced through the operation of heat, and it has [illegible] been known that an excess of carbon dissolved by molten cast [illegible] crystallizes on cooling in the form of graphite, yet the only attempts [illegible] to form diamonds deserving of being mentioned have hitherto [illegible] attended with any measure of success are those in which [illegible] charcoal was dissolved in molten silver at the temperature of [illegible] melting steel. There [illegible] th[illegible] e black [illegible] also colourless octahedral [illegible] with e[illegible] faces, mingled with a [illegible] er amount [illegible] dal crystals.

Var. 2. *Bort*. [illegible] of [illegible] sometimes 1000 carats. [illegible] H. 10, G. = 3·012 to [illegible] C. carbon except [illegible] Found in [illegible] mines of Brazil, &c.

Var. 3. *Ballas*. [illegible] The diamond [illegible] In mammillar[illegible] mas[illegible] and globu[illegible] Brittle. Cl. [illegible] P.G. [illegible]. When cut and polished [illegible] Supposed from Brazil.

14. Graphite, C.

Hexagonal in that [illegible] L[illegible] scaly, or compact. Cl. [illegible] metallic. Colour and [illegible] to dark [illegible] thin lamina, very sectile, feels greasy; leaves a mark on paper of its own colour, conducts electricity. B.B. burns with difficulty, heated with nitre, [illegible] deflagrates. C.c.: carbon, with small quantities of vegetable matter, and ash from 5 to 10 per cent. Strathfarrar (Inverness-shire), Mull, Cruegnan (Ayrshire), Borrowdale in Cumberland, Caithness, Mountains, Ceylon, Greenland. Used for making pencils.

Fig. 263.

15. Tin, Sn.

Tetragonal [illegible] grey or white metallic grains. Reported occurring with Siberian gold, with bismuthite from Guanajuato, Mexico.

16. Iron, Fe.

Cubic; in grains and plates or disseminated. H. 4·5, G. = 7 to 7·8. Steel grey or iron black. Fracture hackly, magnetic. B.B. infusible. Sol. in hot acid. Two varieties are to be distinguished. (*a*) *Telluric iron*, in grains and plates. Almost pure iron, or contains graphite, carbon, lead, or copper, or nickel. Found in Bohemia in lime[illegible] stone, in the clay-slate and sandstone in the Lesper at Mühlhausen; in Tuscany in clay-slate, in Greenland, in an ironstone conglomerate in Disco, and in lava in Auvergne, in the mine of Hackenburg at Bodenmais, in Lib[illegible] Africa along with quartz, a zeolite, and magnetite, enclosed in [illegible] serpentine in Unst (Shetland) and in Sutherlandshire, in basalt in Antrim Ireland, in the gold sands of Brazil, the Urals, and C[illegible] plain, Pennsylvania). (*b*) *Meteoric iron*, sterlingy or silver w[illegible]

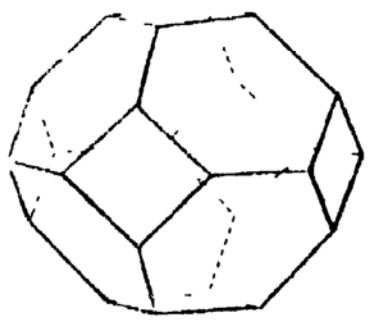
lways contains nickel, with cobalt, copper, and several which are non-terrestrial. When polished and etched ic acid the surface is marked by lines of unaffected inter- ystals called Widmannstatten's figures, most of the nickel nd the a Occurs in masses which vary in size from le ...to cop- dust as dredged from the depths of the o... ...d of 22,050 lb. Many of these masses have been ... suspected, however, to be terrestrial) have ... bed on a basaltic rock near Disco Bay in Green- ... which is 14,000 lb in weight. Several contain ... pores, condensed to the extent of eight times the ... and the pitted depressions frequently observable ... give countenance to the view that, if not dis- volcanic throat, they were set at liberty by some ... gaseous explosion.

...

...dental. Said to be from ... large hexagonal pyramids, ...perfect. H. 2, G. 7. Lu... metallic. Colour and ...h white. Found in a geode in basalt near Melbourne, ...ted with smithsonite, erythrine, and aragonite. Also ...dules of the Muttamutta river.

...PER. Cu.

...s. 25, 30, 26, 33, 37, 264). Twins, on an octahedral face, ...metrically distorted. Often filiform and arborescent, or in ... H. ... G. ... 5 to 8·9. Lustre dull ... colour and streak copper-red, ...ften brown tarnish. B.B. easily ...fuses, the outer flame green. ...acid. Occurs in many rocks ...encous, and frequently as a... ...h zeolites. In the Faroes, Dept. ..., Cornwall, Chessy near Lyons, ...d (Hungary), Siberia, China, ...Brazil, Chili, and Australia ...great size are found, much the ...ing from the Ontanagon river, ...outh of Lake Superior. One ...d in February 1857 was 45 feet ... 22 feet in width, and 8 feet in thickness; its weight was ... Another was found in 1869, 65 feet in length, ...d from 4 to 7 feet in thickness: this weighed upwards of ... and had a value of 100,000 dollars.



264.

...D, Pb.

...but only in thin plates, capillary or filiform. Cl. none. G. 11·36 to 11·4. Ductile, malleable, and sectile, ...y, but with a blackish tarnish. Found in lava in Madeira ... near Cartagena in Spain; in amygdaloid near ...in crystalline tufa at Rautenberg in Moravia: with gold near ...een in the Altai, at Velika in Slavonia, and at Olalpan ...Ivanez: near Ekaterinburg in the Urals; in the district ...huacan in Vera Cruz, in foliated galena, in granular lime- ...the iron and manganese bed of Parsberg in Wermland ...with hæmatite, magnetite, and hausmannite; in wes... ...th-west near the Dog Lake of the Kaministiqua, ca... ...Lake Superior, imbedded in hornstone in plat... and ...the mine of Bogoslovsk on the Kirghiz steppes, in green ...clay at Stutzerbach in Thuringia, with hæmatite in the ...Nias on the west coast of Sumatra.

...URY, Hg.

...Occurs in small liquid globules in its gangue, but may ...also, when it forms octahedral crystals. G. = 13·596 ...(−39°·2) when solid. Lustre brilliant metallic, tin- ...white, sometimes leaving a little tarnish. Readily ...occurs generally in clay-slates or schists of dif- ...ferent periods. Ores of mercury are usually found in veins ...accompanying calomel, at most of the localities for ...which are Idria in Carniola and Almaden in Spain. ...Cinnabar is worked in a soft clay slate. In Transylvania ...it comes from the Carpathian sandstone beds. At the Pioneer mine in California some ...of the specimens are coated with globules of mercury. At Cividale ...nearly all the cinnabar has become metacinnabar. It has also been ...found in crystals, and has even been stated to have ...occurred in a pseudomorph.

...VER, Ag.

...ings. 26, 30, 33, 35, 36, 37) ... generally small, also and ...quently filiform, arborescent, ... plates or crusts. These ...exist into cavities, coating the ..., or rarely in a reticu- ...lation throughout the mass of ... Twins of octahedral ...dihedral composition. H. 2·5 to 3; G. 10·1 ...Lustre metallic. Colour and ... white, but generally ...yellow, brown, or black. Malleable, ductile, and sectile, ...than gold. B.B. ... Sol. in ... ..., ...tion colours the skin black ... silver, with varying proportions of gold, platinum, mercury, copper, antimony, and bismuth. The auriferous from Norway contains silver 72, gold 28; from quartz reefs in Sutherland, silver 71·4, gold 28·6. The cupriferous from Courcy near Caen contains 10 per cent. of copper. The antimonial from Bohemia contains 1 per cent. of antimony. The mercurial from Kongsberg in Norway has ·4 of mercury, found chiefly in veins in gneiss, clay slate, and limestone. Localities: Alva and elsewhere in Scotland, Ballycorus in Ireland, and Cornwall in England; at Freiberg, Andreasberg, and Kongsberg; along with native copper at Lake Superior; in Mexico, in Peru, and in the United States. The finest crystallized silver occurs at Lake Superior, and at Kongsberg. At the last locality the crystals are an inch in diameter, and are disposed on large filiform brushes. Silver occurs in large masses; three of 436, 560, 812 lb have been recorded from Kongsberg. A block which smelted 44,000 lb was for some years used as a table by Duke Albert on his annual visits of inspection to the Schneeberg mine in Saxony. A Mexican specimen was found of 400 lb; the mines of Huantaya in Peru have yielded masses of 444 and 960 lb. Britain produces annually about 760,000 oz. of silver, chiefly, however, from lead ores. The value of annual produce for the whole world from all sources is from 8 to 10 millions of pounds sterling.

22. SCHNEIDERITE (*Gold Amalgam*), Au_2Hg_3.

Tetragonal four-sided prisms, easily crumbling, yellowish white to white; sometimes in grains the size of a pea. C.c.: gold 41·63, mercury 58·37. Found at Mariposa in California. A variety $(Au, Ag)_2 Hg_3$ is found along with platinum in Columbia; this contains gold 38·39, silver 5, mercury 57·40.

23. ARQUEROITE, Ag_2Hg.

Cubic. In octahedra, also in grains and dendrites. G. = 10·8. Like native silver, but softer. C.c.: silver 86·5, mercury 13·5. From Arqueros in Coquimbo, Chili. *Kongsbergite*, $Ag_{18}Hg$, occurs at Kongsberg, with 95·1 of silver and 4·9 of mercury.

24. AMALGAM, Ag_3Hg_2 and $AgHg_3$.

Cubic (fig. 33, in combination with 40, 30, 41, 38). Cl. dodecahedral. H. 3 to 3·5. G. 10·5 to 14. Colour and streak silver-white. Fracture conchoidal, brittle, grates when cut. In closed tube yields mercury and leaves silver. Sol. in n. acid. The first variety (silver 34·8, mercury 65·2) occurs at Moschellandsberg in the Palatinate, where the veins of mercury and silver intersect another, the second (silver 26·25, mercury 73·75) there, at Allemont in Dauphiné, Almaden in Spain, in Hungary, and in Sweden. From Rosilla in Atacama (Chili) Domeyko reports the following other compounds: Ag_3Hg_4, silver, mercury 53·2, white and silvery; $AgHg$, silver 55·1, mercury, granular and dull, Ag_2Hg_3, silver 64·2, mercury 35·8; of the last there is a mass weighing 22 lb in the museum of Santiago.

25. GOLD, Au.

Cubic (figs. 30, 26, 33, 40, 36) and more complex forms. Crystals ...erally small and indistinct through elongation, assuming capillary ...and arborescent shapes. Also in thin plates. Twins rare; twin face ...octahedral. Frequently in rounded and apparently colloidal masses ...imparted in clay, or loose in small grains (pipettes) rolling in the ...bed of streams. Fig. 265 is of such a mass found in Sutherland. H. 2·5 to 3, G. 17 to 19·4. Lustre metallic, but frequently dull and partly coated with a brown crust. Colour and streak yellowish white to bright gold-yellow. Malleable, ductile, and sectile; the purer varieties the more so and the softer. B.B. easily fusible. Sol. in aqua regia, generally with precipitation of chloride of silver. Solution yellow, stains skin purple-red, with corrosion. C.c.: gold, with silver from ·72 to 26 per cent.; sometimes iron and copper under 1 per cent. Found in beds and veins generally of quartz in metamorphic rocks of a schistose nature, rarely in diorite and porphyry, and very rarely in granite. Its general associate ...mineral, formed from decomposition of pyrite; sometimes also hæmatite and magnetite. Occurs also in microscopic grains in quartz, from which it is extracted by crushing and amalgamation. The geological range is from the Azoic to the Tertiary and Cretaceous, as in California, but even in these more recent rocks the original source must have been at least Palæozoic. Of localities which yield gold the following may be noticed:—the Leadhills in Scotland, Wicklow in Ireland, Dolgelly in North Wales, Cornwall in England; Transylvania, Hungary, and Piedmont; the Urals, Ekaterinburg, and India; Kordofan, the coast opposite Madagascar, and the Gold Coast (the fame of which has been recently revived); Minas Geraes in Brazil, Bolivia, North Carolina, and

Fig. 265.

ia ; and more recently New South Wales and Queensland
ralia, Tasmania, and New Zealand.
of the largest single masses of gold found in recent times are
owing:—one of 22 oz. in Transylvania, of 28 lb in North
, of 20 lb in California, one of 96 lb troy near Miask in the
nd one of 184 lb 8 oz., which yielded £8376, 10s. 6d., at
. Australia.
nnual produce of gold from Australia is about 5 millions of
sterling, of the United States about 15 millions, and the
arth about 23 millions.

ollowing sub-species may be noticed :—

lectrum. This name for the alloys of gold and silver
olied by Pliny, whenever the proportion of the latter
as one-fifth. An alloy of 2 gold and 1 silver contains 21 per
silver; this is found in Sutherland. One of 1 to 1 contains
cent. of silver, this last being the most usual proportion
rs in Transylvania, in the Altai, and in Colombia. It,
s brass yellow to yellowish white. G. = 12·5 to 15·5.

rpeite, or *Palladium Gold* (*auro-paladre*), from Porpez in
ontains 9·85 per cent. of palladium and 4·17 of silver.

odium Gold, from Mexico (G. = 15·5 to 16·8), contains from
per cent. of rhodium.

LATINUM, Pt.

; rarely in small cubes or octahedrons, usually in minute
ains, sometimes cohering, and also in rounded lumps. No cl.
4·5; G. = 17 to 19. Lustre metallic. Colour and streak pale
y. Malleable and ductile with difficulty, having a hackly
. When containing much iron, magnetipolar. B.B. in-
. Sol. in aqua regia, but only when heated, solution red;
the skin. C.c.: platinum, but never to a greater extent
·5 per cent. The remainder consists of iron, iridium, rhodium,
m, osmium, gold, copper, and a mechanical mixture of min-
. The iron exists in quantities varying from 1·7 per cent. to
that amount. Occurs in Brazil in syenite, near Popayan
ca) in alluvium, associated with chromite, rutile, palla-
gold, and copper; in the Urals in alluvium derived from
ine rocks; and at Nijni Tagilsk in serpentine along with
e. It is also found in Borneo, California, and Carolina, and
to have been found in the county of Wicklow in Ireland.
ds of many rivers yield it in small amount. Platinum does
r in large masses. A mass in the Madrid Museum from
weighs 26½ oz.; masses have been found in the Urals from
lb.

Platina is a sub-species. This, which has a composition
and contains from 11 to 13 per cent. of iron, is found at
agilsk. G. = 14·6 to 15·8, H. = 6. It is magnetipolar, and
iron much more strongly than an ordinary magnet.

PLATINIRIDIUM.

inute silver-white grains. H. = 6 to 7, G. = 16·94 to 22·8.
s 55·44 platinum, 27·79 iridium, 6·86 rhodium, 4·11 iron,
per, ·49 palladium. Is found in Brazil.

RIDIUM, Ir.

(fig. 27). H. = 6 to 7; G. = 21·57 to 23·46. Cl. cubic, traces.
ightly malleable. Silver-white to steel-grey. B.B. in-
. Insoluble in all acids. C.c. 76·8 iridium, 19·61
m, 0·89 palladium, 1·78 copper. Found at Nijni Tagilsk,
y in minute grains. Is the heaviest known substance.
s, sub-species. From Ava in India. C.c. 60 iridium,
nium (according to Prinsep).

PALLADIUM, Pd.

; in minute octahedrons, and in grains. H. = 4·5 to 5; G. =
11·8. Malleable. Light steel-grey. B.B. infusible. Slowly
s in n. acid, forming a brown-red solution. C.c., palla-
with a little platinum and iridium. From the gold sands
il, often in small plumose crystalline lumps. Also from St
go, and the Urals. Does not tarnish with sulphurous fumes.

ALLOPALLADIUM, Pd_3.

gonal; in small flat hexagons. Cl. basal, perfect. Lustre
silvery. Colour pale steel-grey. From Tilkerode in the
with gold.

NEWJANSKITE (*Osmiridium*), IrOs (iridium 49·78, osmium
and Ir_2Os.

gonal; P 124°. 0P, P, ∞P. Generally in flat scales.
al perfect. H. = 7; G. = 18·8 to 19·47. Lustre metallic.
tin-white. B.B. unchanged. Insoluble
ids. The analyses of this mineral give
ies of iridium varying from 44 to 77 per
nd of osmium from 21 to 49. Ruthenium,
n, and platinum make up the 100 parts.
rgest quantity of ruthenium is 8·49, and

Fig. 266.

iety from New Granada was found to contain no ruthenium,
3 of rhodium, which is more than double its usual amount.
with platinum in Choco (Colombia); at Newjansk and
several localities in the Urals, in Australia, in northern C
(somewhat abundantly in gold sands), also in Canada.

32. SISSERSKITE (*Iridosmium*). $IrOs_4$ (iridium 19·9, osmi
and $IrOs_3$ (iridium 24·8, osmium 75·2).

Rhombohedral; R = 84° 28′. H. = 7·5; G. = 21·12. Col
grey to bluish. B.B. becomes black, with strong odour
acid; in flame of spirit-lamp shines strongly, and colou
yellowish red. Occurs in small quantity with newjanskit
its localities, and in proportionally larger quantity at Sissers
Urals. It is used for pointing gold pens, and in the Unite
sells at 50 dollars an ounce.

COMPOUNDS OF FLUORINE, CHLORINE, BROM AND IODINE (HALOID SALTS).

33. FLUORITE (*Fluor-spar*), CaF.

Cubic (figs. 267 to 270, also figs. 31, 33, 36, 55, 56, 57, 5
divergent crystalline, granular, and compact. Cl. octa
fracture conchoidal, brittle. H. = 4; G. = 3·1 to 3·2. Tra
to pellucid. Lustre vitreous. Colourless, but generally
purple, blue, green, yellow, white, black, and pink. So
two or three colours disposed in layers in one crystal. Fr

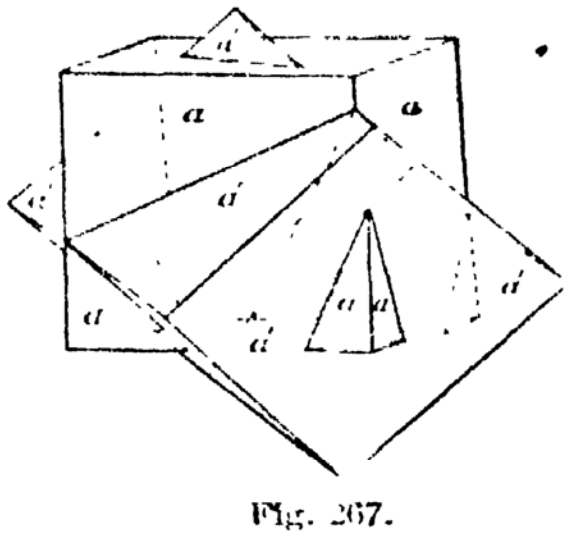


Fig. 267.

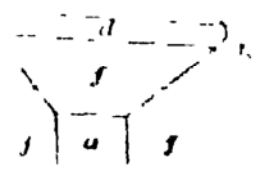


Fig. 268.

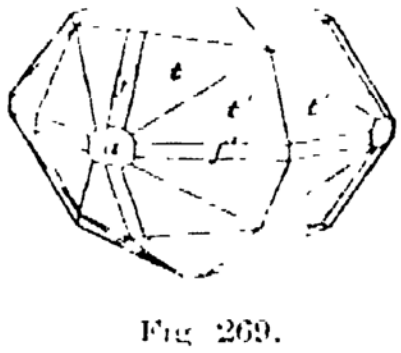


Fig. 269.

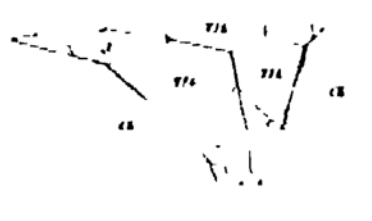


Fig. 270.

phosphoresces with different tints of light, when heated. I
crepitates and fuses to an opaque bead. Sol. in acid with c
of hydrofluoric acid. C.c. of Ca: calcium 48·7, fluorine
mines, generally associated with metallic ores. Shetland,
land, on the Avon, and Bulaton in Scotland; Cum
Northumberland, Derbyshire, and Cornwall; Saxony, I
Freiberg. Used to be turned into vases and other ornament
John"); formerly employed as a flux, now for etching and o
glas

34. YTTROCERITE

In crystalline crusts. H. = 4 to 5, G. = 3·4 to 3·5. Tran
vitreous. Violet blue to grey or white. B.B. infusible.
fluorine when heated with sulphuric acid. C.c.: fluorides o
yttrium and calcium. Finbo and Broddbo near Falun; M
Massachusetts and New York.

35. FLUOCERITE, CeF = Ce_2F_3.

Hexagonal. H. = 4 to 5, G. = 4·7. Opaque or translucen
edges. Pale brick-red or yellowish, streak yellowish whit
infusible. In close tube gives out hydrofluoric acid. C
peroxide of cerium, 1·12 yttria, 16·24 hydrofluoric acid
and Broddbo.

36. FLUOCERITE, $Ce_2F_3 + (Ce_2O_3 + H_2O)$.

Massive, fracture conchoidal. H. = 4·5 to 5. Opaque.
Bright yellow to reddish brown; streak brownish yellow
infusible, darkens with the heat; colour restored on cooling
cerium 17·6, fluorine 10·9, sesquioxide of cerium 66·4, w
From Finbo.

37. BASTNAESITE, $Ce_2F_3 + Ce_2O_3 + 4H_2O$, and

38. HAMARTITE, $2(LaO, CeO)3CO_2 + CeF_3$, are similar. T
from Bastnaes in Sweden, the second from Pike's Peak in C

…LITE, $Al F_3$.

…prismatic. … chloride of calcium with truncated … Solubility … mobile. H. … Lustre … Colour … Stenna gwynn in Cornwall.

…YOLITE, … Al_2 …

…

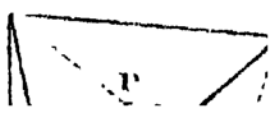
…

…

easily. Sol. in n. acid. C.c. : chloride of lead 40, protoxide of lead 60. Mendip Hills, and Brilon in Westphalia.

68. Schwartzembergite, PbI + 2PbO.

Rhombohedral ; in thin crusts. H. = 2 to 2 [illegible]. Adamantine. Honey-yellow. Desert of Atacama.



69. Atacamite, $CuCl + 3CuO, H_2O$.

Right prismatic ; ∞P (*M*) 112° 25′, P∞ (*I* 1[illegible] 0′. ∞P∞ (*h*) (fig. 275); also reniform. Cl. *h* perfect. Semitransparent ; vitreous. Emerald-green ; streak apple-green. B.B. fuses, leaving copper. Easily soluble in acids. C.c. : copper protoxide 55·85, copper 14·86, chlorine 16·61, water 12·68. Atacama, Chili ; Tarapaca, Peru ; Bolivia ; Burra-Burra, Australia ; Serra de Bembe, Ambriz, Africa : Vesuvius and (?) Etna.

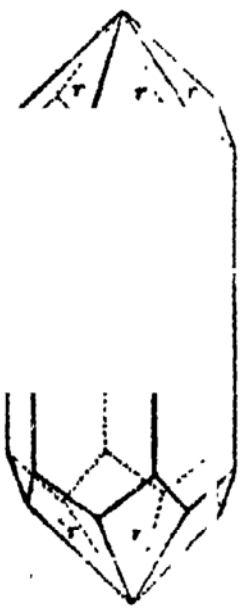


Fig. 276 (sp. 72).

70. Tallingite, $CuCl, H_2O + 4CuO, H_2O$.

In crusts. H. = 3 ; G. 3·5. Bright blue to greenish blue. Translucent ; brittle. Botallack in Cornwall.

71. Percylite, (PbCl + PbO) + (CuCl + CuO).

Cubic (com. of figs. 26, 30, 33, 36). H. = 2. Vitreous. Sky-blue. Sonora in Mexico.

72. Connellite.

Hexagonal (fig 276). *b* : *b* 145° 10′ ; *r* : *r* 13° 50′. Crystals acicular. Vitreous ; translucent. Vitriol-blue. [illegible] chlorida and sulphide of [illegible]

OXIDES OF METALS.

1. Suboxides and Protoxides.

73. Cuprite, Cu_2O.

Cubic (figs. 22, 30, 33, 26, with 39, 40). Compact and granul[illegible] Cl. octahedral ; brittle. H. = 3·5 to 4 ; G. = 5·7 to 6. Transparent and opaque ; adamantine. When transparent, crimson ; when opaque, cochineal or brick-red. Often tarnished grey. B.B. becomes black, fuses, and is reduced on charcoal. Soluble in acids and in ammonia. C.c. : 88·9 copper, 11·1 oxygen. Cornwall, Siberia, Banat, Chessy near Lyons, Linares in Spain, Urals, South Africa, Burra-Burra. Valuable copper ore. *Chalcotrichite* consists of cubes elongated so as to become fibrous. Tile-ore is a ferruginous variety. Hepatic copper, liver ore, or pitchy copper ore seems to be a product of the decomposition of chalcopyrite. *Delafossite*, $Cu_2O + Fe_2O_3$, from Bohemia and Siberia.

74. Water, H_2O.

Hexagonal, when solid, in complex twins in snow crystals ; rhombohedric by cleavage, in ice. H. = 1·5 ; G. = ·918. Hence 100 of water = 1089·5 of ice, or water expands $\frac{1}{11}$th in freezing. Transparent ; vitreous. Colourless, but in bulk pale emerald-green. R 117° 23″. Cl. basal. Water when pure colourless, in mass bluish green. Occurs in centre of geodes of chalcedony in China [illegible] of [illegible] in [illegible] rs in solution, has G. = 1·027 to 1·0285. Waters of saline lakes contain sometimes 26 per cent. of salts, and have G. 1·212. Besides its vast bulk in the ocean, water occurs in enormous amount in the solid form, often as water of crystallization in rocks and minerals, *e.g.*, zeolites. Igneous rocks in some districts are converted largely into saponite, which contains 25 per cent. of water. Water is the standard for specific gravities of solids and liquids ; 1 cubic inch at 60° F. and 30 inches of the barometer weighs 252·458 grains ; 1 litre weighs 1000 grammes.

75. Periclase, MgO.

Cubic ; in cubes and octahedrons. Cl. do. H. = 6 ; G. = 3 to 3·75. Transparent ; vitreous. Grey to dark green. B.B. infusible. Sol. in acids. C.c. : magnesia, with 6 to 8 of iron oxide. Somma.

76. Bunsenite, NiO.

Cubic ; in octahedrons. H. = 5·5 ; G. = 6·4. Vitreous. Pistachio-green. Johann-Georgenstadt.

77. Zincite, ZnO.

Hexagonal and granular. Cl. basal. H. = 4 to 4·5 ; G. = 5·4 to 5·5. Adamantine ; translucent. Blood- or hyacinth-red ; streak [illegible]

80·26, oxygen 19·74 ; sometimes with manganese pe[illegible] Valuable ore of zinc. Franklin and Sterling in New Jersey.

78. Massicot, PbO.

Massive ; scaly crystalline. H. = 2 ; G. = 7·8 to 8. Sulp[illegible] lemon-yellow ; often contains iron. Popocatepetl in Mexico

79. Melaconite, CuO.

Cubic ; compact. H. = 3 to 4 ; G. = 6 to 6·3. Black. infusible ; so[illegible] in acids. Cornwall, Leadhills, Lake Su[illegible] Burra-Burra.

80. Tenorite, CuO.

Oblique prismatic, occurs in thin scales of metallic lustre [illegible] of Vesuvius. Colour black and dark-grey.

2. Sesquioxides.

81. Corundum, Al_2O_3.

Hexagonal ; R 86° 4′. Twins common. Cl. rhombohedral basal. Excessively tough, and difficultly frangible. H. = 9 ; G. = 4 to 4·2. Transparent or translucent ; vitreous, but pearly to resinous on basal face. B.B. unchanged. As *Corundum*, white, grey, greenish, frequently with bronzy lustre on basal face. C.c. : alumina with a little peroxide of iron. China, Ceylon, Bohemia, Macon in North Carolina (one crystal 300 lb weight). *Emery* compact, crystalline, granular ; grey to indigo-blue. Asia Minor, Naxos, Spain, Greenland, America. Corundum is used when cut for cutting and polishing gems in China and India, emery in general for grinding. Alumina occurs also in a purer state in transparent crystals of various tints of colour. When red and of the colour of pigeon's blood they are termed *Rubies* ; these come from Syriam in Pegu, Ava, Ceylon, Bohemia, and near Expailly. When 5 carats in weight a ruby is twice the value of a diamond of the same size, when 10 carats three times the value. When blue the crystal is the *Sapphire*, found chiefly in Ceylon and Pegu ; when green it is the *Oriental Emerald*, when yellow the *Oriental Topaz*, when purple the *Oriental Amethyst*, the a[illegible] here distinguishing them from the true or occidental stone[illegible] same name. Other tints of colour also occur, but with the [illegible]tion of the red and blue they are seldom pure or deep. Th[illegible] when cut with a hemispherical dome sometimes displays rayed star, either of a bright gold or a silvery white colour, greyish blue ground. These receive the name of *Asteria Sa[illegible]* The same crystal frequently shows portions of even three [illegible] tints. When perfectly devoid of colour, they are called *Sapphires* ; such are little inferior to the diamond in bri[illegible] but do not disperse rays of light to the same extent.

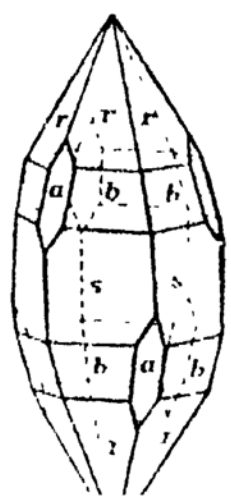


Fig. 277.

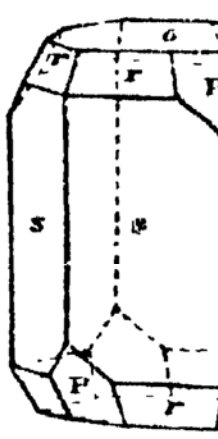


Fig. 27[illegible]

82. Hæmatite, Fe_2O_3.

Hexagonal and rhombohedral ; R 86°. Crystals rhombo[illegible] prismatic, and tabular. Twins with axes parallel. Cl. R, and fracture conchoidal ; brittle. H. = 5·5 to 6·5 ; G. = 5·1 [illegible] Opaque, but in thin lamina transparent and blood-red. [illegible] metallic lustre, iron-black to steel-grey, often brilliantly tarn[illegible] red, yellow, green, and blue tints ; streak cherry red. B.B. in the outer flame becomes black and magnetic. Sol. in acids. C.c. : iron 70, oxygen 30. The following are varietic[illegible] subdivisions :

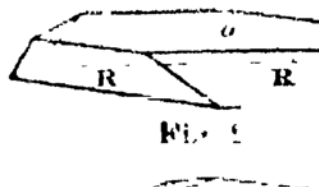


Fig. 279.

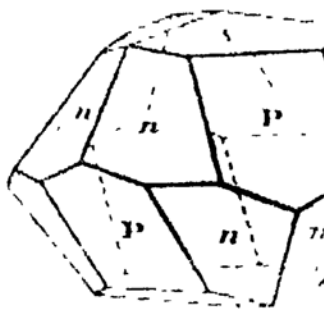


Fig. 280.

Elba Iron Ore, highly modified rhombohedral crystal often brilliantly tarnished. *Specular Iron Ore*, in thin flat crystals, often from volcanoes, as on the island of Ascension ; this variety includes *Micaceous Iron*, thin, lamellar, and curved, and *Red Iron Froth*, scaly. *Red Hæmatite*, in botryoidal and stalactitic forms, which are internally composed of radiating fibres, and often have a concentric structure ; the external surface has red to a brownish red hue. *Compact* and *Ochrey* varieti[illegible] more or less aluminous impurity, pass into *Reddle* or red ch[illegible] when still more earthy into jaspery and columnar ores. Th[illegible] very commonly distributed :—micaceous iron at Pitfichie in A[illegible] [illegible]rnam in Perthshire ; red hæmatite at Leadhills

on in Lancashire, specular iron at Tavistock in Devonshire Cumberland. *Ilmenite* seems to be the same substance in morphic after magnetite; it occurs in octahedra in Bute, d (Vosges), New York, and Brazil.

AMENITE, $FeTiO_3$.

hohedral. H. 5·6. Crystals rhombohedral and tabular, also C. Fracture conchoidal. H. = 5 to 6. G. = 4·66 to 5. ...ame to be, iron black ... brown. Usually black or ... Sometimes slightly ... B.B. infusible, but with ... salt forms a red glass ... of iron; and when pow... C.c.: peroxide of iron, with ... to 53 per cent. oxide o... Occurs in metamor... ks. Common in chlorite ... Scotland. Menaccan (Cornwall), Ilmen Mountains, Salz... gersund (Norway), Arendal, Dauphiné (*Crichtonite*), Massa (*Washingtonite*).

Fig. 281.

RINE.

, in octahedra. Strongly magnetic, in other respect ...mila... te, but occurs in igneous rocks. Common as black iron... Scotland, Lherzolite in Bohemia, Auvergne, Canada, New

MPOUNDS OF SESQUIOXIDE WITH PROTOXIDE (SPINELS).

AGNETITE, FeO, Fe_2O_3.

(figs. 35, 30, 33, 29, 31, 37 with 10, 11, 36). Hemi... ommon on octahedral face (fig. 169). Twin (fig. 286). Faces ...ated in long diagonal. Often compact and granular. Cl... al; fracture conchoidal or uneven; brittle. H. = 5·5 to 6·5, ...e 5·2. Opaque. Lustre metallic. Iron black to brown, bla... Highly magnetic, often polar, forming natural ... B.B. becomes brown and non-magnetic; fuses with ... Powder of mineral. C.c.: 31 protoxide and 69 per ...ron, or 72·4 iron, 27·6 oxygen, sometimes with titanic acid... ds in Shetland and Sutherland, also Cornwall and Antrim; ...lla (Piedmont), Tyrol, Styria. Massive at Dannemora and ...(Sweden), Norway, Urals, Harz, Saxony, Elba. This is ...t important ore in Norway, Sweden, and Russia, and affords ...t iron.

AGNESIO-FERRITE, MgO, Fe_2O_3.

(fig. 30). H. = 6 to 6·5, G. = 4·5 to 4·66. Other ... same as magnetite. C.c.: magnesia 20, peroxide of iron ...marole of Vesuvius.

ROMITE, $(MnO, MgO, (Fe_2O_3, Mn_2O_3$.

, O. Black, vitreous, streak red. Nordmark in Sweden.

RANKLINITE, $(FeO, ZnO, MnO), (Fe_2O_3, Mn_2O_3$.

(figs. 34, 64), also granular. Cl. octahedral; fracture ...dal, brittle. H. = 5·5 to 6·5, G. = 5·07. Metallic lustre ...d, streak reddish brown. Opaque, slightly magnetic ...nsible, but shines and throws out sparks. On charcoal with ...deposit of oxide of zinc. Sol. in hot acid with evolution of ... C.c.: about 67 iron oxide, 17 manganese pe... ide. Franklin and Sterling (New Jersey).

HROMITE, FeO, Cr_2O_3.

...in octahedra, generally granular-massive. H. = ... to 5·5. Opaque; semimetallic to resinous. Iron black to ...own; streak reddish brown. Fracture uneven, sometimes ... B.B. unchanged, or red flame becomes magnetic with ...ous an emerald green bead. Not soluble in acids. C.c.: ... protoxide of iron 0 to 15, magnesia 36 to 61, peroxide of ...e, 9 to 21, alumina. Unst (Shetland), Towanreth (C... , Silesia, Bohemia, Styria, Urals, Turkey, Baltimore ... and Hoboken. The ore of chromium, used in ... chromite mixed with nickeliferous.

VANITE (*Peak Blende*), UO, U_2O_5.

...Occurs usually massive and botryoidal. H. = 5 to 6. ...ks. Lustre pitchlike to nearly dull. Colour velvet black, ...sh black, reddish grey. B.B. infusible. Not affected by ... acid, ... in hot nitric acid. C.c.: oxide of uranium 80, with a mixture ... oxides of cobalt, bismuth, iron, etc. Joachimsthal, Annaberg, Przibram, Redruth (Cornwall). The chief ore of uranium.

AHNITE, ZnO, Al_2O_3.

...(figs. 166, 30). Occurs with 39, 40. Hemitrope-like ...ite. Cl. O. brittle, with conchoidal fracture. H. = 7·5 to ... 4·3 to 4·9. Opaque, vitreous-resinous. Dark bluish-green ..., streak grey. B.B. unchanged. Unaffected by acids or ... C.c.: 44 oxide of zinc, 56 alumina. Falun, Broddbo, ...n in Connecticut, and Franklin in New Jersey. *Dysluite* ... 12 per cent. sesquioxide of iron, and *Kreittonite* contains ... of manganese.

92. HERCYNITE, FeO, Al_2O_3.

Cubic; generally granular massive. H. = 7·5 to 8; G. = 3·95. B.B. infusible. C.c.: oxide of iron 41·1, alumina Ronsberg in the Böhmerwald.

93. SPINEL, MgO, Al_2O_3.

Cubic (figs. 30, 33, 40 with 26); hemitropes united by face of octahedral; fracture conchoidal. H. = 8; G. = 3·4 to 4·1. ...parent to opaque; vitreous. Black, red, blue, green; streak ... B.B. infusible and unchanged. C.c.: 28 magnesia, 72 a... some with a little iron, and the red varieties some chr... Varieties are:—*Spinel Ruby* when scarlet, *Balas Ruby* when r... both often sold as the true ruby, but not nearly so valuable ... of 4 carat valued at half the price of a diamond the same size.

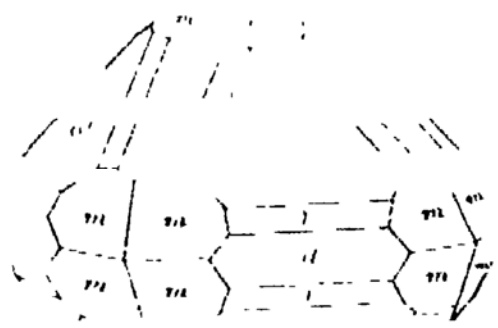


Fig. 282.

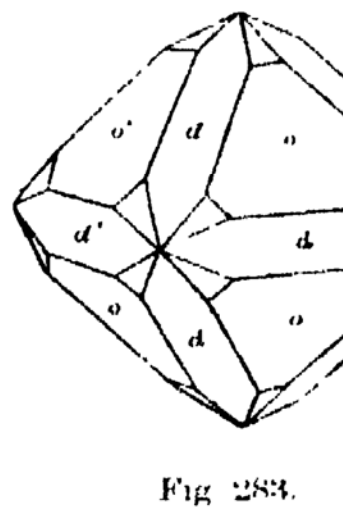


Fig. 283.

come from Pegu (native name Balachan). The violet-colour... *Alabandine ruby* from Alabandin in Caria, (Asia Minor). Th... red is the *Rubicelle*. The above also occur at Ceylon, Ava, ar... *Sapphirine* is pale sapphire blue to greenish or reddish blue, from Aker in Sweden, Greenland, and N... *Hiouaste*, dark green or blue to black, from Candy in Ceylon. *Chlorospinel*, grass-green with a yellowish white streak; from Zlatoust. *Water-spinel* colourless; from Ceylon. *Picotite* is a dark blue chromiferous variety from serpentine.

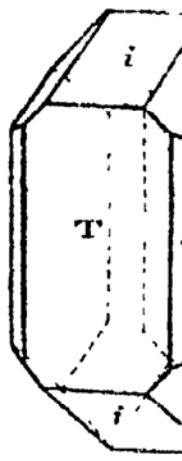


Fig. 284 (

91. CHRYSOBERYL, GlO, Al_2O_3.

Right prismatic (fig. 284). Twins common, united by a face of P∞ (fig. 285, also 156). Cl. brachydiagonal imperfect, macrodiagonal more ...o, fracture conchoidal. H. = 8·5; G. = 3·68 to ...8. Transparent or translucent; vitreous. Greenish white, leek green, and dark emerald-green. B.B. infusible. Not affected by acids. C.c.: glucina 20, alumina 80. Brazil, Ceylon, India, the Urals, Haddam in Connecticut. A very valuable gem. It sometimes possesses an opalescent band, which when the stone is cut *en cabuchon* appears as a streak of floating light; whence it derives its name of *Cymophane*. It is then also called the chatoyant or Oriental chrysolite, and when fine is of extreme value. The emerald-green variety, or *Alexandrite*, is columbine red by transmitted light.

Fig. 2

4. DEUTOXIDES.

95. RUTILE, TiO_2.

Pyramidal; prisms dominant. P 84 40′; P∞ 65° 35′ (f... 287). Hemitropes common, with axes of halves 114° 2... P and ∞P∞, p... H. = 6 to 6·5; G. = 4·2 to 4·3. parent to opaque; adamantine lustre. Brown-red, red, pale yellow, and black; streak yellowish brown. B.B. unchanged, with borax in the ox. flame forms a greenish, in the red flame a violet gl... Not affected by acids. C.c.: titanic acid, with some peroxide of iron. Craigcailloch and Ben-y-Gloe (Perthshire), The Cobbler and Ben-Bheula (Argyllshire), Alps, Limoges, Norway, Brazil. Large cr... Tremnum Mount (Lincoln county, Georgia). Used in p... painting, and for tinting artificial teeth. When attenuated ... are imbedded in rock-crystal they are called Venus' hair.

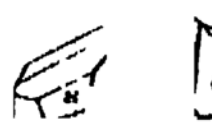


Fig. 286.

Fig. 28

NATASE, TiO_2.

idal; pyramids dominant. P 136° 36′ (fig. 288). Cl. and P, both perfect; brittle. to 6; G. = 3·8 to 3·93. Trans- o opaque; lustre adamantine to Indigo-blue, yellow, brown, olourless; streak white. B.B. . Sol. in hot s. acid C.c.: eid, with a little iron and rarely rnwall and Devonshire, the Alps, é, Valais, the Urals, Minas Brazil).

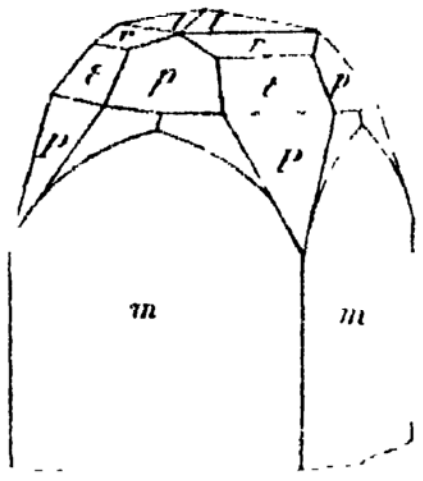
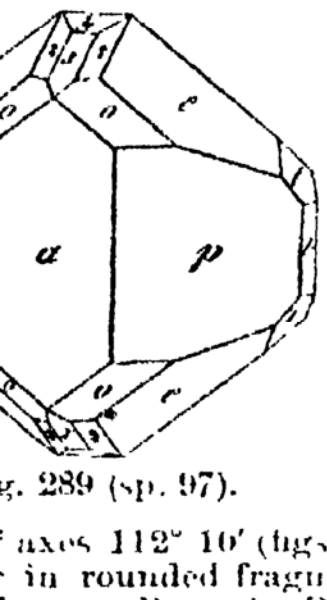


Fig.

ROOKITE, TiO_2.

prismatic; with polar edges 135° 101° 3′ (fig. 289). Cl. macrodia H. = 5·5 to 6; G. 3·86 to 4·2 rent to opaque; lustre metallic ine. Yellowish, reddish, and hair-brown, streak yellowish white to white. B.B. infusible; with microcosmic salt, a brownish yellow glass. C.c.: titanic acid, with per cent. peroxide of iron. Snowdon and Tremadoc (Wales), Chamouni, Bourg d'Oisans, Mask. *Iserine* is iron-black, and submetallic. thick crystals from Arkansa, U.S.



g. 289 (sp. 97).

98. CASSITERITE, SnO_2.

Pyramidal. P 87° 7′. Pz 67° 50′ (figs. 290 to 292). Crystals ∞P, P, or ∞P (*g*), P (*s*), ∞P∞ (*t*), or with P∞ (*P*), (fig. 290), and also ∞P2 (*x*) and 3P3 (*z*), (fig. 291). Heminrope very common, combined by a face of P∞ with axes 112° 10′ (figs. 293, 171, 172, 173), also fibrous (*Wood* in rounded fragments and grains (*Stream Tin*). Cl. pris- long ∞P, and ∞P∞, imperfect, brittle. H. = 6 to 7,

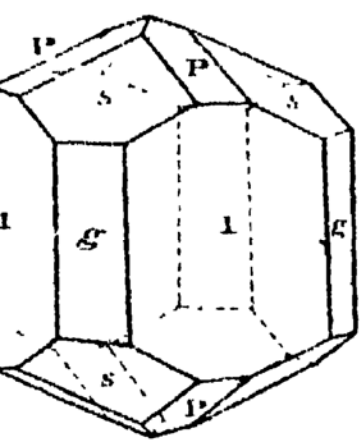


Fig. 290.

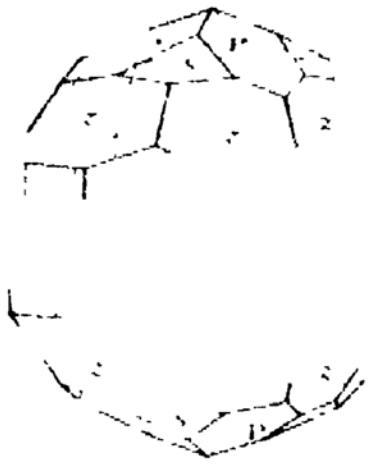


Fig. 291.

to 7. Translucent or opaque; adamantine or resinous. but usually grey, yellow, red, brown, and black; streak light grey, or brown. B.B. in the forceps infusible; on

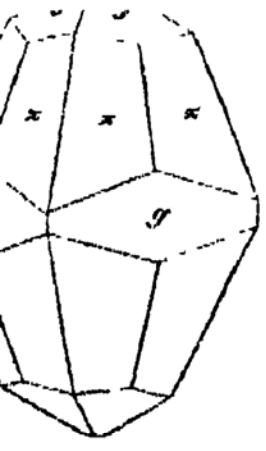


Fig. 292.

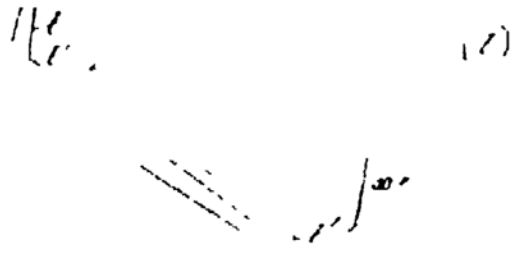


Fig. 293

l, in the inner flame, reduced to tin. Not affected by acids. 8·6 tin and 21·4 oxygen, but often mixed with peroxide of manganese, or tantalic acid. Cornwall, Bohemia, Saxony, lesia, Haute-Vienne in France, Greenland, Russia, North uth America, Malacca, Banca, and Queensland. Almost y ore of tin.

HAUSMANNITE, $2MnO, MnO_2$.

nidal. P 116° 59′; P∞ 98° 32′ (fig. 110). Twins common, ettes of twins (figs. 174, 175). Cl. basal, perfect, less so P and acture uneven. H. = 5·5; G. = 4·7 to 4·8. Opaque; metallic Iron-black; streak brown. B.B. infusible, but becomes brown. Sol. in h. acid, with evolution of chlorine. Powder s. acid red. C.c.: 31 protoxide and 69 peroxide of man Ihlefeld and Ilmenau in the Harz, and Sweden.

100. BRAUNITE, MnO, MnO_2.

Tetragonal. P 108° 39′. Cl. P, brittle. H. = 6 to 6·5; G. 4·9. Metallic lustre. Colour and streak dark brownish C.c.: 70 manganese and 30 oxygen, generally with about 8 p of silica. Ihlefeld and St Marcel. *Marceline* has violet tar

101. PYROLUSITE, MnO_2.

Right prismatic, ∞P 93° 40′, generally radiating fibrous, or rthy. Cl. ∞P, friable. H. = 2 to 2·5; G. = 4·7 to 5. Opaque, lustre silky to semi-metallic. Dark steel-grey to black, streak black. Soils. B.B. infusible, loses oxygen and becomes brown. Sol. in h. acid, with evolution of chlorine. C.c. manganese 63, oxygen 37. Arndilly (Banffshire), Cornwall and Devon. Ilmenau, Ihlefeld, France, Hungary, Brazil. Used for re moving the green iron tint from glass, hence its name and that of *Savon de verre*. Also for obtaining oxygen and chlorine. *Wad* is a variety with 5 per cent. of water, from Warwickshire.

Fig. 294

102. CRONSTEDTITE, $3(FeO, 2MnO, MnO_2)$.

Oblique. H. = 4·5, G. = 5. Metallic. Black, streak Thuringia.

103. PLATTNERITE, PbO_2.

Hexagonal. ∞P 120°. Cl. indistinct, brittle. G. = 9·4. metallic. Iron-black, streak brown. C.c.: lead 86·2, 13·8. Leadhills.

104. MINIUM, $2PbO, PbO_2$.

Pulverulent. H. = 2 to 3; G. = 4·6. Dull. Colour bri streak orange-yellow. B.B. fuses easily and reduced. S acid. C.c.: lead 90·7, oxygen 9·3. Leadhills, Weardale shire, Anglesea, Badenweiler, Siberia.

5. HYDROUS OXIDES.

105. SASSOLINE, BO_3, H_3O.

Anorthic. 0P, ∞P∞ 70° 30′. Scaly in sided plate basal. Flexible and sectile. H. = 1, G. = 1·4 to 1·5. Tran pearly, white, taste bitter; greasy. Sol. in hot water boracic acid 56·45, water 43·55. Hot springs of Sas Siena, Tuscany, and with sulphur in the crater of Lipari Islands.

106. TURGITE, $2Fe_2O_3 \cdot H_2O$.

Massive and fibrous, also earthy. H. = 5 to 6, G. = 3·54 Lustre satin-like, also dull. Colour reddish black to bri Botryoidal surface, fractures like limonite. Opaque. C.c.: iron sesquioxide 94·7, water 5·3. B.B. decrepitates violently and yields water. Korrera (Hebrides), Bogoslovsk (Urals), and many limonite localities. Frequently taken for limonite.

Fig. 295 (si

107. DIASPORE, Al_2O_3, H_2O.

Right prismatic, ∞P 129° 47′, usually thin foliated. Cl. brachydiagonal, perfect, brittle. H. = 6, G. = 3·3 to 3·4. Vitreous, pearly on cleavage planes. Colourless to yellowish, greenish, or violet. B.B. infusible, decrepitates. Insoluble. C.c. alumina 85, water 15. Schemnitz, Brookbo, Switzerland, Naxos, Chester, Chusett. Fig. 295.

108. GOTHITE, Fe_2O_3, H_2O.

Right prismatic, ∞P 94° 55′; also columnar, fibrous, or scaly. Cl. brachydiagonal, perfect; brittle. H. = 5 to 5·5, G. = 3·8 to 4·4. Opaque, or fine crystals transparent, and hyacinth-red; lustre adamantine or silky. Colour yellow, red, or dark brown, streak brownish yellow. B.B. becomes magnetic, difficultly fusible. Sol. in h. acid. C.c.: peroxide of iron 90, water 10. Hoy (Orkney), Achavanisdale (Caithness), Salisbury Crags (Edinburgh), Lostwithiel, Clifton, Bristol, Przibram, Siegen, Saxony, Ural America.

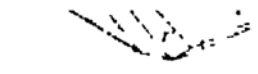


Fig. 296.

ANGANITE, Mn_2O_3, H_2O.

rismatic, sometimes hemihedric; ∞P (*M*) 99·40. Crystals (figs. 298 to 300), vertically striated; mmar or fibrous. Hemitropes com l. brachydiagonal, perfect; brittle. to 4. G. 4·3 to 4·4. Opaque, lustre steel grey to iron black wn. B.B. infusible. Sol. in warm C.c. peroxide of manganese 89·6, Grandholm (Aberdeenshire), pton Pyne (Exeter), Churchhill , Warwickshire, Ilefeld, Thuringia, weden, Nova Scotia.

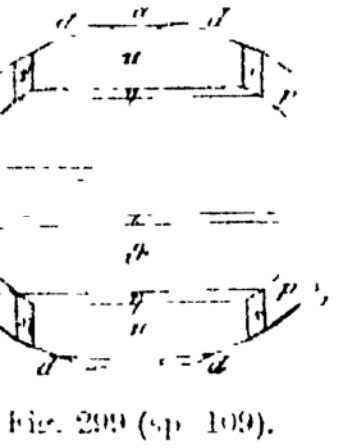


Fig. 299 (sp. 109).

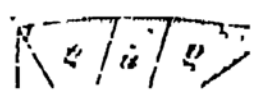


Fig. 300 (sp. 109).

MONITE, $2Fe_2O_3 + 3H_2O$.

. botryoidal, and stalactitic, some- thy. H. 5·5 to 5·5, G. 3·4 to aque; lustre silky, glimmering, or dull. Brown, yellow- blackish brown, often black on surface; streak ochre- In closed tube yields water and becomes red. B.B. in e becomes magnetic, fusing to a glass. C.c. peroxide 5·6, water 14·4. Sandlodge (Shetland), Hoy (Orkney), Bristol, Cornwall, Harz, Thuringia, Nassau, Styria, Carin- tia, United States.

ANTHOSIDERITE, Fe_2O_3, $2H_2O$.

, stellate, also as an ochre. H. = 2·5. Silky or greasy, or earthy. In needles, golden-yellow or brown-red, as yellow, red, or brown; streak ochre-yellow. B.B. like C.c.: peroxide of iron 81·6, water 18·4. Hoy (Orkney), sdale, Kilbride, Wicklow, Ilmenau, Goslar, and Elbingerode iz.

EAUXITE, $(3Al_2O_3, Fe_2O_3)$, $2H_2O$.

concretionary, disseminated; also earthy and clay-like. White, grey, ochre-yellow, brown, and red. C.c.: 50·4, peroxide of iron 26·1, water 23·5. From Beaux or Arles, and elsewhere in France. In grains, in compact Pure varieties used for manufacture of aluminium.

HASITE, $P_2O_3 + 2H_2O$.

hous masses, resin-like. H. 3·5 to 4·5, G. 4 to 5. rown to black; streak wax-yellow to olive-green. C.c.: ent. sesquioxide of uranium, 10 of water, with impurities e near Joachimsthal).

SITE, MgO, H_2O.

ohedral, R 82° 22′; also foliated and botryoidal columnar perfect, ductile, lamina flexible. H. = 2, G. = 2·3 to 2·4 nt, pearly. Colourless. B.B. infusible. Easily soluble in 69 magnesia, 31 water. *Nemalite* is a fibrous variety Swinaness and Quin Gio in Unst, Beresovsk , Hoboken, New Jersey, Texas, Pennsylvania.

, MANGANITE, MnO, H_2O.

d. H. 2·5. Pearly, white, but changing through bronze Reflected by transmitted light. In matrass becomes ssion, bodily black, yielding water. Sol. in h. acid. oxide of manganese 79·8, water 20·2. In veins in mag- Pacher in Tyrol.

BBSITE (*Hydrargillite*), Al_2O_3, $3H_2O$.

onal. C.c. Gibbsia, 34·5 water. The crystals are found in the Urals; stalactites from Richmond in Massachu- Villa Rica in Brazil.

OMITE, Fe_2O_3, $3H_2O$.

e in stalactites, also as a yellow ochre. Like limonite, but astre. C.c.: peroxide of iron 74·8, water 25·2. Leadhills, k (Cornwall), Novgorod Russia.

HYDROTALCITE, Al_2O_3, $3H_2O$ (MgO, H_2O) + $6H_2O$.

onal. Cl. basal, foliated, and somewhat fibrous. H. = 2; . White, pearly. Greasy to the touch. Translucent. mina 16·8, magnesia 39·2, water 44. Zlatoust, Urals; Norway; New York.

119. PYROAURITE, Fe_2O_3, $3H_2O$ + 6MgO, H_2O + $6H_2O$.

Hexagonal; tables and scaly coatings. Lustre pearly to submetallic. Colour white to gold-yellow. Translucent. B.B. infusible, yields water. Sol. in h. acid. C.c.: peroxide of iron 23·9, magnesia 35·8, water 40·3. Haaf Grunay in Shetland, Långban in Wermland.

120. GUMMITE, U_2O_3, $3H_2O$.

In rounded lumps, resembling gum. H. = 2·5 to 3; G. = 3·9 to 4·2. Lustre greasy. Reddish yellow to yellowish brown. C.c.: 72 per cent. sesquioxide of uranium, water 14·75, with impurities. Johann-Georgenstadt.

121. PSILOMELANE, (BaO, MnO) $MnO_2 + 3H_2O$, $MnO_2 + 3H_2O$.

Massive and botryoidal; fracture conchoidal. H. = 5·5 to 6; G. = 4·1 to 4·3. Bluish black. B.B. infusible. About 80 per cent. of oxide of manganese, with baryta, potash, and water. Hoy (Orkney), Leadhills, Cornwall, Devon, Schneeberg, Ilmenau, Vermont in France. *Wad* is similar, but sometimes soft and light. Leadhills, Cornwall, Harz, France.

122. CHALCOPHANITE, $MnOZnO + 2MnO_2 + 2H_2O$.

Hexagonal. R R 114° 30′. Cl. basal. H. = 2·5; G. = 3·91. Metallic lustre. Blue black; streak brown, dull. Opaque; flexible. C.c.: manganese binoxide 59·94, protoxide 6·6, zinc oxide 21·7, water 11·6. Sterling Hill (New Jersey).

OXIDES OF NON-METALS.

I. OXIDES OF ARSENIC-ANTIMONY FAMILY (TEROXIDES).

123. ARSENOLITE, AsO_3.

Cubic, in octahedra also botryoidal, stalactitic. H. = 1·5; G. = 3·7. Lustre vitreous. White, streak pale yellow. Translucent. Sublimes in closed tube, condensing in brilliant octahedra. C.c.: arsenic 75·76, oxygen 24·24. Cornwall, Andreasberg, Joachimsthal, Kapnik (Hungary), Nevada, California.

124. SENARMONTITE, Sb_2O_3.

Cubic; in octahedrons. Cl. octahedral, also massive granular. H. = 2 to 2·5, G. = 5·22 to 5·3. Transparent; adamantine. White or grey. B.B. in inner flame fuses and colours the flame greenish blue. Sol. in h. acid. C.c.: antimony 83·56, oxygen 16·44. Endellion in Cornwall, Constantine in Algeria, Malaczka in Hungary.

125. VALENTINITE, Sb_2O_3.

Right prismatic. ∞P 137°. Cl. ∞P, perfect. H. = 2·5 to 3; G. = 5·5 to 5·6. Translucent; adamantine to pearly. Yellowish white, brown-grey, streak white. Other properties and composition like senarmontite. Glendinning (Dumfriesshire), Przibram, Bräunsdorf (Saxony), Harz, Hungary, Allemont (Dauphiné), Siberia.

126. BISMITE, Bi_2O_4.

Massive, earthy. G. 4·36. Grey, yellow, green. C.c.: bismuth 89·65, oxygen 10·35. St Agnes (Cornwall), Schneeberg, Siberia.

127. MOLYBDITE, MoO_3.

Right prismatic, ∞P 136° 48′. In capillary crystals, also powdery. H. = 1 to 2; G. = 4·5. Straw-yellow to yellowish white. C.c.: molybdenum 65·71, oxygen 34·29. With molybdenite at many of its localities.

128. TUNGSTITE, WO_3.

Earthy. Soft yellow or yellowish green. Sol. in alkalies. C.c.: tungsten 79·3, oxygen 20·7. Cumberland and Cornwall, Monroe in Connecticut.

129. CERVANTITE, $Sb_2O_3 + Sb_2O_5$.

Right prismatic. Acicular, generally earthy. H. = 4 to 5; G. = 4·1. Isabel-yellow, reddish white. B.B. on charcoal reduced; unaltered *per se*. Sol. in h. acid. Harehill, Ayrshire; Endellion, &c., Cornwall; Cervantes, Spain; Felsobanya, Hungary; Mexico, Canada; California.

130. STIBICONITE, Sb_2O_4, H_2O.

Massive, powdery. H. = 4 to 5·5; G. = 5·28. Pale yellow. In closed tube yields water. C.c.: antimony 74·9, oxygen 19·6, water 5·5. Goldkronach (Bavaria).

131. VOLGERITE, Sb_2O_5, $5H_2O$.

Massive and powdery. White. In tube yields water, below redness. C.c.: antimony 58·9, oxygen 19·3, water 21·8. Constantine in Algeria.

132. ZINKENITE (*Tinder Ore*).

In soft, flexible, tinder-like masses. Colour dark cherry-red to blackish red; lustre glimmering. Two varieties:—one, from Klausthal, contains antimony oxide 38, iron oxide 40, lead 16, sulphur 4; the other, from Andreasberg and Klausthal, seems to be a mixture of jamesonite (82·04 per cent.), mispickel (13·46), and pyrargyrite (4·34).

133. TELLURITE.

Yellowish or whitish. Radiated, spherical masses. Gives the reactions of tellurous acid. Facsebaya and Zalathna, Colorado.

4. TANTALIC OCHRE.
wdery; brown; vitreous. Pennikoja in Finland.

2. OXIDES OF CARBON-SILICON FAMILY (BINOXIDES).

5. QUARTZ, SiO_2.
exagonal; the purest varieties tetartohedral. The primary
mid P has the middle edge = 103° 34′, and the polar edges =

. 301.

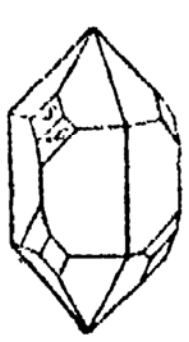


Fig. 302.

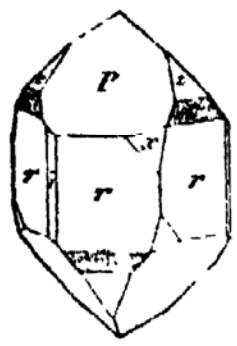


Fig. 303

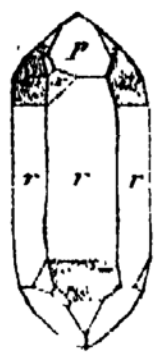


Fig. 304.

Fig. 305.

44′, and is often perfect. Very frequently it appears
a rhombohedron R (or ½P), with polar edges 94° 15′.
tals often of ∞P, P
∞P, P, 4P, the forms
and 4P being combined
n oscillatory manner,
ucing striæ on the face
e prism (figs. 303, 304,
; also ∞P, P, ¾(2P2),
last face appearing as a
nb replacing the alter-
angles between the two
r forms (figs. 307, 308)
y are prismatic, or py-
dal, or rhombohedral,
P is divided into 2

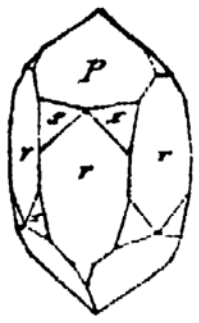


Fig. 306.

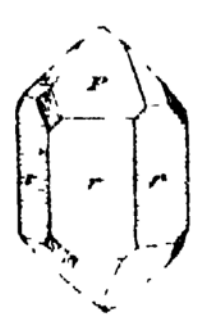


Fig. 307.

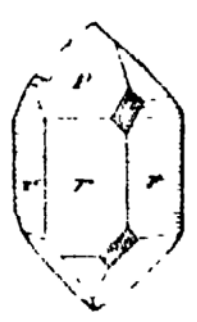


Fig. 308.

and −R; the latter
often wanting. Many faces plagihedral, as
gs. 302, 306, 309.

vins common, with parallel axes, and other
ly in juxtaposition (see fig. 178) or interpene-
ng. Crystals often distorted, as in figs. 310
13. The crystals occur either single, attached,
mbedded, or in groups and druses. Most fre-
tly granular, massive, fibrous, or columnar;
in pseudomorphs, petrifactions, and other
s. Cl. rhombohedral along R, very imper-
prismatic along ∞P, still more imperfect.
ure conchoidal, uneven, or splintery. H. 7;
2·5 to 2·8; 2·65 in the purest varieties
urless, but more often white, grey, yellow,
n, red, blue, green, or even black. Lustre
eous, inclining to resinous; transparent or
slucent; when impure almost opaque. B.B.
ible alone; with soda effervesces, and melt

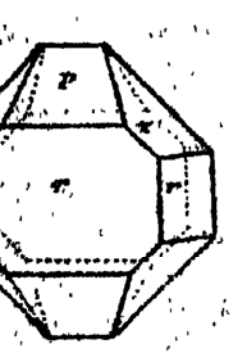


Fig. 310.

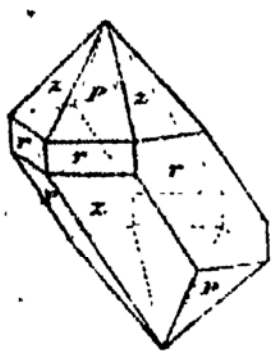


Fig. 311.

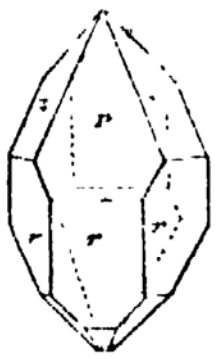


Fig. 312.

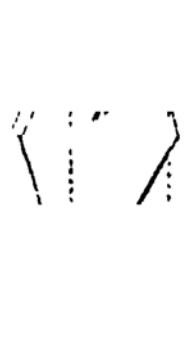


Fig. 313.

5 silicon and 51·95 oxygen; but frequently a small amount of
oxides of iron or titanium, of lime, alumina, and other
tances.

he following are varieties:—

ock-crystal: highly transparent and colourless; Dauphine,
zerland, Tyrol, Hungary, Madagascar, and Ceylon.

methyst: violet-blue (from iron peroxide or manganese), and
n marked by zigzag or undulating lines, and the colour dis-
d in clouds; Siberia, Persia, India, Ceylon, Brazil (white or
ow, named false topaz), Hungary, Ireland (near Cork), and
rdeenshire. Wine-yellow (*Citrin* and *Gold Topaz*): the brown
Smoky Quartz (coloured by a substance containing carbon
nitrogen); and the black or *Morion*, from Siberia, Bohemia,
nsylvania, and other places. *Cairngorm Stone*, black, brown, or
ow, from Aberdeenshire mountains. The above are valued as
mental stones; those which follow are less so.

se Quartz: red inclining to violet blue; Clashmaree Hill (Aber-
), and Rabenstein in Bavaria. *Milk Quartz*: milk-white, and
tly opalescent; Greenland. *Prase*: leek and other shades of
green; Saxony and Cedar Mountain in South Africa. (
inclosing asbestos: greenish white or grey, olive green, red
or yellow; Ceylon and Malabar. *Aventurine*, enclosin
yellow, red, green, or brown; India, Spain, and Scotland.
indigo or Berlin blue; Golling in Salzburg.

Common Quartz, crystallized or massive, white or gray,
brown, &c., is a frequent constituent in many rocks. Som
varieties are properly rocks, as

(1) *Ferruginous Quartz*, or *Iron Flint*: red, yellow, or
often associated with iron ores.

(2) *Jasper*: red, yellow, brown, also green, grey, wh
black: alone, or in spots, veins, and bands (*Ribbon* or
Jasper), Urals, Tuscan Apennines, Harz, and many parts of S

(3) *Lydian Stone*, or *Flinty Slate*: black, grey, or whit
splintery or conchoidal fracture, breaks into irregular fr
and passes by many transitions into clay slate, of which it
merely an altered portion, as in Scotland, used as a touch
gold, and at Eldal (Sweden) manufactured into ornaments

(4) *Hornstone* or *Chert*: compact, conchoidal, splintery
translucent on the edges; dirty grey, red, yellow, green, o
passes into flinty slate or common quartz; common in the M
limestone, Oolite, and Greensand formations; and often
petrifactions, as shells, corals, and wood.

Other siliceous minerals seem intimate mixtures of qu
opal, as —

Flint: greyish white, grey, or greyish black, also yell
or brown, sometimes in clouds, spots, or stripes, se
parent; lustre dull; fracture flat conchoidal, occurs chiefl
Chalk formation, as in England, Ireland, Aberdeenshire,
Germany, and other countries; sometimes in beds or vertic
often in irregular lumps or concretions, inclosing petrifac
sponges, echinoids, shells, or siliceous *Infusoria*. The
partly derived from carbon, or organic matter. Used for
gun flints, and still for the manufacture of glass and pott
cut into cameos or other ornaments.

Chalcedony: semitransparent or translucent; white, gr
green, yellow, or brown, stalactitic, reniform, or botryo
in pseudomorphs or petrifactions; Iceland, Faroes, Trev
Cornwall, Scotland, Hungary, Bohemia, Oberstein. *C*
chiefly blood-red, but also yellow, brown, or almost black
Arabia, Surinam, and Siberia; also Bohemia, Saxony, and
(Fifeshire). *Plasma*: leek or grass-green, and waxy lustr
pus, Black Forest, India, and China.

Chrysoprase: apple green; Silesia, and Vermont in North
Moss-Agate and *Heliotrope*: dark green and dendritic calle
stone when sprinkled with deep red spots), India, Siberia,
Fassa Valley, island of Rum and other parts of Scotland.

136. TRIDYMITE, SiO_2.

Hexagonal; P middle edge 121° 4′, polar edges 127° 35′
crystals very minute hexagonal tables of 0P, ∞P but
edges replaced by P and ∞P2, are rare (fig. 314). Mo

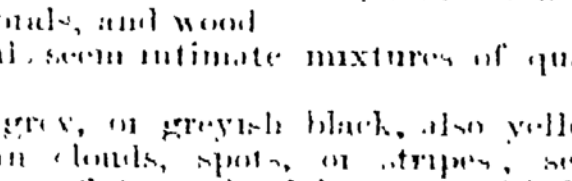


Fig. 314.

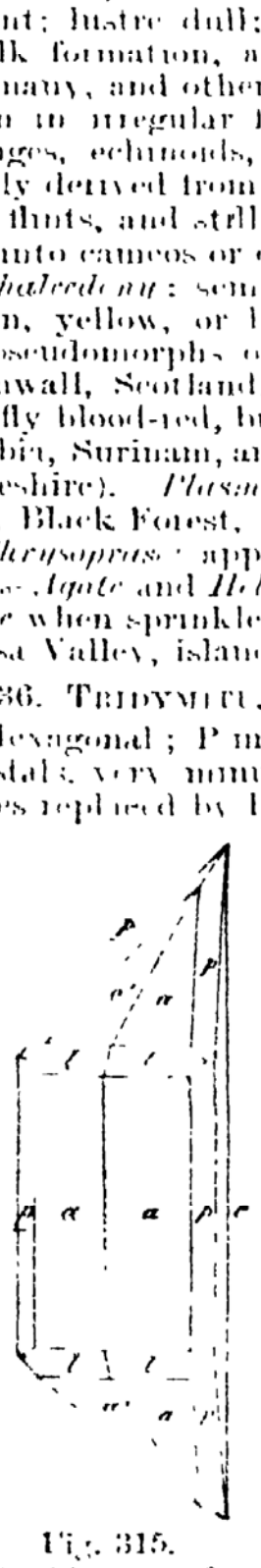


Fig. 315.

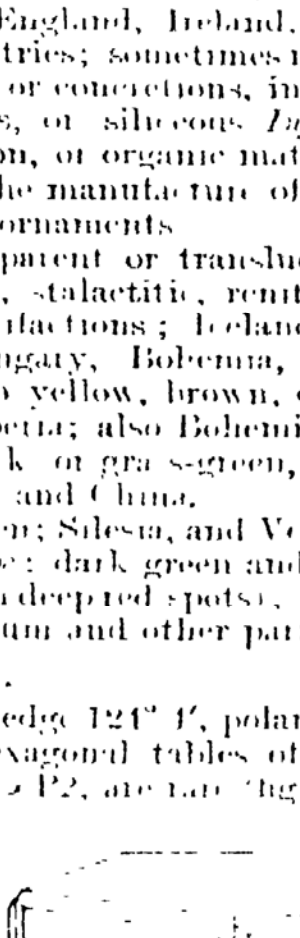


Fig. 316.

in double or (oftener) triple combinations (figs.
315 to 317). Cl. basal, indistinct; fracture con-
choidal. H. 7; G. = 2·282 to 2·326. Colourless
and transparent, vitreous, pearly on the base.
B.B. like quartz. C.C.: 96 silica, with some
alumina, magnesia, and iron peroxide, probably from the
Discovered by Von Rath in the trachyte of San Cristob
Pachuca, in Mexico; also in the trachyte of Mont-Dore
Dome), the Drachenfels, and Hungary. Many opals, trea
solution of potash, leave crystals, as those from Zimapan,
Silesia, and the cacholong from Iceland. Where such
are abundant, the opal becomes opaque or snow white
regards these as still another variety of silica.

Opal, $9SiO_2$, H_2O to $3SiO_2$, H_2O.

phous; fracture conchoidal, very brittle. H. 5·5 to 2 to 2·2. Transparent to opaque vitreous inclining to . Colourless, but often white, yellow, red, brown, green, with a beautiful play of colours. B.B. decrepitates and opaque, but infusible, in the closed tube yield water; wholly soluble in solution of potash. Gives silica with 5 to cent water. Most opals are mixtures of various mineral. ollowing may be noticed: (1) *Hyalite, Glassy Opal*, in parent colours, very transparent, small botryoidal Kaiserstuhl in the Brisgau, Schemnitz, Silesia, Mexico, and other places. (2) *Opal-agate* or *Girasol*, vitreous, in the bright by smith red or yellow, Mexico, and the Faroe Isles. (3) *Noble Opal*, semi-transparent, milky, inclining to vitreous, blue, green, or yellow, with brilliant prismatic colours; must show double or and on breaking or moving specimen. Specific gravity varies (1·9 to 2·3). (4) *Common Opal*, semi-transparent, vitreous, yellow, green, red, or brown, Hungary, Faroes, Iceland, Cape Clear, west coast of Scotland, &c. (5) *Hydrophane*, or *Oculus mundi*, when dry, adheres to the tongue, and becomes translucent when immersed in water, Hungary, Faroes, Iceland, Cape Clear, west coast of Scotland, &c. (6) *Wood opal*, or *Xylopal*, or *Lithoxylon*, with the structure of wood distinctly seen, Hungary, Bohemia, Faroes, Iceland, &c. (7) *Hyalite*, colourless, transparent, botryoidal, or stalactitic, Montbrisontant, near Paris, &c. (8) *Opal-jasper*, yellow, red, or brown, opaque, dull. (9) *Cachalong*, opaque, dull, glimmering, yellowish or greyish-white, translucent on the edges, Faroes, Iceland, the Grand Canary, &c. (10) *Menilite*, brown, slightly translucent, Menilmontant, near Paris, &c. (11) *Opal-basalt*, yellow, red, or brown, opaque, dull. (12) *Cachalong*, opaque, dull, glimmering, yellowish or greyish-white, translucent on the edges, Faroes, Iceland, the Grand Canary, &c. (13) *Siliceous sinter*, from hot springs, &c.

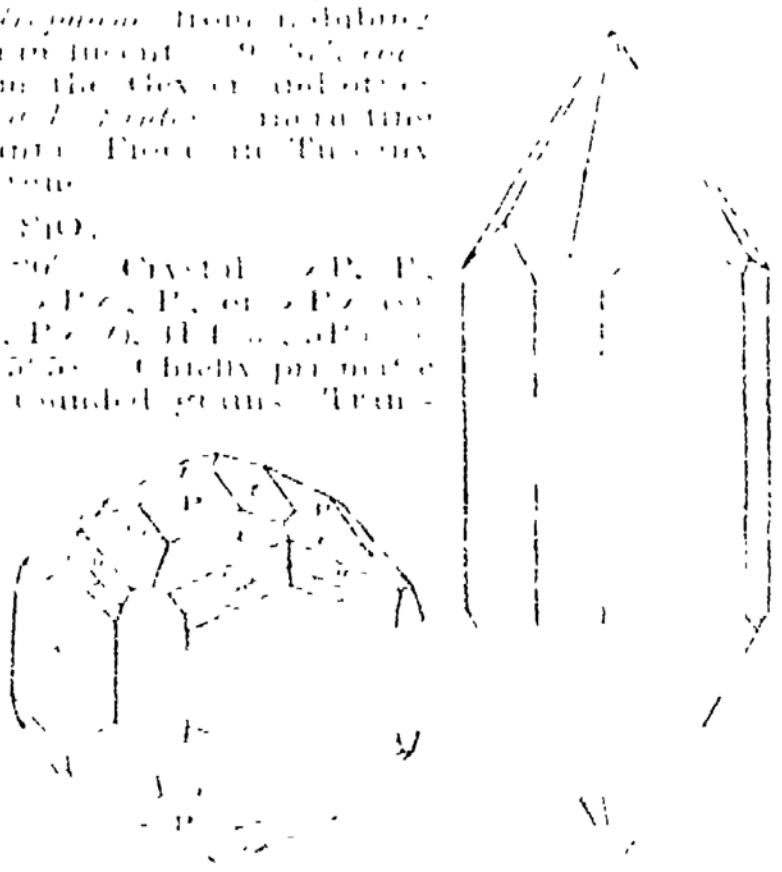


Fig. 320.

Fig. 321 (p. 13).

Meek, Arendal, Sweden, Bohemia, St. Stephens, Corinthia, Tyrol, Ceylon, and North America. Pseudomorphs in Harris (fig. 319), Lewis (*Hunterite*). Sutherland (the cocoanut-variety), are sold for diamonds. The more highly coloured are named hydrophanes, and are valuable gems.

Chromates, Selenides, Tellurides, &c.

Crocoite, $PbCrO_4$.

Prismatic dominant, figs. 320 to 323, also 67 to 77, and basal; cleavage prismatic, or striæ produced by oscillation with face of the cube, visible. Often distorted, Cleavage prismatic, difficult, brittle. H. 6

Fig. 322

G. 4·9 to 5·9. Red to yellow, often somewhat cochineal-streak brownish-red. Gives off on broken coals smell of In closed tube sulphur sublimes. B.B. on charcoal with blue flame, and odour of sulphurous acid. In mixture to magnetic bead. Soluble in acid with deposition of Ore from 16·7, sulphur 5·3, often contains gold in visible when broken. Common in veins of silver ores. Tarnowitz,

Birnam, Scotland; Cornwall, England, Elba and Traversella Rossie, Middletown, and Schoharie in U.S. Auriferous Berezoff (Siberia), Adelfors (Sweden), Mexico. Used to be facets and set as an ornament, under the name of marcasites; also for striking fire in the old firelocks, whence the name of firestone; now used for manufacture of sulphuric acid.

Fig. 323 (sp. 139).

140. Marcasite, FeS_2.

Right prismatic; ∞P 106 5′. Cry tals tabular, thin prismatic, or pyramidal. Twins very frequent, cockscomb-like groups, or and stalactitic. Cl. $\infty P\infty$ fracture uneven, brittle. H. to 6·9. Greenish bronze yellow to greenish grey, often with brown crust, streak greenish grey or brownish black. B.B., &c., like pyrite. Very prone to decomposition being changed into green vitriol, which may be detected by the tongue. *Spear Pyrites* are twin like fig. 325; Lattimer, Pulsnitz, *Hepatic Pyrites* or *Leberkies*, brown, generally decomposing, Harz, Saxony, Sweden. *Cockscomb Pyrites*, Derbyshire and the Harz. *Kyrosite* contains arsenic.

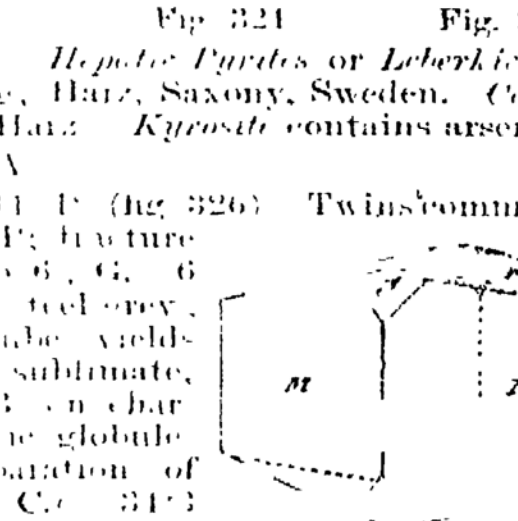


Fig. 324

Fig.

Hepatic Pyrites or *Leberkies*

141. Mispickel, FeS_2 + $FeAs_2$.

Right prismatic; ∞P 111° 5′ (fig. 326). Twins common massive or columnar. Cl. $\infty P\infty$; fracture uneven, brittle. H. 5·5 to 6, G. 6 to 6·2. Silver white to steel-grey, streak black. In closed tube yields but a red then a brown sublimate, leaden metallic appearance. B.B. on charcoal fuses to a black magnetic globule. Sol. in nitric acid with separation of arsenious acid and sulphur. Ore 34·3 iron, 46·1 arsenic, 19·6 sulphur, sometimes silver or gold, or 2 to 9 of cobalt. Cornwall, Freiberg, Zimmwald, Sweden, Franconia, America.

Fig. 326.

142. Leucopyrite, $FeAs_2$.

Right rhombic; ∞P 132° 26′; $P\infty$ (o) 51° 20′. Crystals massive or columnar. Cl. basal; fracture uneven. H. = 5 to 5·5; G. = 7 to 7·4. Silver white with darker tarnish; streak greyish black. B.B. emits strong smell of arsenic, and fuses to a black magnetic globule. Ore: iron 27·2, arsenic 72·8; sometimes iron 32·2 and arsenic 66·8; always some sulphur, and often nickel and cobalt. Found in Norway, Andreasberg, Styria, and Silesia. *Smaltzopyrite*, from Bieber in Hesse, seems a variety.

143. Cobaltine, CoS + $CoAs$.

Cubic and hemihedral, sometimes massive (figs. 67, 7 octahedral perfect. Brittle. H. = 5·5. G. = 6 to 6·3. Brilliant Pinkish silver-white, tarnishes yellow or grey; streak black. B.B. with borax blue glass, evolves smell of arsenic cobalt 35·0, arsenic 44·9, sulphur 19·2. St. Just in Cornwall, Tunaberg in Sweden, Skutterud in Norway, Querbach in Si

144. Glaucodot, $(Co, Fe)S_2$ + $(Co, Fe)As_2$.

Right prismatic; ∞P 111° 36′. Cl. basal, perfect. H. = 6. Lustre metallic. Greyish white; streak black. C.c. 24·7, iron 11·9, arsenic 47·2, sulphur 20·2. Huasco in Chi

145. Smaltine, $(Co, Fe, Ni)As_2$.

Cubic, generally like fig. 27; also reticulated and granu pact. Cl. octahedral; fracture uneven; brittle. H. = 5· tin-white to steel-grey, with dark or iridescent streak greyish black. Evolves odour of arsenic, when h heated. Ore 7·1 arsenic, 28·6 cobalt; sometimes 3 to and 1 to 2 nickel, or 4 bismuth. Dolcoath and Red Cornwall, Schneeberg, Annaberg, Tunaberg, Allemont, C in Connecticut.

146. Chloanthite (*White Nickel*), $NiAs_2$.

Cubic, generally fine granular or compact; fracture brittle. H. = 5·5; G. = 6·4 to 6·6. Tin-white, rapidly ta black. In the closed tube yields a sublimate of arse becomes copper red. Gives odour of arsenic when broke fuses with much smoke, becomes coated with crystals of a acid, and leaves a brittle grain of metal. C.c.: 28·2 nic arsenic, but often with cobalt. Schneeberg, Riechelsdo mont, Chatham in Connecticut.

ERSDORFFITE, $NiS_2 + NiAs_2$.

(figs. 74, 30, 26). Cl. cubic, generally granular. H. = 5·5, f. Lustre metallic. Silver-white to steel-grey, decrepitates tube. B.B. fuses to a black slag; partially sol. in h. acid. ·2 nickel, 45·1 arsenic, and 19·4 sulphur; sometimes balt. Craignuit, near Loch Fyne, with 23 nickel and 6 The Harz, Sweden, Spain, and Brazil.

ILLMANNITE, $NiSb + NiS_2$.

(figs 31, 29, 27); often tetrahedral, and in twins as in , 329. Cl. cubic, perfect; fracture uneven. H. = 5 to 5·5 to 6·5. Lead-grey to tin-white, often with nide cent

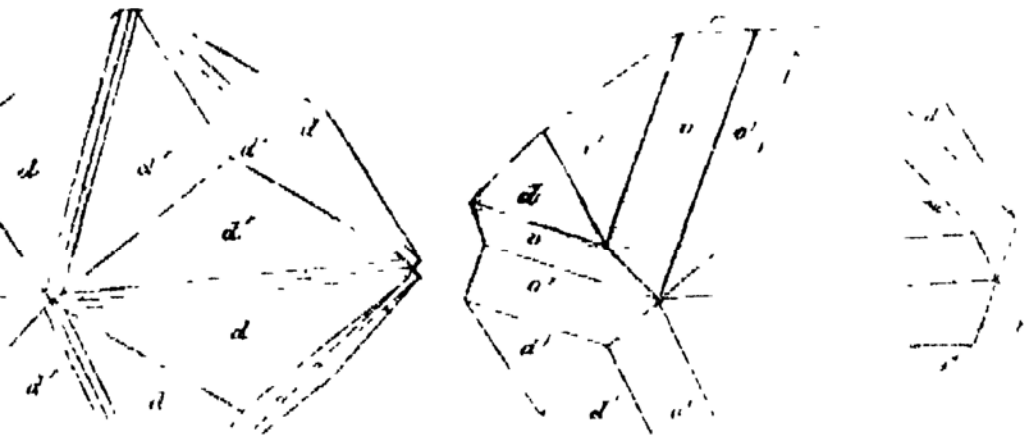


Fig. 328

Fig. 329

B.B. fuses with dense fumes. Sol. in n. acid. C. 57·5 antimony, and 15·1 sulphur. Westerwald, Siegen, ode, Lolling (Curinthia, Lobenstein and Bleiberg.

AMMELSBERGITE, $NiAs_2$.

prismatic; ∞P 123° to 124. Chiefly massive or in botryoidal aggregates. H. 5; G. 7·2. Colour tin-white erg Reichelsdorf, and Wittichen in Baden.

AUERITE, MnS_2

(figs. 30, 30 26, 30 33 37). Crystals simple or in spherical Cl. cubic, perfect; H. = 4; G. 3 to. Reddish brown to h black; streak brownish red. In closed tube yields sul- d leaves a green mass, which is sol. in h. acid. C. = 46 se and 54 sulphur. Kalinka in Hungary.

YRRHOTITE (*Magnetic Pyrites*), Fe_7S_8

onal, P 126 48'. Crystals rare, sometime hemihedral on ; ly massive or granular. Cl. ∞P, imperfect, brittle. H. 5; G. = 4·5 to 4·6. Colour bronze-yellow with purplish rnish; streak greyish black. More or less magnetic. C.c.:

Fig. 330

Fig. 331

n and 36·35 sulphur; sometimes with nickel. Common in limestones and diorites of Scotland. Crystallized in above Askaig on Loch Shin, Sutherland, Carnarvon, Cornwall Bodenmais, Andreasberg. Distinguished by its colour solubility in h. acid.

INNÆITE, $2(Co, Cu)S + CoS_2$.

(figs. 29, 30); often twinned; twin face O also massive. e; brittle. H. = 5·5; G. = 4·9 to 5. Silver-white, with a arnish; streak blackish grey. B.B. fuses to a grey mag- obule, which is bronze-yellow when broken. C.c., cobalt pper 14·4, iron 3·5, sulphur 38·5. Bastnaes (Sweden).

IEGENITE, $CoS + Ni_2S_3$ (?)

; generally in crystals like fig. 29; also massive. Colour hite, inclining to pink. Other features like linnæite. C.c. 0·8, nickel 14·6, sulphur 43·1. Musen near Siegen, Mary- d Missouri. The American mineral has 30·5 of nickel.

POLYDYMITE, Ni_4S_5.

; in minute octahedral crystals and flattened twins. Cl. H. = 4·5; G. = 4·8). C.c.: 39·45 nickel, 40·55 sulphur, but y with 4 of iron. Westphalia. *Saynite* or *grunauite* seems bismuthic and cobaltic variety; it is from Grunau in Sayn- rchen.

155. BYRICHRITE, $3NiS + 2NiS_2$.

H. = 3 to 3·5; G. = 4·7. C.c.: 54·23 ckel, 2·79 ir sulphur. From the Westerwald.

156. HORBACHITE, $4Fe_2S_3 + Ni_2S_3$.

Crystalline masses. H. 4·5; G. 4·43 to 4·7. Colour beck-brown; streak black. C.c., nickel 11·98, iron 41·96, 15·87. Horbach in the Black Forest.

157. SKUTTERUDITE, $CoAs_3$

Cubic (figs. 30, 26 with 33, 40) and granular. Cl. cubic ture conchoidal, brittle. H. 6; G. 6·4 to 6·84. Tin lead grey. Lustre brilliant. In closed tube gives sublim metallic arsenic, otherwise like smaltine. C.c. 79 arse cobalt. Skutterud, near Modum in Norway.

158. GALENA, PbS.

Cubic, crystals chiefly cube, octahedron, and rhombic hedron; rarely 20 and 202. Also massive and granular, or lamellar, and in pseudomorphs of pyromorphite and mimetals. Cl. cubic, very perfect, fracture scarcely observable, sectile. H. 2·5, G. 7·2 to 7·6. Lead grey, with darker or more or less iridescent tarnish, streak grey to black. B.B. decrepitates, fuses, and leaves a globule of lead. Sol. in n. acid. C.c. 86·7 lead, and 13·3 sulphur, but usually contains a little silver, ranging from 1 to 3 or 5 parts in 10,000, rarely 1 per cent. or more. Some contain copper, zinc, or antimony, others selenium, and others (the "supersulphurets") probably free sulphur (2 to 8 per cent.). Most common ore of lead in many countries. Leadhills, Pentland Lanarkshire, Inverkeithing, Monaltrie, Tyndrum, Strontian Orkney, Cornwall, Derbyshire (Castleton), Cumberland Moor), Durham (Allenheads), Wales, Isle of Man.

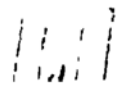


Fig.

159. CUPROPLUMBITE, $2PbS + Cu_2S$.

Cubic. H. 2·5; G. 6·4. Bluish grey. Cuba.

160. BLEIGLANCE, $6PbS + Bi_2S_3$.

Cubic. G. 7·07. Cl. cubic. Lead to dark grey. Lustre C.c., sulphur 15, bismuth 20·6, lead 64·2 with copper 1·7 (Park county, Colorado).

161. CLAUSTHALITE, $PbSe$.

Cubic; but massive granular. H. = 2·5 to 3; G. = 8·2 Lead grey, streak grey. B.B. fuses, smells of selenium, the flame blue, stains the support red, yellow, and wh volatilizes, except a small residue, without fusing. C.c. 7 27·3 selenium, but sometimes 11 % of silver. Zorge, Lerb Clausthal in the Harz. *Tilkerodite* and *Selen-Cobalt Blei*, co 3 per cent. of cobalt, from Tilkerode, are a variety.

162. ZORGITE.

Massive granular, like clausthalite but inclining to red often tarnished. There are four varieties: (*a*) *Selen Le* G. 7·4 to 7·5, 5PbSe + CuSe; with 1 copper, 65 lead, 34 se (*b*) The same, but with G. 5·6; 4Pb, 1Cu, 7Se; with 1·5 48·1 lead, and 35 selenium. (*c*) *Selen Kupfer Bl* with 2PbSe + CuSe, with 8 copper, 57 lead and 32 selenium. (*d*) 90 CuSe, with 46·64 copper, 10·58 lead, and 36·59 selenium. Tilkerode and Zorge in the Harz, and near Gadebusch in Thurin

163. ALTAITE, $PbTe$.

Cubic and granular, fracture uneven, sectile. H. = 3 to 3 8·1 to 8·2. Tin white to yellow, with yellow tarnish. B.B. the flame blue, tinging to a globule, which almost wholly vo C.c. 61·9 lead and 38·1 tellurium. Zavodinski in th California, Colorado and Utah.

164. RUBELLITE (*Ruby Copper*), Cu_2S

Right prismatic. ∞P (*o*) 119° 35', $P\infty$ (*l*) middle edge $\frac{1}{2}P$ (*a*) middle edge 65° 10', $2P\infty$ (*d*) middle edge 125° 40', middle edge 65° 48'. Crystals $0P$ (*s*), ∞P (*o*), $\frac{1}{2}P\infty$ (*p*) (

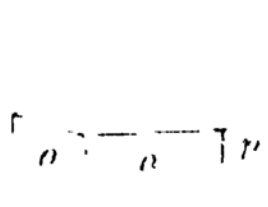


Fig. 333.

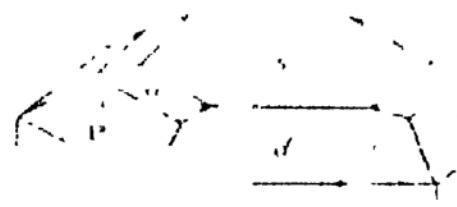


Fig. 334.

334); with hexagonal aspect; also twins and massive imperfect; fracture conchoidal or uneven; sectile. H.

to 5·8. Rather dull; brighter on the streak. Blackish
y, with a blue or other tarnish. B.B. colours the flame
charcoal in the oxygen flame sputters, and fuses easily; in
flame becomes solid. With soda gives a grain of copper.
olution in n. acid, leaving sulphur. C.c.: 79·8 copper, 20·2
Fassnet Burn (Haddingtonshire), Ayrshire, Fair Island,
lluth and Land's End in Cornwall, Saxony, Silesia, Nor-
Banat, Siberia, and the United States. Important copper

STROMEYERITE, $Cu_2S + AgS$.

pearnaite, isomorphous with redruthite. Crystals rare;
massive, fracture flat, very sectile. H. = 2·5, G. = 6·2 to
ht. Blackish lead grey. C.c.: 53·1 silver, 31·2 copper,
sulphur, but often indeterminate proportions of silver (3 to
copper (30 to 75). Schlangenberg in Siberia, Rudelstadt in
and Catemo in Chili.

BERZELIITE, Cu_2Se.

filiform, in thin dendritic crusts, and imbedded in calcite.
hite with a black tarnish; streak shining. In open tube
red sublimate of selenium, with white crystals of selenious
B. on charcoal fuses to a grey, slightly malleable bead,
dour of selenious acid; with soda a grain of copper. C.c.
per and 38·5 selenium. Skrikerum in Småland, Lerbach
arz.

CROOKESITE, $(CuTl)_2Se$.

stalline grains the size of peas. H. = 2·5 to 3; G. = 6·9.
Lead grey. Metallic. B.B. colours the flame intense
.c. 45·76 copper, 3·71 silver, 17·25 thallium, 33·27
. From Skrikerum.

EUKAIRITE, $Cu_2Se + AgSe$.

re and granular crystalline. Cuts with knife. Lead grey;
ming. B.B. fuses to a brittle metallic gram. C.c.: 43·1
·3 copper, and 31·6 selenium. Skrikerum, Atacama, Chili.

ARGENTITE, Ag_2S.

$\infty O\infty$, O; ∞O; and $2O2$ (figs. 29, 56). Crystals generally
n, with uneven or curved faces; in druses, or linear
also arborescent, capillary, or in crusts. Cl. indistinct;
hackly; malleable and flexible. H. = 2 to 2·5, G. = 7 to
ely brilliant, more so on the streak. Blackish lead-grey,
th a black, brown, or rarely iridescent tarnish. B.B. on
fuses, intumesces greatly, and leaves a grain of silver.
con n. acid. C.c.: 87 silver and 13 sulphur. Huel
Dolcoath, Herland, and near Callington in Cornwall;
Sterlingshire: Freiberg, Marienberg, Annaberg, Schneeberg,
Joergenstadt, Joachimsthal, Schemnitz and Kremnitz,
ng. Common ore at Guanajuato and Zacatecas in Mexico,
and at Blagodat in Siberia.

ACANTHITE, AgS.

prismatic. H. = 2·5; G. = 7·33. Iron-black. C.c. like
, thus dimorphous. Freiberg and Clausthal, on argentite;
opaque.

ALFAITE, $3AgS + Cu_2S$.

form O. Cl. cubic; malleable. H. = 2·5; G. = 6·88. Dark
letallic lustre. C.c.: silver 71·78, copper 14·04, sulphur
alpa in Mexico.

LAUTITE $(CuAg)\ AsS$.

Iron-black. H. = 3; G. = 4·96. C.c.: copper 28·3,
arsenic 11·8, sulphur 17·86. Lauta, near Marienberg.

SALMANNITE, $AgSe$.

plates and granular. Cl. hexahedral, perfect. Malleable.
G. = 8. Iron-black. Splendent. C.c.: 73 silver and 27
with 1·91 lead. Tilkerode.

EMBOLITE, Ag_2Fe.

or another (?); massive and granular. Slightly malleable.
to 3. G. = 4 to 8·45. Blackish lead-grey to steel-
B. on charcoal fumes, fuses to a black grain with white
and leaves a grain of
C.c. silver and 35·2
n Zavodinsk in Altai; Nag
banya, California; Chili.

PEARCEITE, $2Ag_2Te + As_2Te_3$.

hessite. Isomorphous.
G. = 8·72, containing 1·8 per
gold, from Nagyag; with
1·94, and 24 to 26 of gold
s and Tuolumne in Cali
Colorado.

DISCRASITE, Ag_3Sb; Ag_5Sb
Sb.

prismatic; P with polar
32° 42′ and 92°; ∞P 120°
gs. 335, 336). Crystals short prismatic, or thick tabular,

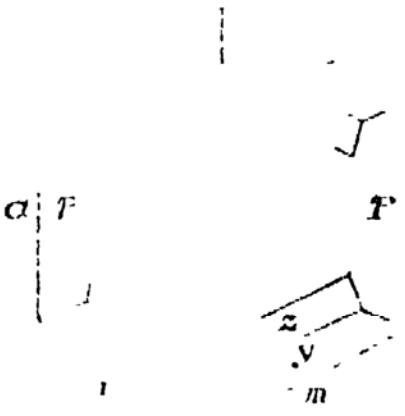


Fig. 335 (p. 176).

and vertically striated (fig. 335); twins united by a face of ∞P; often in stellar groups (fig. 336); also massive or granular. Cl. basal and $P\infty$, distinct; ∞P imperfect; rather brittle, and slightly malleable. H. = 3·5; G. = 9·4 to 9·8. Silver-white to tin-white, with a yellow or blackish tarnish. B.B. fuses easily, fumes staining the charcoal white, and leaves a grain of silver. Sol. in n. acid. C.c.: 64 to 84 silver, and 36 to 16 antimony. Andreasberg, Allemont in Dauphiné, Spain, and Arqueras in Coquimbo (Chili). A valuable ore of silver. A variety from Chili contains 91·2 silver and 5·8 antimony, and is $Ag_{16}Sb$.

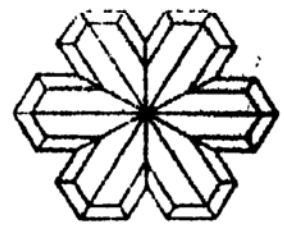


Fig. 336.

177 BLENDE, ZnS.

Cubic and tetrahedral (figs. 152, 153, 337). Twins remarkably common, united by a face of O, and several times repeated; frequently massive and granular. Cl. ∞O, perfect; very brittle. H. = 3·5 to 4; G. = 3·9 to 4·2. Semitransparent to opaque; adamantine and resinous. Brown or black, also red, yellow, and green, rarely colourless or white. B.B. decrepitates, often violently, but only fuses on very thin edges. Sol. in con. n. acid, leaving sulphur. C.c.: 67 zinc and 33 sulphur; but generally in the darker varieties with 1 to 15 iron, 0 to 3 cadmium. Very abundant. Glen Gairn (bright yellow and highly phosphorescent), Leadhills, Tyndrum, Cornwall, Derbyshire, Cumberland, the Harz, Freiberg, Przibram, Schemnitz, Kapnik, North America, Peru. Used for producing zinc vitriol and sulphur, and as an ore of zinc. Lithium, indium, thallium, and gallium have all been found in blende.

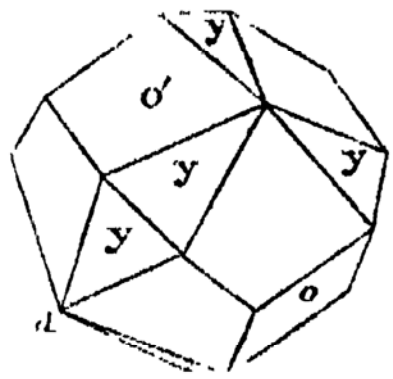


Fig. 337.

178. WURTZITE, $6ZnS + FeS$.

Hexagonal; ∞P, P, with well-marked horizontal striæ. Cl. basal, and prismatic. H. = 3·5 to 4; G. = 3·9 to 4·1. Brownish black; streak light brown. C.c.: like blende, which is thus dimorphous. Oruro in Bolivia, and Przibram (radiated and cadmiferous).

179. GREENOCKITE, CdS.

Hexagonal, and generally hemimorphic. P 86° 21′; 2P 123° 54′. Crystals 2P, 0P, ∞P, P, or P, 2P, ∞P; attached singly. Cl. ∞P, imperfect; basal perfect. H. = 3 to 3·5; G. = 4·8 to 4·9. Translucent; brilliant resinous, or adamantine. Honey- or orange yellow, rarely brown; streak yellow. B.B. decrepitates, and becomes carmine-red, but again yellow when cold; fused with soda forms a reddish brown coating on charcoal. Sol. in h. acid. C.c.: 77·6 cadmium, and 22·4 sulphur. Bishopton in Renfrewshire, Przibram, and Friedensville in Pennsylvania.

Fig. 338.

180 ALABANDINE, MnS.

Cubic; O and $\infty O\infty$, usually massive and granular. Cl. hexahedral, perfect; fracture uneven; rather brittle. H. = 3·5 to 4; G. = 3·9 to 4. Opaque; semi-metallic. Iron-black to dark steel-grey, brownish black tarnish; streak dark green. B.B. fuses on thin edges to a brown slag. Sol. in h. acid. C.c.: 63 manganese and 37 sulphur. Nagyag, Kapnik, Alabanda in Caria, Mexico, and Brazil.

181. MILLERITE, NiS.

Hexagonal rhombohedral; R 144° 8′; in fine acicular prisms of $\infty R2$, R. Brittle. H. = 3·5; G. = 4·6 (or 5·26 to 5·65). Brass- or bronze-yellow, with a grey or iridescent tarnish. B.B. fuses easily to a blackish metallic globule, which boils and sputters. In nitro hydrochloric acid forms a green solution. C.c.: 64·4 nickel and 35·6 sulphur. Morven (Argyllshire), Chapel (Fife), Ayrshire, near St Austell in Cornwall, at Merthyr-Tydvil, Johann-Georgenstadt, Joachimsthal, Przibram, Camsdorf, Riechelsdorf, Pennsylvania.

182. PENTLANDITE (*Eisennickelkies*), $2FeS + NiS$.

Cubic, massive and granular; fracture uneven; brittle. H. = 3·5 to 4; G. = 4·6. Light pinchbeck-brown, with darker streak. Not magnetic. B.B. acts in general like pyrrhotite; the roasted powder forms with borax in the red. flame a black opaque glass. C.c.: 36 sulphur, 42 iron, and 22 nickel; but mixed with pyrrhotite and chalcopyrite. Lillehammer in southern Norway. *Inverarite*, $5FeS + NiS$, with 11 of nickel, from near Inveraray, is a variety.

183 NICKELITE (*Copper Nickel*), $NiAs$.

Hexagonal; P 86° 50′. Crystals ∞P, 0P; rare. Arborescent, reniform, and massive; fracture conchoidal and uneven; brittle. H. = 5·5; G. = 7·5 to 7·7. Light copper-red, with a blackish tarnish. It forms no sublimate in the closed tube. B.B. fuses with strong

to a white, brittle, metallic globule. C.c.: 43·6 nickel and rsenic. Hilderston in Linlithgow, Pibble in Kirkcudbright, ills, Pengelly and Huel Chance in Cornwall, Freiberg, Schnee- Joachimsthal, Sangerhausen, Andreasberg, Chatham in Con- ut. Used as an ore of nickel.

Breithauptite (*Antimonial Nickel*), NiSb.

agonal; P 86° 56′. Crystals, thin striated hexagonal tables ∞P. H. = 5; G. = 7·5 to 7·6. Brilliant. Light copper red, lly with violet tarnish. B.B. fumes, but fuses with great lty. C.c.: 32·2 nickel and 67·8 antimony. Andreasberg.

Stannite (*Tin Pyrites*), $2CuS, SnS_2 + 2(FeS, ZnS) + SnS_2$ ic; in cubes very rare, generally massive and granular. Cl edral, imperfect; fracture uneven or small conchoidal, . H. = 4; G. = 4·3 to 4·5. Steel-grey; streak black. C.c.: 32 tin, 24 to 30 copper, 5 to 12 iron, 2 to 10 zinc, and 30 ur. Huel Rock near St Agnes, St Michael's Mount, and Carn- Cornwall; Zinnwald. Bell metal ore.

Sternbergite, $(AgS + 2FeS) + FeS_3$.

ht prismatic; P middle edge 118°. Crystals usually thin r; in twins, or in fan-like and spheroidal groups. Cl basal, t; sectile, and flexible in thin e. H. = 1 to 1·5; G. = 4·2 to Dark pinchbeck-brown, often et-blue tarnish; streak black. 31·2 silver, 35·4 iron, and 30·4 ur. Joachimsthal, Schneeberg, ohann-Georgenstadt. *Flexible* *ver of Silver*, from Hungary and Freiberg, is identical. *Fre-* $Ag_2Fe_6S_8$, in twins (fig. 339), is a variety.

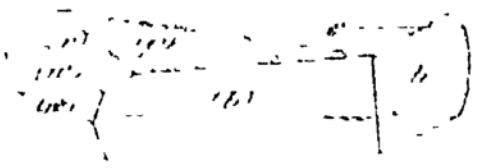


Fig.

Rittingerite, Ag_3As.

ique prismatic. ∞P 126° 18′. P ∞ inclined to 0P. Cl. basal; re conchoidal; brittle. H. = 2·5 to 3 G. = 6·33. C.c.: silver he remainder being arsenic, with some mum. Joachimsthal, , Felsobanya in Hungary.

Covellite, CuS.

agonal. Crystals ∞P, 0P, rare; u m and granu- Cl. basal; sectile. Thin lamin flex H. 1·5 to 2; G. 4·6. Resinous. Indigo-blue, str bla B.B. burns blue flame. Sol. in n. acid. C.c. 66·7 copper, 33·3 sulphur. peg in Cornwall, Vesuvius, La g (Austria), Chili, Angola, Zealand, and Victoria.

Chalcopyrite (*Copper Pyrites*), CuS + FeS.

amidal; and sphenoidal hemihedrie; ½P (*l*) with polar edges '; ∞P∞. Crystals generally small and deformed; twins common, like fig. 340. P ∧ (*b*) 89° 10′, 2P ∧ (*c*) 126° 11′,), P (fig. 89). Most commonly compact and disseminated; botryoidal and reniform. Cl. pyramidal 2P ∧; some- rather distinct; fracture conchoidal or uneven. H. = 3·5 to = 4·1 to 4·3. Brass yellow, often with a gold yellow or ent tarnish (peacock copper ore), greenish black. B.B. on charcoal be- darker or black, and on cooling red; easily to a steel-grey globule, which at becomes magnetic, brittle, and greyish the fractured surface; with borax and ields a grain of copper; moistened with l, colours the flame blue. C.c. essenti-

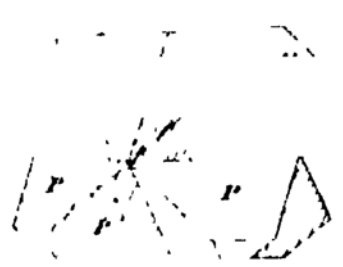


Fig. 340.

atom copper, 1 atom iron, and 2 atoms ur; with 34·5 copper, 30·5 iron, and 35 ur. The most abundant ore of copper. In Kirkcudbright- and Wigtownshire, Tyndrum in Perthshire, Inverness-shire, in Sutherland, Shetland, Anglesea (Parys mine), Derbyshire, dshire, Cumberland, Gunnislake (Devonshire), St Austell wall), Wicklow, Falun, Roraas, Freiberg, Mansfeld, Goslar, rberg, Müsen, Siberia. It is distinguished from pyrite by ng readily to the knife, by its tarnish, and by forming a green on in n. acid.

Bornite (*Purple Copper*), $3Cu_2S, Fe_2S_3$.

ic. Crystals ∞O∞, and ∞O ∧, O; but rare, and generally or uneven; also twins. Mostly massive. Cl. octahedral; ro conchoidal; slightly brittle; sectile. H. = 3; G. = 4·9 to Colour between copper-red and pinchbeck-brown, with tarnish red or brown, then violet or sky blue; streak greyish black. ets like chalcopyrite. Soluble in con. n. acid, leaving sulphur. 55·6 copper, 16·4 iron, and 28 sulphur. Crystals near Redruth t Day in Cornwall; massive at Killarney in Ireland; also y, Sweden, Mansfeld, Silesia, Tuscany, and Chili. An ore of .

Cuban, CuS, Fe_2S_3.

ic. H. = 4; G. = 4·1. Bronze-yellow; streak bronze-yellow and Barracanao in Cuba, Tunaberg and Kafveltorp in Sweden.

192. Domeykite, Cu_6As.

sotryoidal or massive; fracture uneven; brittle. H. G. = 7 to 7·5. Tin- or silver-white, inclining to yellow, ridescent tarnish. Not affected by h. acid: C.c. 71·63 co 28·37 arsenic. Calabazo in Coquimbo, and Copiapo in Ch *darite*, massive, seems an impure variety; from Condurrow near Redruth (Cornwall). *Algodonite* from Lake Superior *nite* from Mexico, and *Darwinite* (88 copper) are also or similar.

193. Melonite, $NiTe_2$.

Hexagonal; minute tabular crystals, foliated and g Metallic lustre. Reddish white; streak dark grey. C.c.: n silver 4·1, tellurium 73·4. Stamford and Calaveras (Ca

194. Sylvanite, $AgTe_2 + AuTe_3$.

Oblique prismatic, C 55° 21′. ∞P 91° 26′. P ∞ 119° 2 62° 43′. Crystals small, short tabular, and often twinned and in rows like letters, sectile, but friable. H. 1·5 to 2; G.

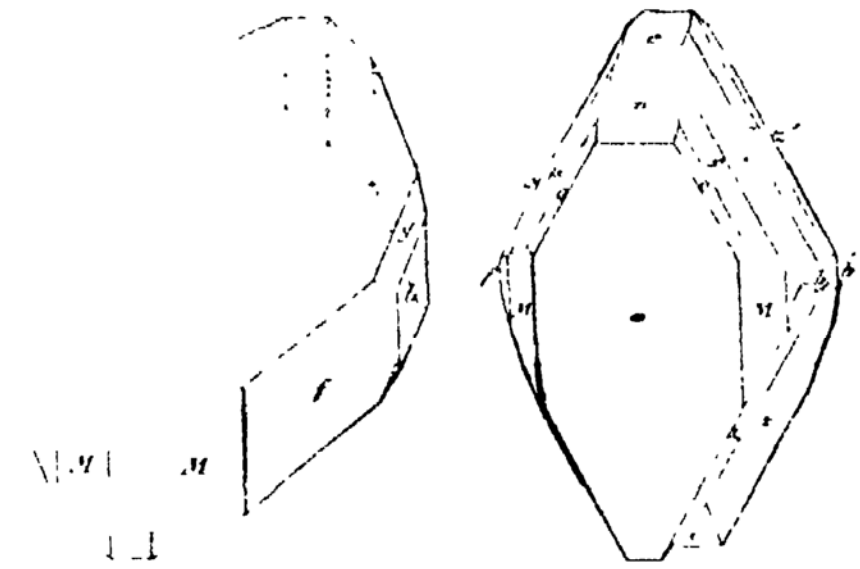


Fig. 341.

Fig. 342.

8·33. Steel-grey to silver-white, and pale bronze-yellow. C tellurium, with 0·6 to 8·5 antimony, 26·5 gold (in some 13·9 silver, with 0·2 to 1·5 lead. Offenbanya (*Graphic Tel* Nagyag (*Yellow Tellurium*), and California.

195. Nagyagite, *Black Tellurium*.

Pyramidal. P 137° 52′; P ∧ 122° 50′, and 0P (fig. 343). tabular, rare: in general in thin plates or folia ted. Cl. basal, perfect, sectile, thin lamine flexible. H. = 1 to 1·5, G. = 6·85 to 7·2. Splendent. Blackish lead-grey. C.c. 51 to 63 lead, 6 to 9 gold, 1 copper and silver, 13 to 32 tellurium, 3 to 12 sulphur, and 0 to 4·5 antimony. Nagyag and Offenbanya in Transylvania.

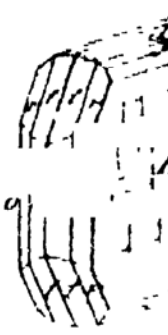


Fig. 343.

196. Maldonite, Au_2Bi.

H. = 1·5 to 2; G. = 8·2 to 9·7. Colour silver-white, with black tarnish. C.c. gold 64·5, bismuth 35·5. Occurs in granite veins at Maldon in

197. Chilenite, $Ag_{10}Bi$.

Minute plates of metallic lustre. Silver white, but tarn or yellow. Silver 83·9, bismuth 16·1. From the m Antonio near Copiapo in Chili.

198. Cinnabar, HgS.

Hexagonal and rhombohedral, R 71° 48′. R ∧ −½R (*o*), ∞ R (*i*) (fig. 344). Crystal rhombohedral, also granular, compact, and earthy. Cl. ∞R, perfect, fracture uneven and splintery, sectile. H. = 2 to 2·5, G. = 8 to 8·2. Trans- parent, with circular polarization. Adamantine. Cochineal red, streak scarlet. C.c.: 86·2 mercury, 13·8 sulphur. Idria in Carniola, Almaden in Spain, Wolfstein in Bavaria, Saxony, Hungary, Tuscany, China, Cali- fornia, Mexico, Peru. Chief ore of mercury. Also a *Hepatic Cinnabar*, a bituminous mixture.

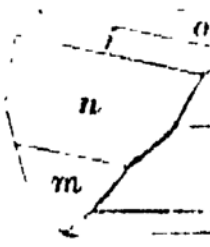


Fig. 3

199. Tiemannite, $HgSe$.

Fine-granular, brittle. H. = 2·5, G. = 7·1 to 7·4. Bright lead-grey. C.c. 75 mercury, 25 selenium. Clausthal and

200. Lerbachite, $(PbHg)Se$.

Granular and massive. G. = 7·8 to 7·88. Colour steel iron-black. Brittle. Lerbach, Tilkerode in the Harz.

201. Guanajuatite, Bi_2Se_3.

Massive; granular; foliated and fibrous. H. = 2·5 to 3, G. Blue-grey; streak grey and shining. Metallic; soft and m C.c.: selenium 34·3, sulphur 7, bismuth 65. Santa Rosa juato, Mexico).

COLORADOITE, $HgTe$.

...ve and granular. H. ... 3, G. = 8·63. Metallic. Iron-black. ...idal fracture. ... Clausthal, 39 mercury, 39 tellurium. Colorado.

MOLYBDENITE, MoS_2.

...gonal (... Crystals 0P, ∞P, and 0P, ∞P. Generally scaly. ...l, perfect ... ...ble and flexible. Feels greasy. H. 1 to 1·5; ... to 1·9. ... lead-grey with red tinge, grey streak on paper, ... on porcelain. B.B. colours flame ... yish green, on ... with ... phurous fumes, ... white coating, in warm ... ...

erg, Marienberg, Przibram, Schemnitz and Kremnitz. rg, Mexico, Nevada, &c.

Proustite, $3Ag_2S + As_2S_3$.

bohedral, like pyrargyrite, except R 107° 50′ (fig 353). to 5·6. Semi- ent to trans- on the edges. al to crimson-red. 5·5 silver, 15·1 and 19·4 sulphur. urora-red. B.B. odour, and y reduced to silver At the ralities as pyrar- both are valu- s of silver Red has a lower gravity, and streak; cumular es before the e.

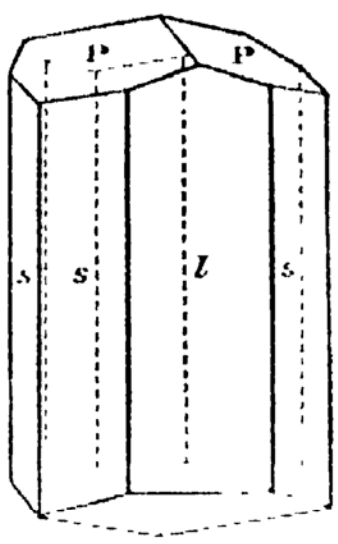


Fig. 352 (sp 225)

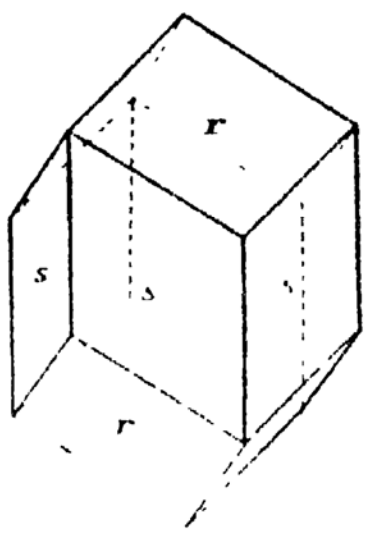


Fig. 353 (sp 226).

Boulangerite, $3PbS - Sb_2S_3$.

granular, columnar, radiating, or fibrous; rhombic-prismatic. G. = 5·8 to 6. Silky, metallic Blackish lead-grey, with streak. B.B like jamesonite Comp 59 lead, 22·5 antimony, ·2 sulphur. Molieres in France, Oberlahr (Rhenish , Lapland, and Siberia. *Plumbostib* or *Umbrathite*, from sk, is only a variety.

Kobellite, $3PbS, Bi_2S_3 + 3PbS, Sb_2S_3$.

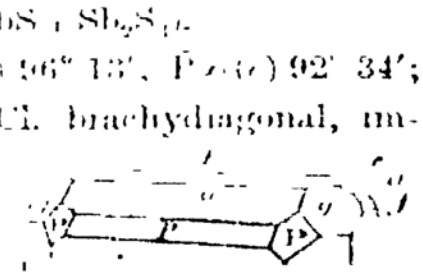
ted columnar; soft G = 6·21 to 6·3 Comp 53 lead, 20 bismuth, 10 antimony, and 17 sulphur. Hvena in Nordmark (Sweden).

Wittichenite (*Cuprous Bismuth*), $3CuS + Bi_2S_3$.

prismatic; in tabular crystals like bournonite. Wittichen Black Forest.

Bournonite ($3CuS + Sb_2S_3$) + ($3PbS + Sb_2S_3$).

prismatic. ∞P (*d*) 93° 40′, $\breve{P}\infty$ (*a*) 96° 13′, $\bar{P}\infty$ (*c*) 92° 34′; $\infty\breve{P}\infty$ (*s*); $\infty\bar{P}\infty$ (*k*) (fig. 351) Cl. brachydiagonal, imfracture uneven to conchoidal; brittle. H. = 2·5 to 3, G. 5·7



ay, and 19·6 sulphur. Rehruth eralston; Harz (Neudorf), Braunsapnik, Servoz; Alais and Pontgi- France.

hite from Wolch in Carinthia is ari ty.

Aikinite (*Needle-ore*), $2(3PbS + 3(CuS + Bi_2S_3)$.

prismatic; long thin crystals ed in quartz, often bent or broken, brittle. H. = 2·5; G. 6·7 to 6·8.

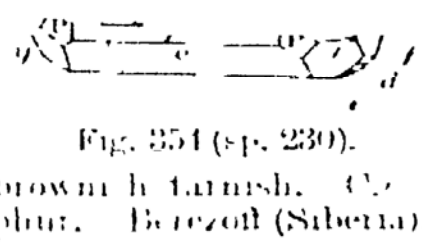


Fig. 354 (sp. 230).

h lead-grey or steel-grey, with a brownish tarnish. Co- 11 copper, 36 bismuth, and 17 sulphur. Berezoff (Siberia),

Stylotype, $3(CuAgFe)S + Sb_2S_3$.

t prismatic. 0P 92° 30′. H. = 3; G. = 4·8. Black. Copiapo,

Annivite, $4CuS + (As_2S_3, Sb_2S_3, Bi_2S_3)$.

ive, similar to the foregoing. From Anniver in Valais. *te* is similar, but with 15·5 of antimony.

Julianite, $3Cu_2S + As_2S_3$.

e. G. = 5·12. Metallic. Reddish grey. Rudelstadt in

Meneghinite, $4PbS + Sb_2S_3$.

que prismatic, C 72° 8′. ∞P 140° 24′; $P\infty$ 70°. Crystals acicular, chiefly of $\infty P\infty$, $\infty P\infty$, ∞P; rare; mostly . H. = 3; G. = 6·4. Bottino in Tuscany, Schwarzenberg in .

Jordanite, $4PbS + As_2S_3$.

t prismatic; ∞P 123° 29′. Cl. brachydiagonal, perfect. black. G. = 6·38. Comp.: lead 68·9, arsenic 12·5, sulphur Binnen and Nagyag.

Tetrahedrite (*Fahlerz*), $3Cu_2S + Sb_2S_3$.

eral and tetrahedral. In crystals $\frac{O}{2}$, $-\frac{O}{2}$, ∞O, $\frac{2O2}{2}$ (figs. 358, also 65, 66, 206). Twins (figs. 164, 207), generally e. Cl. octahedral; fracture conchoidal; brittle. H. = 3·44;

G. = 4·5 to 5·2. Steel-grey to iron-black; streak black (da when containing zinc). B.B. on charcoal boils slightly, an to a steel grey slag, usually magnetic, and with soda gives Comp. essentially Cu_2S in combination with Sb_2S_3. Arthu

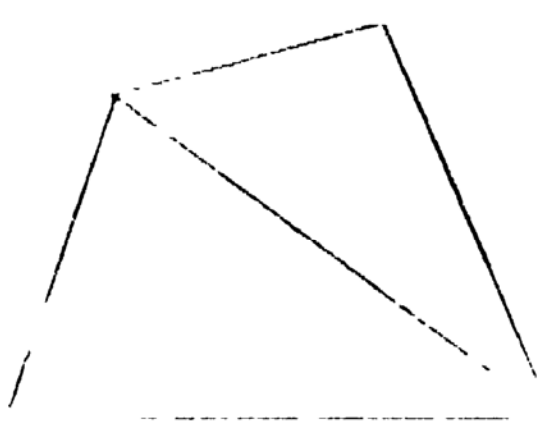


Fig. 355.

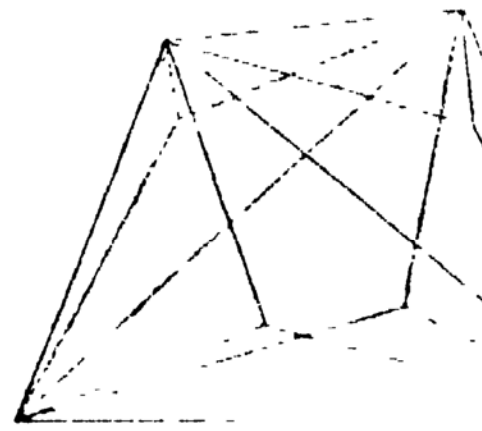


Fig. 356.

Fig. 357

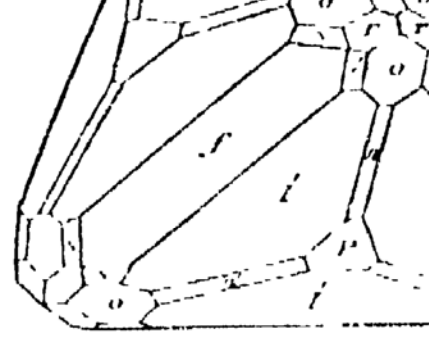


Fig. 358

Stirling, Sandlodge in Shetland, Tonnada-hin on Loch Tay cudbright; Crinnis and other Cornish mines near St Austell Musen, Freiberg, Camsdorf, Alsace, Kremnitz, and Kapnik, with 17 to 31 silver are the *Silver Fahlore* (Freiberg), copper and silver.

238. Tennantite, (CuS, FeS) As_2S_3.

Cubic (like fig 237) Cl. ∞O. Brittle. H. = 4, G. = 4· Iron-black; streak dark red, grey Comp. 49 copper, 4 arsenic, and 28 sulphur. Redruth and St Day (Cornwa Skutterud. *Copper-blende*, with brownish-red streak, G. = 4 tains 8·9 zinc. Freiberg.

239. Polybasite (*Heterogenite*), $4RS + Sb_2S_3$

Like tetrahedrite. H. = 2·5, G. = 5·4 to 5·7 Comp. silver lead 38 to 52, antimony 8·5 to 22, sulphur 13 to 22·5 Fr

240. Stephanite, $5Ag_2S + Sb_2S_3$

Right prismatic ∞P (*o*) 115° 39′, P (*l*) middle edge $2\breve{P}\infty$ (*d*) middle edge 107° 48′, 0P (*s*), $\infty\breve{P}\infty$ (*p*) Cl. *d* and *p*, both imperfect; fracture conchoidal or uneven H. = 2 to 2·5; G. = 6·2 to 6·3 Iron-black to blackish-l Comp. 68·5 silver, 15·3 antimony, and 16·2 sulphur Freiberg, Schneeberg, Annaberg, Joachimsthal, Przibram, nitz, Mexico, Peru, and Siberia Valuable ore of silver

241. Glocknerite, $5PbS + (Sb, As)_2S_3$

Right prismatic. Fracture conchoidal, scarcely H. = 2 to 6·45 to 6·51. Pale lead-grey Comp. 67 lead, with 1 to 2 co iron, 16 antimony, with 1·7 arsenic, and 17 sulphur Sweden. Meneglo (Ovindoli in Spain, and near Pietrosanto in

242. Kilbrickenite, $6PbS + Sb_2S_3$

Massive, granular or foliated Comp. 70·01 lead, 13·76 an and 16·23 sulphur. County Clare in Ireland.

243. Polybasite, $9(Ag_2, Cu_2S) + (Sb, As)_2S_3$.

Hexagonal, P 117° Crystals 0P, ∞P, and 0P : P, Cl. basal, imperfect; sectile, and easily frangible H. = 2 G. = 6 to 6·25. Iron-black, in very thin lamellæ, tra red Comp. 64 to 72 silver, 3 to 10 copper, 16 to 17 sulpho 8 antimony, and 1 to 6 arsenic. Freiberg, Joachimsthal, nitz, Guanajuato, Nevada, and Idaho Rich ore of silver

244. Polargyrite, $12AgS + Sb_2S_3$.

Cubic. Typical form O, $\infty O\infty$, ∞O, $\frac{n}{2}O\frac{n}{2}$ Cl. cubic G. = 6·97 Metallic, iron-black; streak black. Malleable 78·2 silver, 7·4 antimony, 14·5 sulphur Wolfach in Bad

245. Enargite, $3Cu_2S + As_2S_5$.

Right prismatic. Cl. ∞P 97° 53′ perfect, brachydiagonal and macrodiagonal less so. Typical form ∞P, 0P, $\infty\breve{P}\infty$ Brittle. H. = 3; G. = 4·3 to 4·5. Iron-black. Comp.: 48·3 19·1 arsenic, and 32·6 sulphur. Morococha in Peru.

LARITE, $3CuS + As_2S_3$.

e prismatic. Ordinary form ∞P, $0P$, mP. H. 3·5. G. 4·46. Dark blue-grey. Kinzig-Baden. Lamellar.

MANITE, $3(Cu_2S + Sb_2S)$.

pr[illegible] Twins of form $0P$, ∞P, $\frac{1}{2}P\infty$, $\frac{1}{2}P3$. Massive or [illegible]. H. 3·5. G. 4·7. Copper-red to grey; streak black. [illegible] Mountains Argentine Republic and Cerro de Pasco in

[illegible], $2PbS + Bi_2S_3$.

[illegible]. G. 6·9. Metallic. Lead-grey. Chivato

[illegible], $6RS + As_2S_3$.

[illegible] ∞P 110°. Steel-grey. H. 3·5. White-

[illegible]ANGERITE, $3PbS + Sb_2S_3$.

pr[illegible]. G. 6·3. Metallic. Blue-black. Altenburg

[illegible], $2(3Ag_2S + As_2S_3) + 3Ag_2S + As_2S$.

onal rhombohedral. R 0R 110° 30′. Crystals thin hexagonal, brittle, easily fusible. H. 2 to 2·5. G. 5 to 5·5. Translucent, adamantine. Orange-yellow or brown; streak In the closed tube fuses easily, becomes lead-grey. Ore, 14·7 arsenic, and 21·9 sulphur. Himmelsfürst mine at

[illegible] (*Ziz-blende*).

prismatic, crystals like stibnite. ∞P 139° 12′. Twins on onal H. 2; G. 4·2. Lustre pearly, and adamantine. [illegible] azimuth red and bright yellow. Soluble. Ore 62·5 silver, [illegible]hur and antimony. Freiberg, Andreasberg, Przibram.

OXYSULPHURETS.

[illegible]MONITE, $Sb_2O_3 + 2Sb_2S_3$.

[illegible] prismatic; crystals $\infty\bar{P}\infty$ $0P$ acicular and diverging; H. 1 to 1·5; G. 4·5 to 4·6. Translucent; adamantine; streak similar. Soluble in hot acid. In potash-solution yellow, and dissolves. Ore 75·3 antimony, 19·8 sulphur, [illegible] Braunsdorf, Przibram, Pernek near Beeskerek (Hungary), [illegible], Southham Canada.

[illegible]OLITE, $ZnO + 4ZnS$.

[illegible]ng. H. 4·5; G. 3·7. Yellow. Pontgibaud and [illegible]thal.

[illegible]VELLINITE, $3BiO + BiS$.

[illegible]. G. 6·6. Metallic. Lead-grey. Zavodinski in the Altai.

[illegible]OLIVITE, $Bi_2O_3 + Bi_2S_3$.

[illegible]ohedral. From Bolivia.

SELENITES.

[illegible]RACOMELITE, $CuSe + 2H_2O$ [= CuO, SeO + 2H₂O].

[illegible] prismatic, C [illegible] 20′. G. = 3·76. Bright blue. Transparent [illegible] selenious acid 18·2, copper oxide 36·4, water 15·3. [illegible]cahuta, Mendoza, Argentine Republic.

NITRATES AND BORATES.

Na_2O, N_2O_5.

[illegible], 16 to 30. Tarapaca in Peru. Used in the [illegible] nitre; but deliquesces in moist air.

[illegible]TRE, KNO_3 [K_2O, N_2O_5].

[illegible] [illegible] 3′ 11·49, $2P\infty$ (P) 70° 55′, P∞ 109° 52′; [illegible] shoots with aragonite. Acicular, [illegible], or pulverulent. Fracture conchoidal. H. 1·9 to 2. [illegible] vitreous or silky. Colourless, white, or grey [illegible] and cooling. Deflagrates [illegible] acid. B. on platinum wire melts very [illegible] colouring the flame [illegible] 46·6 potash and 53·4 nitric [illegible] always more or [illegible] in the lime-tone caves of [illegible] countries, Hungary, [illegible] for producing nitric [illegible] glass-making, medicine, and the manufacture of gunpowder.

NITROCALCITE, $CaN_2O_6 + H_2O$.

[illegible]s or pulverulent. White or [illegible] [illegible] 30·8 lime, 59·3 [illegible], and 9·9 water. Limestone caves of Kentucky; on old [illegible] limestone rocks.

NITROMAGNESITE, $MgN_2O_6 + H_2O$.

[illegible] bitter. In the same places, and similar to nitrocalcite.

262. BORACITE, $2\dot{M}g_3\ddot{B}_4 + MgCl$.

Tesseral and hemihedral (figs. 63, 253, 359). Cl. octahedral, perfect; fracture conchoidal; brittle. H. = 7; G. = 2·9 to 3. Transparent or translucent; vitreous or adamantine. Colourless, or white, often greyish, yellowish, or greenish. Becomes polar-electric by heat. B.B. fuses with difficulty to a clear yellowish bead, which on cooling forms a white opaque mass of needle-like crystals; at the same time colours the flame green. [illegible]d in hot acid. Ore [illegible] boracic acid, 26·9 magnesia, 7·9 chlorine, and 2·7 magnesium. Lüneburg, Strassfurt in Holstein, Stassfurt.

Fig. 359.

263. STASSFURTITE.

In very minute prismatic crystals. White. C.c. same as boracite, and thus perhaps dimorphous. Stassfurt.

264. RHODIZITE, $2(\dot{C}s_2\ddot{B}_4 + \dot{K}_2\ddot{B}_4) + \ddot{B}_2$.

H. = 8 and G. = 3·3 to 3·42, agrees in most characters with boracite. Pyro-electric. Mursinsk in Siberia.

265. LUDWIGITE, $2MgB + FeFe$.

Fibrous, massive. From limestone at Moravitza in the Banat.

266. BORAX + *Tincalconite*, $Na_2\ddot{B} + 10\dot{H}_2$.

Oblique prismatic, C [illegible] 2′. ∞P 87°; P 122° 34′ (fig. 360). Almost isomorphous with aucite, brittle. H. = 2 to 2·5. G. = 1·7 to 1·8. Pellucid, resinous. Colourless, or yellowish, greenish, and greyish white. Taste feebly alkaline and sweetish. C.c.: 16·4 soda, 36·6 boracic acid, and 47·1 water; but often with 2 phosphoric acid or other impurities. Shores of salt lakes in Tibet and Nepal, in California, and near Potosi.

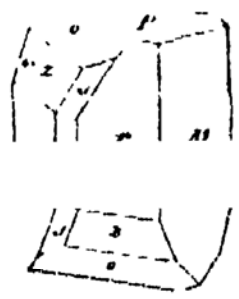


Fig. 360 (sp. 266).

267. BORACALCITE, $Ca2B + 6H$.

Similar to ulexite (sp. 268), and from same locality.

268. ULEXITE, $Na_2\ddot{B} + 2\dot{C}a_2\ddot{B} + 18\dot{H}$.

Fibrous. H. = 1; G. = 1·6. White. Tasteless. Iquique and Nova Scotia.

269. SZAIBELYITE, $2Mg_2\ddot{B} + 3\dot{H}_2$.

H. = 3·5, G. = 2·7. Werkesthal in Hungary.

270. HYDROBORACITE, $2Ca\ddot{B}_3 + 2Mg\ddot{B}_3 + 12\dot{H}_2$.

Radiating and foliated. Caucasus. A similar mineral, with soda in place of magnesia, is found in Peru.

271. STERNBERGITE, $(Mn, Mg)_3\ddot{B} + \dot{H}_2$.

Fibrous, silky. White. H. = 2–3; G. = 3·4. Franklin (Sussex county, New Jersey).

ANHYDROUS CARBONATES.

272. CALCITE (*Calc-spar, Calcareous Spar*), $\dot{C}a\ddot{C}$.

Hexagonal and rhombohedral, R 105° 5′ (fig. 101). The forms and combinations exceed those of any other mineral. Among them are more than fifty rhombohedrons, especially $-\frac{1}{2}R$ 135°; R; $-2R$ 79°, and $4R$ 60°, with 0R and ∞R as limiting forms. There are one hundred and fifty-five distinct scalenohedrons, as R3; R2; $\frac{1}{2}R3$, and the second hexagonal prism $\infty P2$. Hexagonal pyramids are among the rarer forms. Some of the most usual combinations are ∞R, $\frac{1}{2}R$ (∞R, $\frac{1}{2}R$, for 1·4); or $\frac{1}{2}R$, ∞R, very frequent; also ∞R, 0R, likewise $-2R$, R (∞R, $-\frac{1}{2}R$, fig. 107); R3, ∞R, $-2R$; R5 (*y*), R3 (∞R), R ($\infty P2$), $4R$ (∞R, $\infty P2$) (fig. 109); R, R3 (fig. 108). Several hundred distinct combinations are known.

Hemitropes and twins are not uncommon. These occur with the axes parallel (figs. 106, 146, 148, 180, 366, 367). Others

Fig. 361.

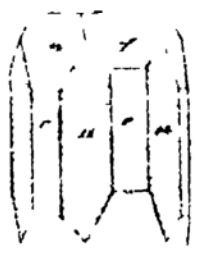


Fig. 362.

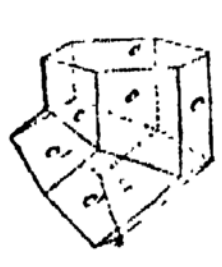


Fig. 363.

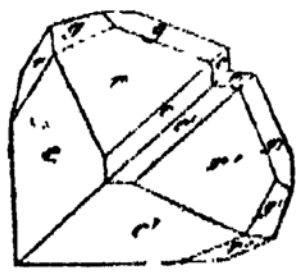


Fig. 364.

are conjoined by a face of R, the axes being almost at right angles, 89° 8′ (figs. 183, 369) or by a face of $-\frac{1}{2}R$, in which the chief axes form an angle of 127½°; and usually many times repeated, so that the centre crystals appear in lamellæ not thicker than paper (fig. 181); at an obtuse angle, as figs. 149, 363, or an acute

angle, as figs. 364, 368. Also occurs granular, lamellar, parallel or radiated fibrous, compact and earthy. Cl. rhombohedral along R, very perfect and easily obtained, so that the conchoidal fracture is rarely observable; brittle. H. = 3; G. = 2·6 to 2·8; pure transparent crystals = 2·72. Pellucid in all degrees. Very distinct double refraction. Lustre vitreous, but several faces resinous, and OR pearly. Most frequently colourless or white, but often grey, blue, green, yellow, red, brown, or black; streak greyish white. B.B. infusible, but becomes caustic and emits a bright light. Effervesces, and is entirely sol. in h. or n. acid. The fine powder, ignited on platina foil over the spirit-lamp, forms a somewhat connected mass, and even adheres to the platina. Consists of the purest varieties, carbonate of lime, with 44 carbonic acid and 56 lime, but usually contains magnesia and protoxide of iron or of manganese. Remarkable specimens of the crystallized variety or proper calc-spar are found at Alston Moor in Cumberland (flat rhombic crystals) and in Derbyshire (pale yellow

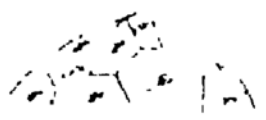


Fig. 365.

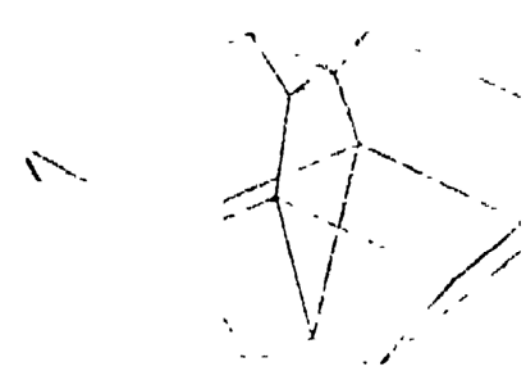


Fig. 366.

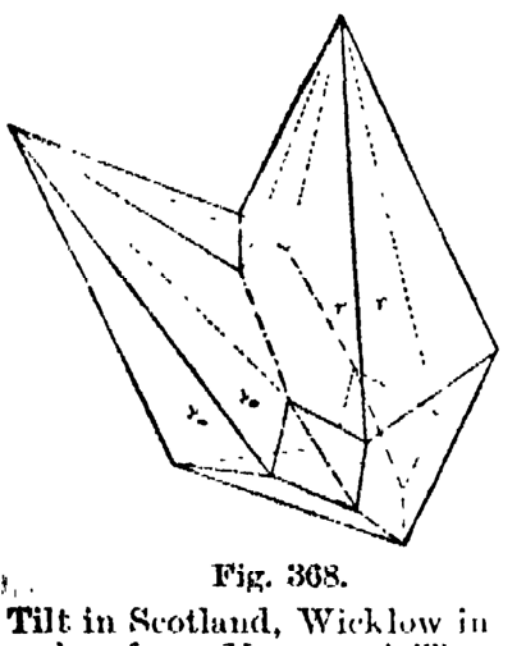


Fig. 368.

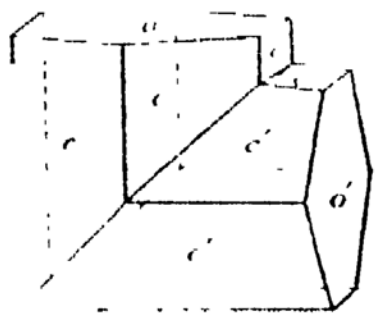


Fig. 369.

transparent pyramids), at Strontian, Elie in Fife (figs. 370, 371, 372), Andreasberg and other parts of the Harz (six-sided prisms), and at Freiberg, Tharand, and Maxen in Saxony.

Certain varieties are distinguished. *Iceland Spar*, remarkable for its transparency and double refraction, occurs massive and in huge crystals in a trap rock in Iceland. *Slate Spar*, thin lamellar, often with a shining white pearly lustre and greasy feel, Aberdeen and Glen Tilt in Scotland, Wicklow in Ireland, and Norway. *Aphrite*, fine scaly; from Hesse and Thuringia. *Marble* is the massive crystalline variety of this mineral, produced by igneous action on compact limestone. Paros, Naxos, and Tenedos furnished the chief supply to the Grecian artists; Carrara, near the Gulf of Genoa, to those of modern times. Some of the coloured marbles

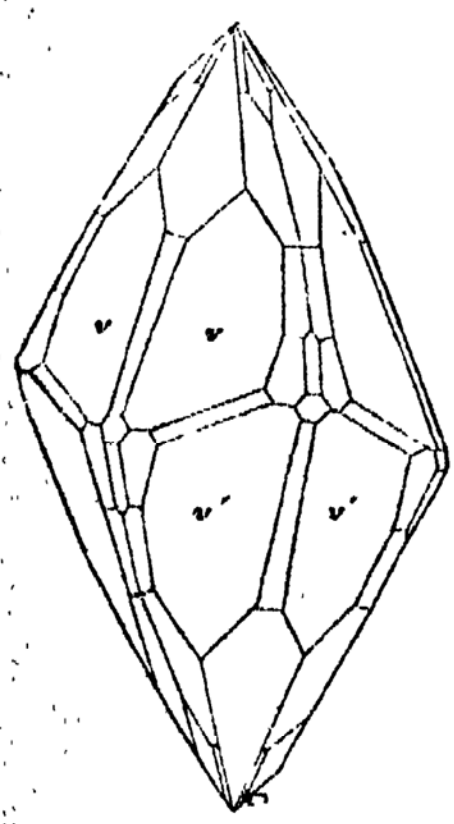


Fig. 370.

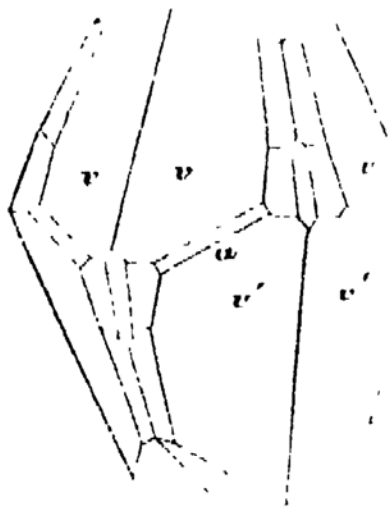


Fig. 371.

of the ancients were impure limestones, as the *Cipollino*, zoned with green talc or chlorite, and *Verde Antique*, mixed with green serpentine. *Ruin Marble* shows irregular markings like Val d'Arno (Florentine marble), and Bristol (Cotham). *Lucullite* from Egypt, and *Anthraconite*, from Campbellton, Kilkenny, are black from carbon. *Lumachello*, from Bleiberg, Carinthia, exhibits beautiful iridescent colours from fossils; sometimes deep red or orange (*Fire Marble*). *Hislopite*, Poonah, is green, from celadonite.

Limestone occurs in all formations under various names, as egg-stone, or roe-stone, rounded concretions with a concentric structure like the roe of a fish; *Pisolite*, or pea-stone, similar structure; *Chalk*, soft earthy; *Lithographic Stone*, yellowish and compact, from Solenhofen; and *Marl*, calcareous matter more or less mixed with clay. *Calcareous Tufa*, generally a recent deposit from calcareous springs, has often a loose friable texture, but at other times is hard and compact; and in the neighbourhood of Rome forms the common building stone *Travertino*. The sandstone of Fontainebleau is carbonate of lime (95) mixed with quartz sand (5), and occasionally crystallizing in rhombohedrons.

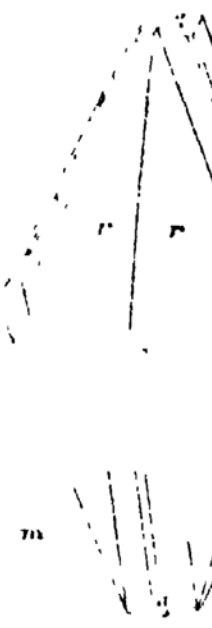


Fig. 372.

This mineral is employed in many ways: the coarser varieties, when burnt to drive off the carbonic acid, as lime, for mortar, manure, tanning, &c.; as a flux in melting iron and other ores, or in preparing glass, and for similar purposes; the finer, as marbles, for sculpture, architecture, and ornamental stone work; the chalk for writing, washing, or producing carbonic acid.

Plumbocalcite. Cl. 101 5′. White and pearly, soft; calc-spar, but G. = 2·8–2·4. Contain 2·3 to 7·8 carbonate of lead. Wanlockhead and Leadhills (Scotland).

273. DOLOMITE (*Bitter-spar*), $CaC + MgC$.

Hexagonal rhombohedral, R 106° 15′ 20″; most frequent R. The rhombohedrons often curved and saddle-shaped, granular or compact, often cellular and porous. Cl. rhomb. H. 3·5 to 4·5, G. = 2·85 to 2·95. Translucent, vitreous, often pearly. Colourless or white, but frequently pale red or green. B.B. infusible, but becomes caustic and often traces of iron and manganese. Fragments effervesce very little or not at all in hydrochloric acid; the powder is partially or wholly when heated. Consists of 54·3 carbonate of lime and 45·7 carbonate of magnesia, but generally carbonate of lime with less than 20 per cent. carbonate of magnesia and less than 20 carbonate of iron.

Varieties are *Dolomite*, massive-granular, easily divisible; *Rhomb* or *Bitter-spar*, larger grained, or distinctly crystallized, cleavable, often nearly white to green; and *Brown-spar* and *Pearl-spar* in simple crystals generally curved (fig. 373) or in imitations of colours inclining to red or brown, more distinct pearly lustre, under 16 per cent. carbonate of iron. Leadhills and Glen Tilt in Scotland, Alston in Cumberland, in Derbyshire, Traversella Piedmont, St Gotthard, Gap in France, Greenockite, twinned, in Tuscany (*Micaceo*), and Tharand in Saxony (*Transcendent*).

The massive and compact varieties are very common, valued as building stones; state trial of Milton, Vol. Manchester Houses of Parliament at Westminster. The Parian marble also the Sutherland and Iona marbles, belong to this species.

271. ANKERITE, $CaC + MeC$.

R 106° 12′. Usually massive and granular. G. = 2·9. Otherwise like dolomite. Ores of Shetland, Styria.

275. MAGNESITE, MgC.

Rhombohedral; 107° 10′ 40″. Reniform or massive. G. = 2·85 to 2·95. Subtranslucent or opaque; streak white. Snow-white, greyish or yellowish white, and pale yellow. Norway, North America.

276. BREUNNERITE (*Gurhofite*), $MgC + (MnFe)C$.

Hexagonal rhombohedral, R 107° 10′ 30″. Granular or massive. Cl. R, very perfect. H. = 4 to 4·5; G. = 2·9 to 3·1. Translucent or translucent on the edges; highly vitreous. Colourless, yellowish brown or blackish green. Consists essentially of magnesia, with 51·7 carbonic acid and 48·3 protoxide of iron mixed with 8 to 17 carbonate of iron or manganese. Salzburg, Fassa Valley, &c., St Gotthard, Harz.

277. SIDERITE (*Spathic Iron*, *Chalybite*), FeC.

Hexagonal and rhombohedral. R 107°. Usually R of the saddle-shaped (fig. 252), or lenticular. Cl. rhombohedral, perfect, brittle. H. = 3·5 to 4·5, G. = 3·7 to 3·9. Translucent in various degrees, becoming opaque when we observe, vitreous. Rarely white, generally yellowish grey or yellowish brown.

blackish brown on exposure. B.B infusible, but becomes magnetic, with borax and salt of phosphorus shows or iron, with soda often manganese. In acids soluble effervescence. Cornwall carbonate of iron, with 62·1 protoxide of 37·9 carbonic acid but usually 0·5 to 10 or even 25 of manganese, 0·5 to 15 magnesia, and 0·1 to 2 lime. Varieties. In beds or masses in Braunton in Devonshire, Cumberland, and in many of the tin-mines in Styria, Carinthia, and Westphalia; in veins in Anhalt Pyrenees and the Basque provinces of Joachimsthal, Freiberg,

grey blue brown, or black. G. 2·8 to 3·5
magnetic variety

Mine

ten curved,
niform, and columnar
G. H. 5 to 5·5 G. 3·3 to 3·6. Trans-
ly. Red to flesh-red; streak white
protoxide and 38 carbonic acid. Freiberg,

Colour
hedral and pleochroitic. H. 4; G. 4 to 4·13. Peach-
but dark externally. Schneeberg

Crystallization, Zinc
hombohedral, R 107° 40'. Usually uniform, stal
mmer or granular. Cl. R, perfect, but curved; fracture
hoidal; brittle. H. 5, G. 4·1 to 4·5. Translucent
pearly or vitreous. Colours but often pale greyish
wn, or green. Or: 64 zinc oxide and 35·2 carbonic
ntic in Somerset-shire, Matlock in Derby-shire, compact at
ur, Ches vy near Lyons, Altenberg near Verviers, Chapelle,
Westphalia Tarnowitz in Silesia, Hungary, Siberia

ARAGONITE, CaC.

Crystallization. ∞P 116° 10', $P\infty$ 108° 28'. The most common
ons are $\infty P\infty$ (*b*), $\infty P(M)$, $P\infty$ (*d*), *P* (fig. 275), generally
nate (like the separate crystals in fig. 164), $\infty P\infty$, ∞P,
ally short prismatic; crystal of 6 P, ∞P, $P\infty$, $6P\infty$ (*q*)
ate pyramidal. But simple crystals are
the great tendency to form twins, com
a face of ∞P, and repeated either in
angement (fig. 176) or in rosette groups
186). Also columnar, fibrous and re
alactite, and other forms. Cl. brachy-
distinct, fracture conchoidal or uneven
to 4. G. 2·9 to 3·0; rises to 2·95. Trans
translucent, vitreous. Colourless, but
white to brick-red, also light green
or grey. In the closed tube, before
red heat, it swells, and falls down in
coarse powder, evolving a little water
Leadhills, Valencia, Molina and el
Aragon; Leogang in Salzburg, and Arto-
Strontianite, cornflood, in the iron-mines of
Witherite, fine fibrous silky, at Dutton
chester. Sulcatine, coast of Galloway
Buckingham-shire, and Devon-shire. Also
as tufa by the Carlsbad and other hot

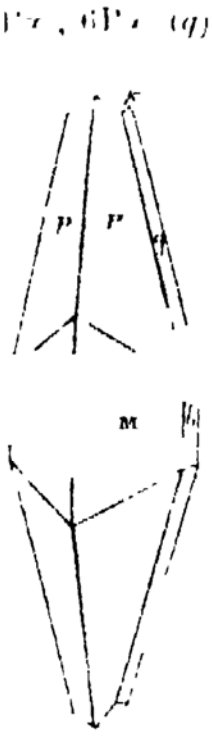


Fig. 373.

WITHERITE, BaC.

prismatic. ∞P (*o*) 118° 30', $2\breve{P}\infty$ (*f*) 112°. Crystals
ten 4 to 6, but usually with quite an hexagonal
ne being twinned like aragonite
Others short tabular, dihexagonal, or
wheat-sheaf-like aggregations. Cl. ∞P
fracture uneven. H. 3
Somerset coal
Colourless, but generally
or grey. It decrepitates easily
transparent glass; opaque when
charcoal-ball becomes caustic
into the sulphuret; soluble with
nce in nitric acid. Or: 22·3
acid and 77·7 baryta. Alston
Hexham in Northumberland
tyria, Salzburg, Hungary, Scotland
nd Cuba.

Fig. 374.

ALSTONITE, $BaC + CaC$.

prismatic. ∞P 118° 50'; $2\breve{P}\infty$ 111° 50', usual combination
∞P, resembling an hexagonal pyramid (fig. 375). Cl. ∞P
and $\infty\breve{P}\infty$, rather distinct. H. = 4 to 4·5; G. = 3·65 to 3·76.
3·76. Translucent; weak resinous.
Colourless or greyish-white. Or:
66 carbonate of baryta and 34
carbonate of lime. Fallowfield near
Hexham, and Alston Moor.

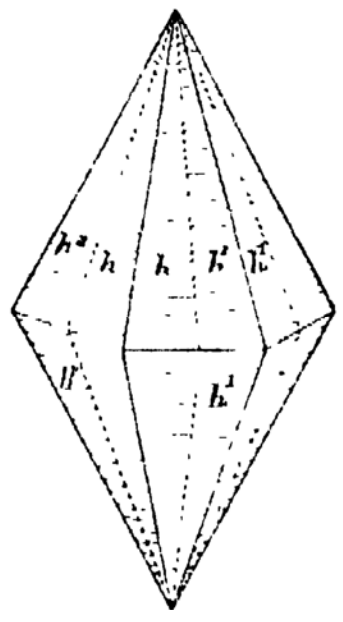


Fig. 375 (sp. 283).

284. STRONTIANITE, SrC.

Right prismatic. ∞P 117° 19',
$P\infty$ 108° 12'. Crystals (fig. 376)
and twins like aragonite, also broad
columnar and fibrous. Cl. pris-
matic along ∞P (*M*). H. 3·5,
G. = 3·6 to 3·8. Translucent or
transparent, vitreous or resinous
on fracture. Colourless but often
light asparagus or apple
rarely greyish, yellowish
ish. B.B. fuses in a strong heat
only on very thin edges intumesces
in cauliflower-like forms, shines
brightly, and colours the flame red; easily soluble in acids, with
effervescence. Or: 30 carbonic acid and 70 strontia, but often
contain carbonate of lime (6 to 8).
Strontian in Argyllshire, Sutherland, Leogang in Salzburg, Braunsdorf in Saxony, Hamm in Westphalia, the Harz, at Schoharie (N.Y.) and elsewhere in United States (*Emmons*). It is used to
produce red fire in pyrotechnic exhibitions.

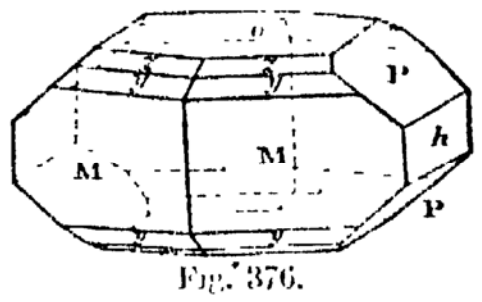


Fig. 376.

285. MANGANOCALCITE, $(Mn, Ca, Fe)\breve{C}$.

Right prismatic; in prisms like aragonite, and bears the same relation to dialogite that aragonite does to calc-spar. H. = 4 to 5; G. = 3·03. Red or reddish white. Vitreous. Schemnitz.

286. CERUSSITE (*Lead Spar*), PbC.

Right prismatic, isomorphous with aragonite and nitre. ∞P (M) 117° 14', $\breve{P}\infty$ 108° 16'; $2\breve{P}\infty$ (*u*) 69° 20'; also $0P$, P (*t*); $3\breve{P}\infty$ (*s*); $\infty\breve{P}\infty$ (*l*); $\infty\breve{P}3$ (*i*) (fig. 377). Twins common (figs. 158, 159, 378, 379). Also granular or earthy. Cl. ∞P and $2\breve{P}\infty$, rather distinct; fracture conchoidal; easily frangible. H. = 3 to 3·5; G. = 6·4 to 6·6. Transparent or translucent; adamantine or resinous. Colourless and often white, but also grey, yellow, brown, black, rarely green, blue, or red; streak white. B.B. decrepitates violently, but easily fused and reduced; soluble with effervescence in n. acid. Or: 83·5 protoxide of lead and 16·5 carbonic acid. Very common. Leadhills, Wanlockhead, Keswick, Alston Moor, Beeralston in Devonshire, St Minver in Cornwall; Przibram, Mies, and Bleistadt;

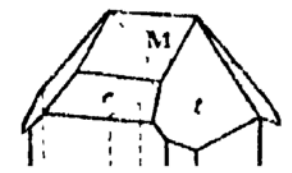


Fig. 377.

Fig. 378.

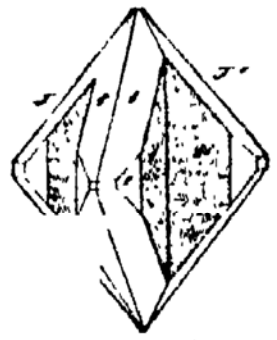


Fig. 379.

Tarnowitz, Johann-Georgenstadt, Zellerfeld, Klausthal, and many other pla

287. BARYTO-CALCITE, $BaC + CaC$.

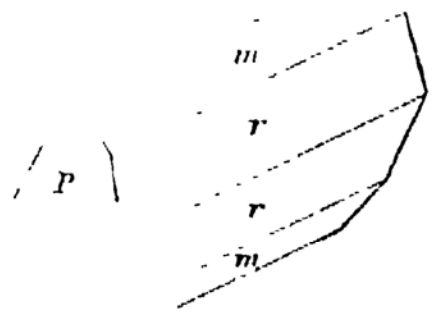


Fig. 380.
Oblique prismatic, C 69° 30'.

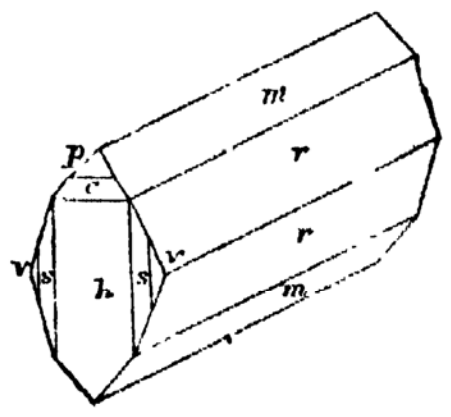


Fig. 381.
∞P (m) 84° 52', P (s) 106° 54',

) 61° (figs. 380, 381): also columnar and granular. Cl. P
P∞ less perfect. H. 4; G. = 3·6 to 3·7. Transparent
luscent; vitreous, inclining to resinous. Yellowish white.
ke alstonite. Alston Moor.

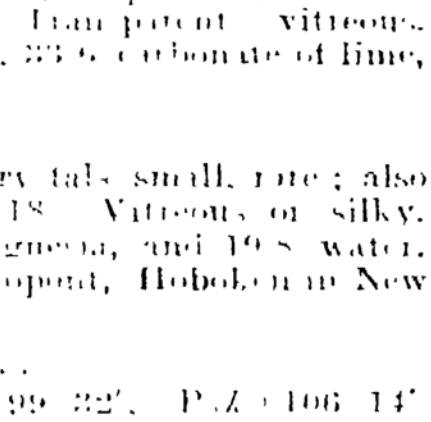
BISMUTO-SPHAERITE, $Bi_2\dot{C}$.

l fibrous brown concretions from Neustadtel, near Schnee-

HYDROUS CARBONATES

THERMONATRITE, $Na_2\dot{C} + H_2$.

prismatic. ∞P2 (*o*) 107° 50′; P∞ (*o*) 83° 50′, with ∞P∞
rectangular tables (fig. 382). Cl.
diagonal, perfect. H. = 1·5; G. 1·5
Colourless. B.B. like natron.
s not melt. Ce. 50·1 soda, 25·1
c acid, and 14·5 water. Natron
Lagunilla in Venezuela, of Lower
and of the steppes between Urals
n.



NATRON, $Na_2\dot{C} + 10H$.

ne prismatic, C 57° 40′. Crystals
l; with ∞P 79° 41′; P 76° 28′
odiagonal, distinct. H. 1 to 1·5,
to 1·5. Pellucid; vitreous
ss or greyish white. B.B. melts
colouring the flame yellow. Ce. 22·2 carbonic
d 63 water; but mixed with chloride of other
Only as an efflorescence on the ground or rock. Lake of
s and Etna in various countries. Hungary, Egypt, Tartary
mineral springs and lakes. Used in the manufacture of
dyeing, and in bleaching.

TRONA, URAO, $Na_4\ddot{C}_3 + 4H$.

ne prismatic. Crystals of P, *o*, *M*, *T*, *M*
(fig. 383). Cl. orthodiagonal, p
5 to 3; G. = 2·1 to 2·2. Transparent to
ent. Colourless. Does not decompose in
Taste alkaline. Ce. 38 soda, 10·6 c
id, and 22 water. Fezzan and Barbary
, Lagunilla (*Urao*).

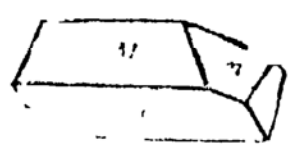


Fig. 383.

GAYLUSSITE, $Na_2\dot{C} + Ca\dot{C} + 5H$.

ne prismatic, C 78° 27′. Cl. ∞P, imperfect, fracture
dal. H. 2·5; G. 1·9 to 1·95. Transparent, vitreous.
ss. Ce.: 31·5 carbonate of soda, 37·6 carbonate of lime,
ter, with 1·5 clay. Lagunilla.

HYDROMAGNESITE, $Mg_4\ddot{C}_3 + 4H$.

ne prismatic. ∞P 88° nearly. Crystals small, rare; also
. H. = 2·5 to 3; G. 2·11 to 2·18. Vitreous or silky.
Ce.: 36·2 carbonic acid, 44 magnesia, and 19·8 water.
Shetland), Moravia, Kumi in Negropont, Hoboken in New
and Texas in Pennsylvania.

AZURITE (*Blue Copper*), $Cu_3\ddot{C}_2 + H_2$.

ne prismatic, C 87° 39′. ∞P (*M*) 99° 32′, P,*Z* 106° 14′
OP, ∞P, ∞P∞, -P (for *h*, *M*, *s*, *k*, in fig. 384, but in
position); also radiated and earthy. Cl. clinodiomatic (*P*)
rather perfect; frac-
onchoidal or splintery.
to 4·2; G. = 3·7 to 3·8.
cent or opaque; vitre-
Azure-blue, the earthy
s (and streak) smalt-
B.B. on charcoal fuses
elds a grain of copper;
with effervescence in
nd also in ammonia.
0·1 protoxide of copper,
rbonic acid, and 5·2 water. Crystals at Redruth, Alston
Chessy near Lyons, in Siberia, Moldawa in the Banat, Burra-
Australia). Valued as an ore of copper.

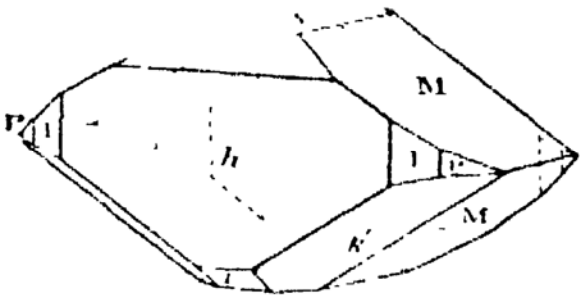


Fig. 384.

MALACHITE, $Cu_2\dot{C} + H_2$.

ne prismatic, C 61° 50′. ∞P 104° 20′. Crystals ∞P (*M*),
(*s*), OP (*P*), in hemitropes (fig. 385). In general acicular,
r reniform, stalactitic, and radiated fibrous.
l and clinodiagonal, very perfect. H. = 3·5
. = 3·6 to 4. Transparent or translucent on
ges; adamantine, vitreous, silky, or dull.
l and other shades of green; streak apple-
B.B. and with acids like azurite. Ce.:
opper protoxide (= 57·5 copper), 20 carbonic
nd 8·2 water. Crystalline at Rheinbreiten-
the Rhine and Zellerfeld in the Harz; fibrous
npact at Sandlodge in Shetland, Leadhills, Cornwall, Wales,
land, at Chessy in France, Siberia, the Urals, Saalfeld in

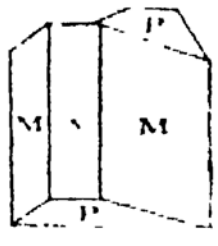


Fig. 385.

Thuringia, Moldawa in the Banat, in North America, Afri
Australia. Frequently pseudomorphous after copper and i
also after calcite and cerussite. Valuable ore of copper; t
varieties are prized for ornamental purposes.

296. HYDROZINCITE, $Zn\ddot{C} + 2ZnH_2$.

Massive. Ce.: zinc oxide 75·3, carbonic acid 13·6, wate
Spain, Westphalia, Bavaria, Persia, United States. Valuab

297. AURICHALCITE, $2Cu\ddot{C} + 3ZnH_2$.

Acicular. H. 2. Translucent, pearly, and verdigris-
Ce.: 39·2 copper protoxide, 11·7 zinc oxide, 16·2 carbon
and 9·9 water. Leadhills, Matlock, Loktevsk in the Altai

298. EMERALD NICKEL (*Zaratite*), $Ni\ddot{C} + 6H$.

Amorphous, reniform, and incrusting. H. = 2·5; G. = 2·6
Translucent, vitreous. Emerald green. Ce.: 59·3 nick
to oxide, 11·7 carbonic acid, and 29 water. On chromite at H
in Unst, Texas in Pennsylvania, also Cape Ortegal in
Tyrol, and Ekaterinburg on the Urals.

299. LIEVRITE, $Fe_2\ddot{C} + 2Ca\dot{C} + 4H$.

In small black-green crystalline aggregates. H. 2·5
From Elias mine near Joachimsthal, implanted on pitch-ble

300. VOGELITE, $4Fe\ddot{C} + 7Ca\dot{C} + 3Cu\dot{C} + 2H_2$.

Rhomboidal. Emerald-green to pale with pearly lustre.
mine, Joachimsthal.

301. LINDACKERITE, $\dot{C}u\ddot{C} + Ca\dot{C} + 2H_2$.

Mammillary concretions. H. = 2 to 2·5. Apple-green.
ople, Joachimsthal, and Johann-Georgenstadt.

302. BISMUTITE, $Bi_4\ddot{C}_3 + 4H$.

Disseminated, investing or acicular, fracture conchoidal
even, very brittle. H. = 4 to 4·5, G. = 6·8 to 6·91. Opaqu
vitreous. Grey, yellow, or green. Ce.: 90·1 bismuth ox
carbonic acid, and 9·5 water. Ullersreuth (Reuss), Schn
Johann-Georgenstadt; also Chesterfield in South Carolina.

303. LANTHANITE, $LaC + 3H_2$.

Right prismatic. ∞P 92° 46′. Small tabular crystals;
granular or earthy. Cl. basal. H. = 2, G. = 2·7. Dull or
White or yellowish. Ce.: 21 carbonic acid, 55 lanthanum
and 24 water. Bastnaes in Sweden, Lehrbach in Pennsylvani

CARBONATES WITH HALOID SALTS, &c.

301. PHOSGENITE, $PbCl + PbC$.

Pyramidal. P 113° 56′. Crystals short-prismatic or
pyramidal. Cl. ∞P, rather perfect, fracture
conchoidal. H. 2·5 to 3. G. 6 to 6·7
Trans-parent or translucent, to moderately adaman-
tine. White, yellow, green, or grey. Ce.:
51 chloride and 49 carbonate of lead. Very

Fig. 387.

Stolzite, *a*, *m*
near Elgin in
Scotland, Matlock
and Crowford in
Derbyshire, Tar

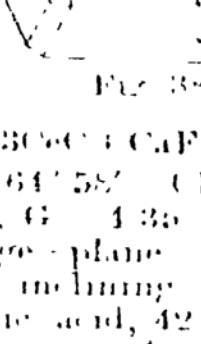


Fig. 3

305. PARATHITE, $3CeFCO_3 + CaF$
Hexagonal. P 164° 58′. C
perfect. H. = 4·5, G. = 4·35
ous or cleavage-plane
Brown to yellow, inclining
Ce. 23·5 carbonic acid, 42
oxide of cerium, 8·2 lan
oxide, 9·6 didymium oxide, 2
10·1 fluoride of calcium, and 2·2 fluoride of cerium. I
mine of the Muzo Valley in Colombia, Urals.

306. LEADHILLITE (*Warrite*), $Pb_{18}C_9S_2O_{51} + 3H_2$.

Right prismatic. P middle edge 137°; ∞P 120° 20′; 2P∞

Fig. 388.

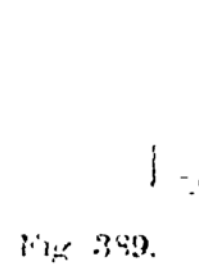


Fig. 389.

Mostly tabular; also twins. Cl. basal, perfect; slightly
H. = 2·5; G. = 6·26 to 6·44. Transparent or translucent;

amantine, pearly on cl
yellow, or brown
acid, 8·12 sulphuric
·8 wate
Taunton, New brick,
da. *Mazzite* from Sa

Yellowish white, inclining to grey,
81·98 oxide of lead, 8·03 car-

Fig. 390 (p. 307).

Fig. 391 (p. 307).

the Surtarbrand mine at
but very rare,
dark grey tufa from the Banat

ANHYDROUS SULPHATES

ANGLESITE (*chisolite*), PbS.

pri matic Acute pyramid, with ∞P 120° 24′; dimorphous
rhombohedral, with R 55° 14′ Mostly in crusts, or pul-
Cl basal, imperfect H 2·5 to 3, G 6·2 to 6·4 Reduced,
on to smoke Colourless or white Ce 51 potash and 46
ric acid Lavas of Vesuvius and other volcanoes

MASCAGNINE, $(NH_4)_2S$

pri matic ∞P 127° 8′, but chiefly in crust and stalac-
Cl perfect, sectile H 2 to 2·5, G 1·7 to 1·8 Pol
vitreous Colourless, white, or yellowish Taste pungent
ter Ce 25·9 ammonia 60·6 sulphuric acid and 13·6
Near volcanoes, as Etna, Vesuvius, the Solfatara, the
Islands, in the marble near Siena, and in ignited coal beds,
Dudley in Staffordshire

THENARDITE Na_2S

pri matic Acute pyramids P, with 0P and ∞P, in crusts
Cl basal, perfect, fracture uneven H 2·5, G
2·7 Pellucid, vitreous White Ce 43·82 soda and
sulphuric acid In salt deposits near Aranjuez (Spain) and
pacer (Peru)

GLAUBERITE (*Brongniartine*), $Na_2S + CaS$

que pri matic, C 68° 16′, 0P, P on with ∞P (*P*, *t*, *M*, fig
Cl basal, perfect along ∞P Fracture H 2·5
G 2·75 to 2·80 Translucent, vitreous to
Colourless Ce 51·1 sulphate of soda,
sulphate of lime Valdaliga in Spain, Vic,
Cadeo, near Biaza in Aragon, Aussee and
in Austria Tarapaca in Peru, with 1 to 5
acid

Fig. 392.

ANHYDRITE (*Karstenite*), CaS.

pri matic ∞P 90° 0′ Chiefly granular, or almost com-
columnar Twin rare Cl macrodiagonal and brachy-
perfect basal perfect H 3 to 3·5, G 2·8 to
translucent; vitreous, on ∞P∞ pearly
white but often blue, red, or grey; streak greyish
sulphuric acid and 41·2 lime.
Westphalia, at the salt mines of Vic, Hall
Styria, also at Sulz Stassfurt and Bleiberg
Aussee, Berchtesgaden, Lisleben, and the
near Bergamo The contorted, or
Wieliczka and Bochnia

BARYTES, BaS

right pri matic, P 78° 20′, P∞ (*y*) 105° 22′, ∞P2 (*o*) 77°
also ∞P∞ (*x*) 78° 13′, but on a different portion,
being placed ver
crystals show very many forms
combinations, and
columnar often in druses or
; also foliated, fibrous, granular, or compact. Cl brachy-
pinacoidal perfect, also P basal, traces H. 3
G 4·3 to 4·6 Transparent to translucent; vitreous
nous Colourless and white, but frequently reddish white,
flesh-red, yellow, grey, blue, brown, or black B.B.
decrepitates violently, and fuses, often with a flash, or only on the
colouring the flame yellowish green Not soluble in acids.
34·3 sulphuric acid and 65·7 baryta, but occasionally
to 15 sulphate of strontia Very common, chiefly in veins,
alone or accompanying ores Crystallized at Arran, Strontian,
Sutherland; Dufton, Bohemia, Felsobanya and Kremnitz in
Hungary, Auvergne, and United States. Columnar at Freiberg. The radiated from near Bologna, or the *Bolognese Stone*, phosphoresces in the dark. Massive, or *Cawk*, from Derbyshire and Staffordshire, Leadhills, and Arran.

Lime Barytes, from Derbyshire, Strontian, Freiberg, seems a mixture with sulphate of lime; crystals tabular, in rosettes and other groups, G. 4 to 4·3. *Hepatite*, dark grey, from carbonaceous matter; Kongsberg. *Allomorphite*, scaly, white, and pearly, near Rudolstadt, agrees essentially with barytes.

314. BARYTO-CELESTINE, $2SrS + 3BaS$.

Radiated and foliated. Bluish white. Brittle and friable. H. = 2·5, G. = 3·92 Difficultly fusible. Lake Erie, Upper Canada, and Binnenthal

315. CELESTINE, SrS

Right prismatic, forms like barytes and anglesite. P∞ (*o*) 104° 8′, P (*M*) 75° 52′ and combinations. P∞, P∞, ∞P∞; or this with ∞P2 (*d*) also columnar and foliated; or fibrous, fine granular, or compact. Cl macrodiagonal, perfect; along P∞ less perfect H = 3 to 3·5, G = 3·9 to 4 Transparent or translucent; vitreous or resinous. Colourless, but usually bluish white to milk-blue, and rarely reddish or yellowish B.B. decrepitates and fuses easily to a milk white globule; colours the flame carmine-red. Distinguished from barytes by a splinter, after ignition in the inner flame, on being moistened with hydrochloric acid, and held in the blue border of the flame of a candle, colouring this of a lively purple red Scarcely affected by acids. Ce.: 43·6 sulphuric acid and 56·4 strontia, but often one baryta or lime. Tantallon Castle, Calton Hill, Clachnabarry; near Bristol and Knaresborough, sulphur mines of Girgenti and other parts of Sicily, Herrengrund in Hungary, Bex, Salzburg, Monte Viale near Verona, and Meudon and Montmartre near Paris. Used for producing a red light in pyrotechnic mixtures.

Fig. 393.

316. ANGLESITE, PbS

Right prismatic, ∞P 103° 43′; P∞ 75° 35′. The crystals, of many forms and combinations, are short prismatic, pyramidal, or tabular. Cl. prismatic along ∞P, and basal; fracture conchoidal very brittle. H 3; G 6·2 to 6·35. Transparent or translucent, adamantine or resinous. Colourless and white, but occasionally yellow, grey, brown, or blue, streak white. Decrepitates in candle, B.B. on charcoal fuses in the oxygen flame to a milk white bead, very difficultly soluble in acids, wholly in solution of potash. Ce. 73·7 lead protoxide and 26·3 sulphuric acid. Leadhills (fig. 397), St Ives in Cornwall, Derbyshire, Parys mine in Anglesea; Zellerfeld, Klausthal, Badenweiler, Siegen, Silesia, Linares, Phoenixville in Pennsylvania.

Fig. 394.

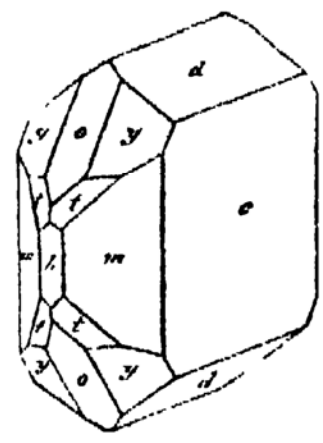


Fig. 395.

Fig. 396.

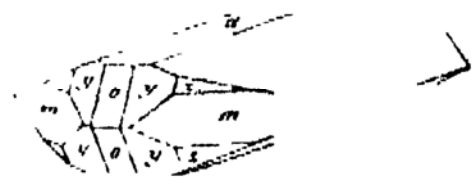


Fig. 397.

317. LANARKITE, $PbS + Pb$.

Oblique prismatic ∞P 49° 50′ Cl. basal, perfect; sectile; thin lamina flexible H 2 to 2·5; G. = 6·3 to 6·7. Transparent;

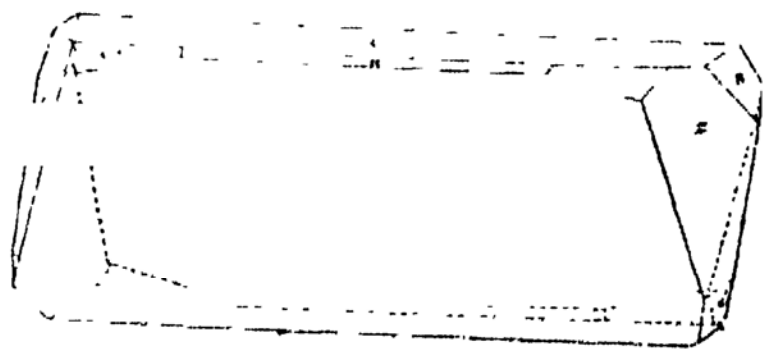


Fig. 398.

resinous or adamantine; on 0P pearly. Greenish or yellowish white, inclining to grey; streak white. B.B. on charcoal fuses to a white globule containing metallic lead; partially soluble in n.

h effervescence. C.c.: sulphate of lead 57·6, oxide of lead Leadhills; rare.

HYDROUS SULPHATES.

MIRABILITE (*Glauber Salt*), $Na_2S + 10H_2$.

no prismatic, C 72° 15′. Cl. orthodiagonal; fractur dal. H. = 1·5 to 2; G. = 1·4 to 1·5. Pellucid and colour c.: 19·2 soda, 24·8 sulphuric acid, and 56 water As rescence in quarries, on old walls, or on the ground, in ers of lakes and springs in Russia and Egypt, and on s on lava.

GYPSUM, $CaS + 2H_2$.

ne prismatic, C 80° 57′. The most common forms are ′30′; P 138° 40′; −P 113° 30′, and ∞P∞. Two common ations are ∞P(*f*), ∞P∞ (*o*), −P (*l*) the 129°, and the Lenticular crystals often occur; hemitropes frequent fres , 151); also granular, compact, fibrous, scaly, or pulverulent odiagonal perfect, along P much le perfect flexible. H. = 1·5 to 2 (lowest on P), G. to 2·4 rent or translucent; vitreous, on cleavage ss, and snow-white, but often red, grey, yell d rely greenish or bluish. In the closed tube comes opaque and white, soluble in 100 t carcely more so in acids. C.c.: 46·5 sulph id, nd 20·9 water.

parent crystals, or *Selenite*, occur in the cl ins of Be erland, of the Tyrol, Salzburg, and Bohemia, the sulphur f Sicily, at Lockport in New York in porphy at Gomeck, lay of Shotover Hill near Oxford, at Chalky n Bath, and ther localities. Fibrous gypsum at Comp Matlock in ire, and at Ilfeld in the Harz. Compact ex ure in whole many parts of England, Germany, France, ed Italy, at in Tuscany (*Alabaster*) often with to k. The finer s (or alabaster) are cut into various ornamental articles.

KIESERITE, $MgS + H_2$.

mbic, but chiefly massive. G. = 2·57. Pellucid, greyish C.c.: magnesia 29, sulphuric acid 58, water 13. In beds at t.

EPSOMITE (*Epsom Salt*), $MgS + 7H_2$.

prismatic. P mostly hemihedric, ∞P 9 oP (*M*),), P (*l*) (fig. 399). Granular, fibrous, iv. Cl agonal, perfect. H. 2 to 2·5. Pellucid; vitreous; and white itter. C.c.: 16·32 magnesia, 32·53 acid, and 51·15 water. Efflorescence us rocks, as at Hurlet near Paisley Montmartre, and Freiberg; on the in Spain and the Russian steppe ral waters, as at Epsom in Surrey, tz and Seidlitz in Bohemia. Used in e.

GOSLARITE (*White Vitriol*), ZnS

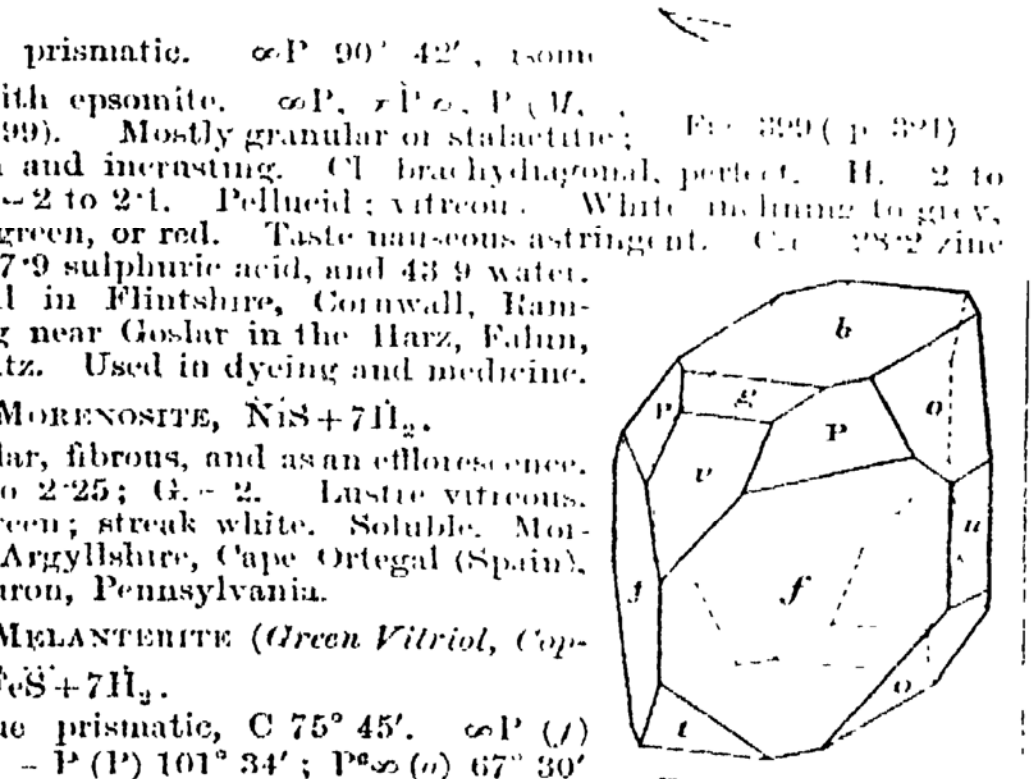


Fig. 400 (sp. 324).

prismatic. ∞P 90° 42′, isom ith epsomite. ∞P, ∞P∞, P (*M*, 99). Mostly granular or stalactitic; and incrusting. Cl. brachydiagonal, perfect. H. = 2 to ; G. = 2 to 2·1. Pellucid; vitreous. White inclining to grey, green, or red. Taste nauseous astringent. C.c.: 28·2 zinc 7·9 sulphuric acid, and 43·9 water. d in Flintshire, Cornwall, Ramg near Goslar in the Harz, Falun, tz. Used in dyeing and medicine.

MORENOSITE, $NiS + 7H_2$.

lar, fibrous, and as an efflorescence. o 2·25; G. = 2. Lustre vitreous. reen; streak white. Soluble. Mor- Argyllshire, Cape Ortegal (Spain), ron, Pennsylvania.

MELANTERITE (*Green Vitriol, Cop-*

$FeS + 7H_2$.

ue prismatic, C 75° 45′. ∞P (*l*) − P (P) 101° 34′; P∞ (*o*) 67° 30′ ; chiefly stalactitic, reniform, or in Cl. basal, perfect; prismatic less so. H. = 2; G. = 1·8 to 1·9 ent, rarely transparent; vitreous. Leek- or mountain-green. h a yellowish coating; streak white. C.c.: 26 protoxide of sulphuric acid, and 45 water. Hurlet near Paisley, is, Rammelsberg, Falun, Schemnitz, Bilin. Used in dyeing, and in manufacturing ink, Prussian blue, and sulp acid.

325. SMIKITE, $Mn_2S + H_2$.

Stalactitic aggregates. Rose to white. Felsobanya (Hung

326. MALLARDITE, $MnS + 7H_2$.

Crystalline foliated masses, apparently oblique prismatic. Bay mine in Utah.

327. BIEBERITE (*Cobalt Vitriol*), $CoS + 7H_2$.

Oblique prismatic, usually stalactitic, or an efflorescence. rose-red. C.c.: 20 cobalt oxide, 1 magnesia, 29 sulphuric acid 47 water. Bieber near Hanau, and Leogang

328. ALUNOGENE (*Hair-Salt*), $Al_2S + 15H$.

Capillary or acicular, in crusts or reniform masses. H. 2; G. = 1·6 to 1·7. Silky. White, inclining to green or y C.c.: 36 sulphuric acid, 15·4 alumina, 48·6 water. Volcanic South America, in coal and lignite in Germany, and on old wa

329. ALUMINITE (*Websterite*), $Al_2S + 9H$.

Reniform, and very fine scaly, or fibrous. Fracture ear sectile or friable. H. = 1, G. = 1·7. Opaque, dull or glimme snow-white or yellowish white. C.c.: 29·8 alumina, 23·2 sulp acid, and 47 water. Newhaven in Sussex, Epernay, Autenil Lunel Viel in France; Halle and Morl in Prussia. *Edelfo* from Hungary, in rhombic tubes, is similar, but has 1 cent. of water.

330. COQUIMBITE, $Fe_2S + 9H_2$.

Hexagonal. P 58°. Crystals oP, with ∞P and P; us granular. Cl. ∞P, imperfect. H. = 2 to 2·5, G. = 2 to White also brown, yellow, red, and blue. C.c.: 28·5 iron pero 42·6 sulphuric acid, and 28·9 water. Copiapo in Chili, and C in Bolivia.

331. COPIAPITE, $2Fe_2S + 13H_2$.

Six-sided tables; but system uncertain; also granular. Cl fect. Translucent, pearly. Yellow. C.c.: 34 iron peroxid sulphuric acid, and 21 water. Copiapo in Chili. Also radi fibrous masses, dirty greenish yellow, metamorphic the fo with 32 sulphuric acid and 37 water. Both probably mixture *Fibrous ferrite*, also from Chili, and *Yellow Iron Ore* from the b coal at Kolosoruk in Bohemia and Modum in Norway, are reniform, or compact and earthy. H. = 2 to 3, G. = 2·7 t Colour ochre-yellow. *Ipatite*, reniform-earthy, yellow, Auteuil near Paris, is granular, also *Vitriol Ocher* from I *Misy*, from Rammelsberg in the Harz, containing sulphates of copper, zinc, and other metals, is a product of decomposition.

332. PISSOPHANE, $Al_2Fe_2S + 15H_2$.

Stalactitic; fracture conchoidal, very easily frangible. H. G. = 1·9 to 2. Transparent or translucent, vitreous. Olive- to liver-brown, streak greenish white to pale yellow. C.c.: alumina, 10 to 40 iron peroxide, 12 sulphuric acid, and 41 w Saalfeld and Reichenbach in Saxony.

Carphosiderite, reniform, opaque, resinous, and straw-yellow, a greasy feel, is related. H. = 2·5, G. = 2·5. Consists of hydrous sulphate of iron. Labrador.

333. CHALCANTHITE, $CuS + 5H_2$.

Anorthic. ∞P ∞ : ∞P ∞ (*r*) 79° 19′, P (*l*) : ∞P (*T*) 117° 40′, P : *r* 120° 50′, P : *T* 103° 27′, ∞P (*T*) : ∞P (*M*) 123° 10′ (fig. 401). Generally met with Cl. *T* and *M*, imperfect. H. = 2·5, G. = 2·2. Blue. C.c.: 32 protoxide of copper, 32 sulphuric acid, 36 w Cornwall, Wicklow, Hungary, T Falun, and on lava of Vesuvius.

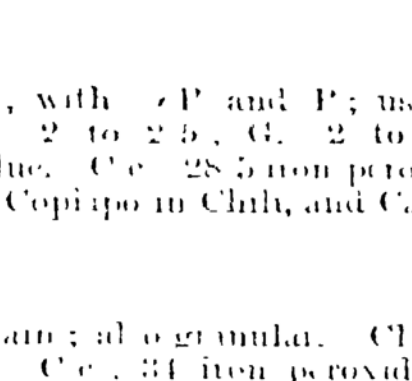


Fig. 401 (sp. 333).

334. BROCHANTITE, $CuS + 3CuH_2$.

Right prismatic. ∞P 101° 32′, 15° 37′, and ∞P∞ al reniform brachydiagonal, perfect. H. = 3·5 to G. = 3·75 to 3·9. Transparent or t lucent; vitreous. Emerald or blac green; streak bright green. C.c. copper protoxide, 18 sulphuric and 12 water. Sandlodge (Unst), Roughton Gill in Cum

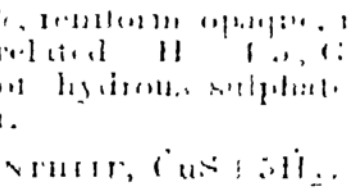


Fig. 402 (sp. 334).

Rezbanya, Elaterolite; also Krisuvig in Iceland (*Stigite*).

LANGITE, $CuS \cdot CuSO_4 + 2H_2O$.

[illegible] $P = 120° 44'$. Crystals long tabular, mostly [illegible]. Also in botryoidal and concretionary crusts, with [illegible]. Cl. basal and brachydiagonal. H = 2·5, G = 3·5. [illegible] Copper protoxide, 16·4 sulphuric acid, [illegible] water. Cornwall [illegible] also *Krisuvig* from Siberia.

[illegible] (*Leonhardite*)

[illegible] Cl. [illegible]. Crystal similar to [illegible] Color flesh-red; natural [illegible] in concretionary [illegible]. H = [illegible]; G = 3·19. Semitransparent, [illegible]. Dull lustre. Bright-green [illegible] oxides [illegible] oxide of copper 5·99, sulphuric acid 29·02, water [illegible]. Chessy-shaft, Bohemia; Johann-Georgenstadt.

[illegible] $(MgNa_2S + 9H_2O)$

[illegible] Cl. [illegible]; $P = 112° 15'$; $\infty P2 = 119° 35'$; [illegible]; $P\infty$, $P\infty$, ∞P, $\infty P\infty$, $P\infty$, P, [illegible]. In prismatic [illegible]. H = [illegible]. Transparent. White or [illegible] sulphuric acid, 8·5 soda, [illegible] and 21·5 water. Salt lake [illegible] Volga near Astrakhan, Inder, and near Mendoza in South [illegible] from Seidlitz-similar, but [illegible].

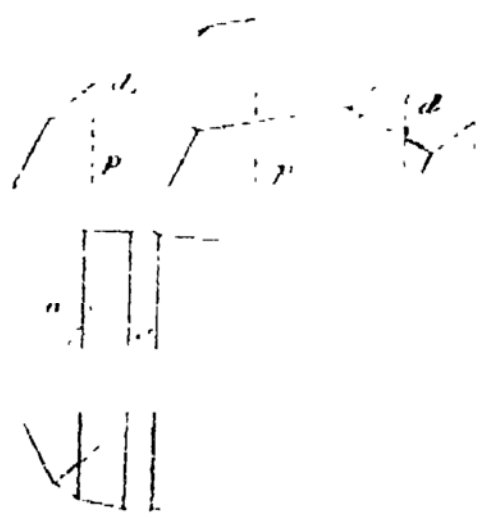


Fig. 403 (sp. 335).

[illegible] $(2Na_2S + MgS) + 5H_2O$. [illegible] but only compact [illegible] [illegible], also octahedral, with [illegible] 11′ and 105° 2′. H = 2·5 [illegible] 1·76. Vitreous. Yellow [illegible] to flesh-red. Ca, [illegible] 20 soda, 13 magnesia, 52 sulphuric [illegible] 15 water. Ischl.

[illegible] $(K_2S + CaS + H_2O)$

[illegible] prismatic, C = [illegible]; ∞P 7[illegible]; [illegible] Crystals $\infty P\infty$ (*a*), $0P$ (*c*), ∞P (*p*), $\infty P2$ (*p′*), $2P2$ (*o*), P (*o′*), $2P$ (*n*), $P\infty$ (*d*), $\frac{1}{2}P\infty$ (*d′*), $2P\infty$ (*e*), $\frac{1}{3}P\infty$ (*f*), $\frac{1}{4}P\infty$ (*g*), $\frac{1}{5}P\infty$ (*h*), $\frac{1}{6}P\infty$ (*i*), $\frac{1}{7}P\infty$ (*k*), $\frac{1}{8}P\infty$ (*l*), $\frac{1}{9}P\infty$ (*m*), $\frac{1}{10}P\infty$ (*n*), $\frac{1}{11}P\infty$ (*r*), $\frac{1}{12}P\infty$ (*s*), $\frac{1}{13}P\infty$ (*t*), $\frac{1}{14}P\infty$ (*u*), $\frac{1}{15}P\infty$ (*v*), $\frac{1}{16}P\infty$ (*w*), $\frac{1}{17}P\infty$ (*x*), $\frac{1}{18}P\infty$ (*y*), $\frac{1}{19}P\infty$ (*z*), $\frac{1}{20}P\infty$ (*a′*), $\frac{1}{21}P\infty$ (*b′*), $\frac{1}{22}P\infty$ (*c′*), $\frac{1}{23}P\infty$ (*d′*), $\frac{1}{24}P\infty$ (*e′*), $\frac{1}{25}P\infty$ (*f′*), $\frac{1}{26}P\infty$ (*g′*), $\frac{1}{27}P\infty$ (*h′*), $\frac{1}{28}P\infty$ (*i′*), 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TELLURATES AND CHROMATES.

MONTANITE, $Bi_2Te + 2H_2$.

...ting, earthy. Lustre waxy. Yellowish. Opaque. C.e. ...66·8, tellurium 26·8, water 5·9. Highland in Montana.

MAGNOLITE, HgTe.

... acicular crystals from Keystone mine in Colorado.

...ROCOISITE, PbCr.

...ne prismatic, C 77° 27′. ∞P 93° 42′ (*M*), −P 119° 12′ (*r*), ...) 56° 10′, ∞P∞ (*g*). (fig. 409). ... distinct; sectile. H. = 2·5 to ...5·9 to 6·1. Translucent, ada... Hyacinth- or aurora-red; ...range yellow. C.e.: 31 chromic ...1·69 lead protoxide. Berezoff, ...k, and Nijni-Tagilsk in the ...ongonhas do Campo in Brazil, ...a, Moldawa, and Tarnowitz ...a pigment, but not permanent.

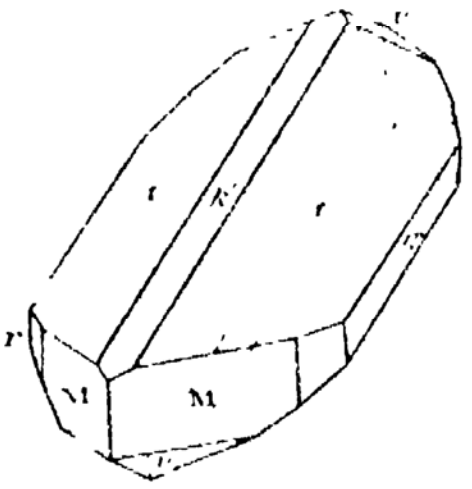

Fig. 409 (sp. 355).

...HOMBICO-CHROLITE, 2PbCr + Pb ... prismatic; dimensions un... H. = 3 to 3·5, G. = 5·75 ...ent on the edges; resinous ...antine. Cochineal- to liver ...d; streak brick-red. C.e.: 23 chromic acid, and 77 prot... lead. Berezoff.

VAUQUELINITE, 2,2PbCr + Pb + 2CuCr + ...ne prismatic, C 67° 15′. Crystals oP, P, ... ways, twinned (fig. 410), the faces of oP ... an angle of 131° 30′, also botryoidal or ... H. = 2·5 to 3, G. = 5·5 to 5·8. Semi... ent or opaque, resinous. Blackish or ...ve green; streak siskin-green. C.e.: 61 ...toxide, 11 copper protoxide, 28 chromic acid. Leadhills, ..., Congonhas do Campo (Brazil).

Fig. 410.

MOLYBDATES AND TUNGSTATES.

WULFENITE, PbMo.

...nidal. P 131° 48′. oP (*o*), ¾P (*l*), P, ∞P (*m*), ∞P2 (*r*) (figs. ...). Cl. P; brittle, ... uneven, or con... H. = 3; G. = 6·3 ... P; fluid; resinous ...nantine. Orange-... honey-yellow, and ...ss. C.e.: protoxide ...61·5, molybdic acid ...ed varieties have ...romic acid. Lack... in Kirkcudbright ...2). Bleiberg, Rez... Pennsylvania, Za... $2PbOMoO_3$ + ...O_3, with 6·88 of ...curs in Chili.

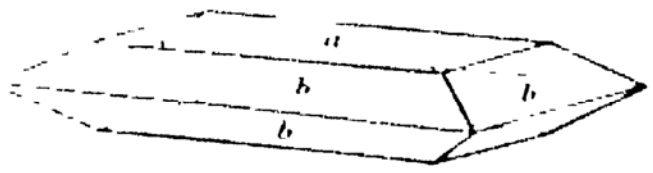

Fig. 411.

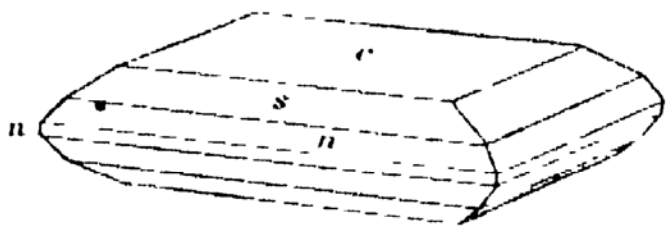

Fig. 412

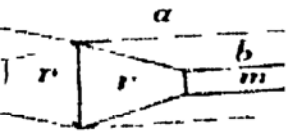

Fig. 413 (sp. 358).

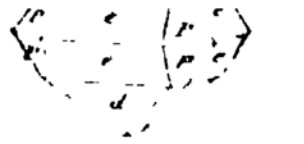

Fig. 414 (sp. 358).

EOSITE.

...nidal. oP (*c*) : *p*′ 117° 10′; *p*′ : *p* 125° 16′ (fig. 415). H. = 3 ...Colour deep aurora-red. Streak orange ... A vanadio-molybdate of lead. Lead

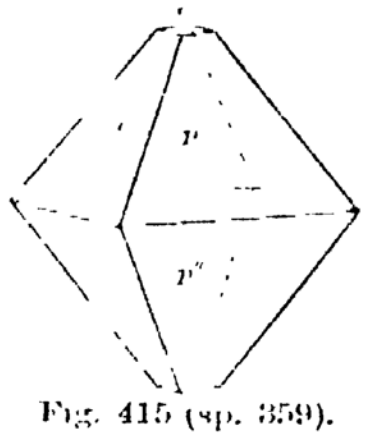

Fig. 415 (sp. 359).

MEGABASITE, Mg_2W_3.

...que prismatic; similar to wolframite. ...needles. H. = 3·5 to 4; G. = 6·45 to ... Vitreous to adamantine. Yellowish ...to brownish red, translucent hyacinth... ...treak ochre-yellow. C.e.: protoxide ...nganese 23·1, protoxide of iron 5·4, ...c acid 71·5. Schlaggenwald, Sadis ...Jorococha in Peru.

SCHEELITE, CaW.

...nidal; with many of the modifying planes hemihedric. P ...2′. Cl. 2P∞ (*n*) 130° 33′, perfect; P and oP less so. Frac... ...onchoidal. H. = 4 to 4·5; G. = 5·9 to 6·2. Translucent; ...s to adamantine. Colourless, and grey, yellow, or brown; ...white. C.e.: 19·4 lime, 80·6 tungstic acid. Caldbeckfell near Keswick, Pengelly in Cornwall, Zinnwald, Schlaggenwald ... burg, Chili, Si... beria, Connecti... cut. Employed for the extrac... tion of yellow tungstic acid, a fine pigment.

362. STOLZ ...ITE, PbW ... Pyramidal, generally hemihedric. P ... 31° 25′. Crystals sometimes spindle-... shaped. Cl. P, imperfect. H. = 3, G. = ... 9 to 8·1. Translucent, resinous. Grey, ... yellow, brown. C.e.: 48·1 protoxide of ... lead, 51·6 tungstic acid. Keswick, Zinn... wald, Coquimbo (Brazil).

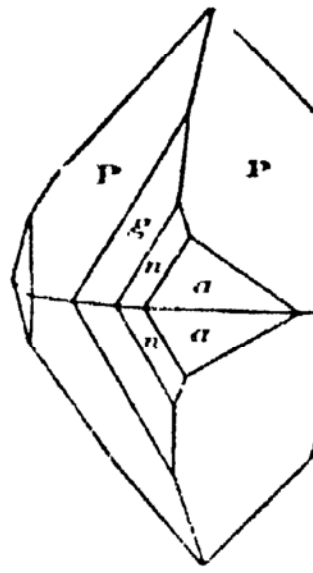

Fig. 417 (sp. 3

363. REINITE, FeW.

Pyramidal. P 103° 32′; basal angle 122° 8′. Cl. ... P. G. = 6·64. C.e.: protoxide of iron 23·1, tungstic acid ... Kimbosan in Japan.

364. WOLFRAMITE, (Fe, Mn)W.

Oblique prismatic, C 89° 22′. P : *M* = 100° 37′, −P ... 61° 0½′, P∞ : ∞P 98° 6′, ∞P∞ : ∞P∞ = 94°2′ 30″, − ... 32°2′ 30″. Twins common. Also laminar ... Cl. clinodiagonal, perfect; fracture un... even. H. = 5 to 5·5, G. = 7·1 to 7·5. ... Opaque, resinous, metallic, adamantine ... on the cleavage. Brownish black, ... streak black (varieties with most iron to ... reddish brown (most manganese). C.e.: ... 76 tungstic acid, 9·5 to 20 protoxide of ... iron, and 4 to 15 protoxide of manganese, ... in some with 1·1 niobic acid. East ... Pool, Cambrae, and mines near Redruth; ... Godolphin's Ball in Cumberland, Alten... berg, Geyer, Ehrentriedersdorf, Schlag... genwald, Zinnwald, the Harz, also ... Urals, Ceylon, and North America.

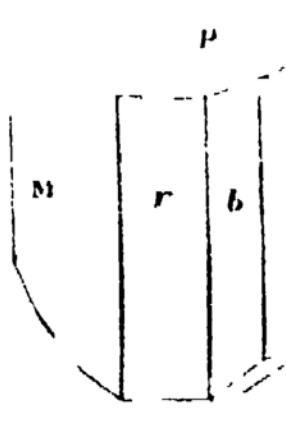

Fig. 418

Hübnerite, with 26 protoxide of iron ... and 2FeW + Fe (H. = 4 to 4·5, G. = 6·7 to 6·8), from Spain, ... different.

365. HÜBNERITE, MnW.

Right prismatic. ∞P (*M* : *M*) 105°. Cl. ∞P∞, ... usually foliated or columnar. H. = 4·5, G. = 7·14. Adama... cleavage; elsewhere greasy. Brown-red, streak yellow... C.e.: protoxide of manganese 23·4, tungstic acid 76·6. M... district in Nevada.

ANHYDROUS PHOSPHATES, ARSENIATES, AN... VANADIATES.

366. XENOTIME, Y_2P.

Pyramidal. P 87° 22′. Mid. angle, polar angle 1... Crystals P; ∞P∞ : ∞P. Cl. ∞P∞, ...

Fig. 419 (sp.

Powder sol... ...e, 27·37 ph...

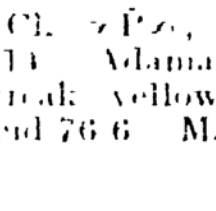

Fig. 420 (sp

H. = 4·5; G. = 4·6 to 4·55. Translucent ... in thin splinters, resinous. Yellowish ... and flesh-red. C.e.: 62 yttria, and 38 ... phosphoric acid, but some with 8 to 11 ... cerium protoxide. Lindesnäs and Hit... tero in Norway, Ytterby (Sweden), ... Georgia, and (*B*...) St Gotthard.

367. CRYPTOLITE, Ce_2P.

Acicular crystals, imbedded in apatite. ... G. = 4·6. Translucent. Pale wine-yellow. ... s acid. Wöhler found 73·70 cerium protoxide, 27·37 ph... acid, and 1·51 iron protoxide. Occurs in ... the apatites of granite in Scotland, but not ... in those of lime-stone. Also at Arendal.

368. MONAZITE, $(Ce, La, Th)_2P$.

Oblique prismatic, C 76° 13′. ∞P 93° ... 23′; crystals (fig. 120) generally thick or ... tabular. Cl. basal, perfect; translucent on ... edges. Flesh-red and reddish brown. C.e.: ... 28 phosphoric acid, 37 to 46 cerium prot... oxide, 24 to 27 lanthanum oxide; that f... Zlatoust from 18 to 32·5 of thoria. Näs... in Norway, Miask, Norwich in Connecticut, and the Rio ... Colombia. *Turnerite*, from Dauphiné, in complex tra... honey-yellow crystals, is monazite.

RRHYLLITE, $(2\dot{F}e, Li_2)\ddot{P}$
orismatic. ∞P 13…, chiefly granular. H. 5; G. 3·6.
Greenish grey with blue spots. C.c., iron protoxide 40, …e protoxide 2·0, lithia 7·5, phosphoric acid 45. Boden-Bavaria. Norwich in Massachusetts. *Lithophilite*, from …Compositions is a mixture of triplite.

…RITE. *Kobell*, $(CaMg)_3As$…
… H. 5·5 to 6, G. 2·95. C.c.: lime 23, magnesia 15, …id 50·5. Dalecarlia (Sweden).

…STALLITE or NICKEL, Ni_3A…
…ous. H. 4, G. 4·9. Sulphur-yellow. C.c., oxide of …, or … acid 50·5. Johann-Georgenstadt.

…CHITE, Ni_3A… $2N$…
…line to massive. G. 4·4. Dark cabbage-green, streak lighter …en inclined to grey. C.c., arsenic acid 36·0. Johann-Georgenstadt.

…ITE. $(Pb, Zn)_3V_2$…
…dal and cubic (the). H. 3 to 4. G. 5·0–9. Lustre …resinous. Yellowish red, deep red, brownish orange to pale …C.c., oxide of lead, 15·5 oxide of zinc, 21·2 of vanadic …Hochkönig, Freiburg, Baden, Lauter Valley.

…ITE. $3Pb_3V_2 + Cu_3V_2 + 6CuH$…
…ellow and massive. H. 4. G. 6·0. C.c., oxide of lead 53·2, copper oxide 18·95, water 8·58 …(Montan).

…ITE, B_2A…
…rismatic. ∞P 123° 56′. H. 4, G. 6·25. Cleavage, per… Red or reddish brown, streak yellow. Easily soluble …C.c., bismuth oxide 74·7, vanadic acid 25·3. Schneeberg.

…ITE, Ca_3Sb…
…ic. ∞P 90 with 96 and 33. H. 5·5 to 6. G. 5. Lustre …adamantine. Yellow to reddish brown. Translucent. C.c., antimonic acid …47·5, iron protoxide 2·7, manganese protoxide 1·0, lime 48·8. Långbanshyttan.

HYDROUS PHOSPHATES, &c.

…ITE, $(CaCu)_3PH_2P_2O_{11}$…
…prismatic. ∞P 68° 45′. Needle crystals. H. 2 to 2·5. …Vitreous. C.c., lime 32·6, phosphoric acid 41·3, water …Island and Sombrero (Antilles).

…WELLYITE, $MeAlH_4P_2O_{11}$…
…rismatic. Cl. brachydiagonal. C.c., phosphoric acid 41·2, …2, water 35·7. From lime, Skiptor Cave, Victoria.

…ARSENIATE, $Co_3As_2O_8 + 3H_2O$…
…prismatic. ∞P 100°. Cl. perfect, …ectile, flexible. …2·0. G. 2·5 to 2·9. Otherwise like phosphocobaltite. C.p. …85·6 arsenate of lime, 14·2 water.

…ITE, $B_2A_2 + 2H_2O$…
…Cl. monoclinodiagonal. Rose-red, streak white. H. …3·46. C.c., 25·5 lime, 10·3 cobalt oxide, 3·0 magnesia, …ic acid, 8·2 water. Schneeberg.

…ARMACOLITE. $2CaAs_2O_4 + 6H_2O$…
…prismatic. ∞P 65° 1′ (fig. 120). $\infty P\infty$ (*a*), ∞P (*m*), $P\infty$ …(*r*), $\frac{1}{2}P\infty$ (*o*), $\frac{1}{3}P\infty$ (*d*), $2P\infty$ (*e*), $3P\infty$ (*f*), $\infty P3$ (*g*), $\frac{1}{2}P$ (*n*), P (*s*), $2P$ (*p*), $3P$ (*q*), $\frac{3}{2}P3$ (*t*), $\frac{1}{2}P\frac{3}{2}$ (*u*), $\frac{1}{3}P3$ (*v*), $\frac{1}{3}P\infty$ (*x*), $\frac{1}{2}P2$ (*y*), $\frac{1}{3}P\frac{3}{2}$ (*z*), $\frac{1}{4}P\frac{3}{2}$ (*w*), $\frac{1}{5}P\frac{3}{2}$ (*k*), $\frac{1}{6}P\frac{3}{2}$ (*l*), $\frac{1}{7}P\frac{3}{2}$ (*h*), $\frac{1}{8}P\frac{3}{2}$ (*i*), $\frac{1}{9}P\frac{3}{2}$ (*g*), $\frac{1}{10}P\frac{3}{2}$ (*f*), $\frac{1}{11}P\frac{3}{2}$ (*e*), $\frac{1}{12}P\frac{3}{2}$ (*d*), $\frac{1}{13}P\frac{3}{2}$ (*c*), $\frac{1}{14}P\frac{3}{2}$ (*b*), $\frac{1}{15}P\frac{3}{2}$ (*a*), $\frac{1}{16}P\frac{3}{2}$ (*z*), $\frac{1}{17}P\frac{3}{2}$ (*y*), $\frac{1}{18}P\frac{3}{2}$ (*x*), $\frac{1}{19}P\frac{3}{2}$ (*w*), $\frac{1}{20}P\frac{3}{2}$ (*v*), $\frac{1}{21}P\frac{3}{2}$ (*u*), $\frac{1}{22}P\frac{3}{2}$ (*t*), $\frac{1}{23}P\frac{3}{2}$ (*s*), $\frac{1}{24}P\frac{3}{2}$ (*r*), $\frac{1}{25}P\frac{3}{2}$ (*q*), $\frac{1}{26}P\frac{3}{2}$ (*p*), $\frac{1}{27}P\frac{3}{2}$ (*o*), $\frac{1}{28}P\frac{3}{2}$ (*n*), $\frac{1}{29}P\frac{3}{2}$ (*m*), $\frac{1}{30}P\frac{3}{2}$ (*l*), $\frac{1}{31}P\frac{3}{2}$ (*k*), $\frac{1}{32}P\frac{3}{2}$ (*j*), $\frac{1}{33}P\frac{3}{2}$ (*i*), $\frac{1}{34}P\frac{3}{2}$ (*h*), $\frac{1}{35}P\frac{3}{2}$ (*g*), $\frac{1}{36}P\frac{3}{2}$ (*f*), $\frac{1}{37}P\frac{3}{2}$ (*e*), $\frac{1}{38}P\frac{3}{2}$ (*d*), $\frac{1}{39}P\frac{3}{2}$ (*c*), $\frac{1}{40}P\frac{3}{2}$ (*b*), $\frac{1}{41}P\frac{3}{2}$ (*a*), $\frac{1}{42}P\frac{3}{2}$ (*z*), $\frac{1}{43}P\frac{3}{2}$ (*y*), $\frac{1}{44}P\frac{3}{2}$ (*x*), $\frac{1}{45}P\frac{3}{2}$ (*w*), $\frac{1}{46}P\frac{3}{2}$ (*v*), $\frac{1}{47}P\frac{3}{2}$ (*u*), $\frac{1}{48}P\frac{3}{2}$ (*t*), $\frac{1}{49}P\frac{3}{2}$ (*s*), 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$\frac{1}{220}P\frac{3}{2}$ (*d*), $\frac{1}{221}P\frac{3}{2}$ (*c*), $\frac{1}{222}P\frac{3}{2}$ (*b*), $\frac{1}{223}P\frac{3}{2}$ (*a*), $\frac{1}{224}P\frac{3}{2}$ (*z*), $\frac{1}{225}P\frac{3}{2}$ (*y*), $\frac{1}{226}P\frac{3}{2}$ (*x*), $\frac{1}{227}P\frac{3}{2}$ (*w*), $\frac{1}{228}P\frac{3}{2}$ (*v*), $\frac{1}{229}P\frac{3}{2}$ (*u*), $\frac{1}{230}P\frac{3}{2}$ (*t*), $\frac{1}{231}P\frac{3}{2}$ (*s*), $\frac{1}{232}P\frac{3}{2}$ (*r*), $\frac{1}{233}P\frac{3}{2}$ (*q*), $\frac{1}{234}P\frac{3}{2}$ (*p*), $\frac{1}{235}P\frac{3}{2}$ (*o*), $\frac{1}{236}P\frac{3}{2}$ (*n*), $\frac{1}{237}P\frac{3}{2}$ (*m*), $\frac{1}{238}P\frac{3}{2}$ (*l*), $\frac{1}{239}P\frac{3}{2}$ (*k*), $\frac{1}{240}P\frac{3}{2}$ (*j*), $\frac{1}{241}P\frac{3}{2}$ (*i*), $\frac{1}{242}P\frac{3}{2}$ (*h*), $\frac{1}{243}P\frac{3}{2}$ (*g*), $\frac{1}{244}P\frac{3}{2}$ (*f*), $\frac{1}{245}P\frac{3}{2}$ (*e*), $\frac{1}{246}P\frac{3}{2}$ (*d*), $\frac{1}{247}P\frac{3}{2}$ (*c*), $\frac{1}{248}P\frac{3}{2}$ (*b*), $\frac{1}{249}P\frac{3}{2}$ (*a*), $\frac{1}{250}P\frac{3}{2}$ (*z*), $\frac{1}{251}P\frac{3}{2}$ (*y*), $\frac{1}{252}P\frac{3}{2}$ (*x*), $\frac{1}{253}P\frac{3}{2}$ (*w*), $\frac{1}{254}P\frac{3}{2}$ (*v*), $\frac{1}{255}P\frac{3}{2}$ (*u*), $\frac{1}{256}P\frac{3}{2}$ (*t*), $\frac{1}{257}P\frac{3}{2}$ (*s*), $\frac{1}{258}P\frac{3}{2}$ (*r*), $\frac{1}{259}P\frac{3}{2}$ (*q*), $\frac{1}{260}P\frac{3}{2}$ (*p*), $\frac{1}{261}P\frac{3}{2}$ (*o*), $\frac{1}{262}P\frac{3}{2}$ (*n*), $\frac{1}{263}P\frac{3}{2}$ (*m*), $\frac{1}{264}P\frac{3}{2}$ (*l*), $\frac{1}{265}P\frac{3}{2}$ (*k*), $\frac{1}{266}P\frac{3}{2}$ (*j*), $\frac{1}{267}P\frac{3}{2}$ (*i*), $\frac{1}{268}P\frac{3}{2}$ (*h*), $\frac{1}{269}P\frac{3}{2}$ (*g*), $\frac{1}{270}P\frac{3}{2}$ (*f*), $\frac{1}{271}P\frac{3}{2}$ (*e*), $\frac{1}{272}P\frac{3}{2}$ (*d*), $\frac{1}{273}P\frac{3}{2}$ (*c*), $\frac{1}{274}P\frac{3}{2}$ (*b*), $\frac{1}{275}P\frac{3}{2}$ (*a*), 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$\frac{1}{528}P\frac{3}{2}$ (*h*), $\frac{1}{529}P\frac{3}{2}$ (*g*), $\frac{1}{530}P\frac{3}{2}$ (*f*), $\frac{1}{531}P\frac{3}{2}$ (

Heterozite. H. = 5; G. = 3·5. Opaque; vitreous or resinous. Dark violet or blue to greenish grey; streak violet-blue or crimson-red. Contains more iron and less manganese than the above. Hureaux.

392. Dickinsonite, $4(\dot{R}_3\ddot{P}_2)+3\dot{H}_2$.

Oblique prismatic, C 60° 30′. Crystals tabular. Cl. basal, perfect. H. = 3·5 to 4; G. = 3·31. Vitreous; pearly on cleavage. Olive- to oil-green, and grass-green; streak white. Transparent; brittle. C.c.: phosphoric acid 40, iron protoxide 12·7, manganese protoxide 25, lime 11·8, soda 6·6, water 3·8. Branchville (Connecticut).

393. Triplogidite, $(\dot{M}n, \dot{F}e)_3\ddot{P}_2+\dot{H}_2(\dot{M}n, Fe)_2$.

Oblique prismatic, C 51° 56′. Generally fibrous; transparent resinous to adamantine. H. = 4·5 to 5; G. = 3·7. Yellowish brown. C.c. 48·15 oxide of manganese, 14·88 protoxide of iron, 32·4 phosphoric acid, 4·1 water. Fairfield (Connecticut).

394. Fairfieldite, $\dot{R}_3\ddot{P}_2+2\dot{H}_2$.

Anorthic; usually foliaceous. H. = 3·5; G. = 3·15. White to straw-yellow; streak white. Pearly to brilliant-adamantine on cleavage. Transparent; brittle. C.c. phosphoric acid 38·4, iron protoxide 5·6, manganese protoxide 15·6, lime 30, soda 7, water 10. Fairfield (Connecticut).

395. Chondrarsenite, $\dot{M}n_3\ddot{A}s_2+2\dot{H}_2$.

In small grains. H. = 3. Yellow to reddish-yellow. Translucent; brittle; fracture conchoidal. Parsberg mines (Wermland).

396. Reddingite, $\dot{M}n_3\ddot{P}_2+3\dot{H}_2$.

Right prismatic. P; ∞P2; ∞P∞. H. = 3 to 3·5; G. = 3·1. Vitreous; rose-pink to yellowish white. Translucent; fracture uneven; brittle. C.c.: phosphoric acid 34·5, iron protoxide 5·43, manganese protoxide 46·3, lime 8, water 13·1. Branchville.

397. Scorodite, $\dot{F}e_2\ddot{A}s_2+4\dot{H}_2$.

Right prismatic. P with polar edges 102° 52′ and 114° 10′. Crystals P (*p*), ∞P∞ (*a*), and ∞P∞ (*b*); also 0P, ½P (*c*), ∞P (*o*), 2P2 (*s*), ∞P2 (*d*, 120° 10′, and 2P∞ (*m*) 132° (fig. 427), also columnar and fibrous. Cl. imperfect; brittle. H. = 3·5 to 4; G. = 3·1 to 3·2. Translucent; vitreous. Leek-green to greenish black, also indigo-blue, red, and brown. B.B. fuses easily, with arsenical odour, to a grey magnetic slag. Sol. in h. acid, to a brown solution. C.c.: 49·8 arsenic acid, 34·6 iron peroxide, and 15·6 water. St Austell in Cornwall, near Limoges in France, Schwarzenberg, Lölling in Carinthia, Brazil, and Siberia.

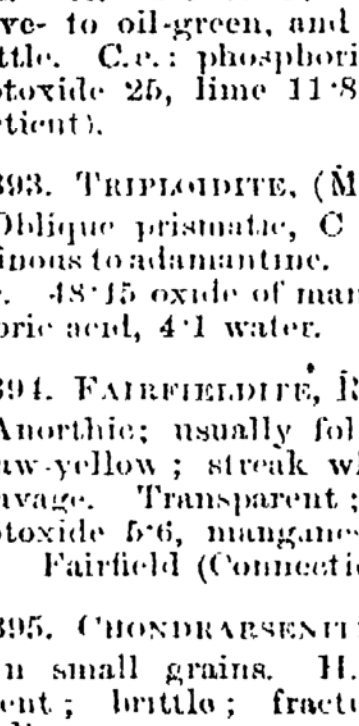


Fig. 427 (sp. 397).

398. Strengite, $Fe_2\ddot{P}_2+4\dot{H}_2$.

Right prismatic. P with polar edges 101° 38′ and 115° 36′, middle edge 111° 30′. ∞P2 (*d*) and ∞P∞ (*r*), P (*P*), 0P (*h*), 2P∞ (*m*) 48° (fig. 428). Crystals generally *r*, *P*, *d*, *r* dominant. Cl. *r*. H. = 3 to 4; G. = 2·87. Cherry-red. Translucent. C.c.: protoxide of iron 43·18, phosphoric acid 37·42, water 19·4. Rock Bridge (Virginia).

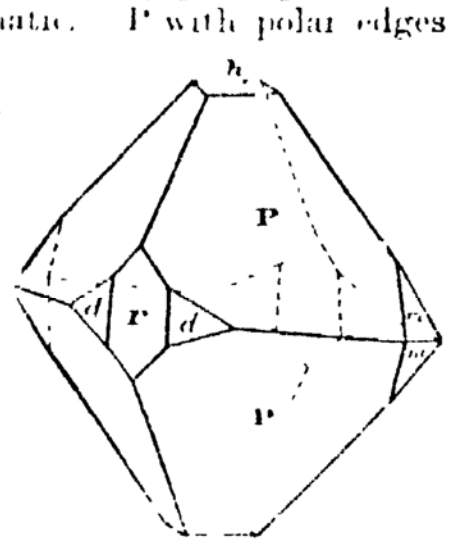


Fig. 428 (sp. 398).

399. Dufrenite (*Kraurite*), $2Fe_2\ddot{P}_2+3\dot{H}_2$.

Right prismatic. ∞P about 123°. Spherical or reniform. Cl. brachydiagonal; brittle. H. = 3 to 3·5; G. = 3·3 to 3·4. Translucent on the edges, or opaque; shining or dull. Dirty leek-green or blackish green; streak siskin-green. C.c.: 63 iron peroxide, 28 phosphoric acid, and 9 water. Westerwald, Hirschberg, and Limoges.

400. Beraunite, $5\dot{F}e_2\ddot{P}_2+14\dot{H}_2$.

Occurs in small foliated and columnar aggregates. Cl. plane metallic pearly. H. = 2; G. = 2·878. Colour hyacinth-red to reddish brown; streak dirty-yellow. C.c.: 51·5 peroxide of iron, 28·65 phosphoric acid, and 16·55 water. Bohemia, Scheibenberg in Saxony.

401. Eleonorite, $3Fe_2\ddot{P}_2+8\dot{H}_2$.

Oblique prismatic, C 48° 33′. Twin face the ortho. Cl. ∞P∞. H. = 3 to 4. Dark hyacinth-red; streak. Vitreous to pearly. C.c.: 51·91 peroxide of iron, 31·88 phosphoric acid, 16·37 water. Eleonore mine near Bieber.

402. Cacoxene, $2Fe_2\ddot{P}_2+12\dot{H}_2$.

Radiated tufts, of a brownish-yellow colour. H. = 3. G. = 2·38. Sol. in h. acid. From the Hrbeck mine near Z. Bohemia.

403. Pharmacosiderite (*Cube Ore*), $4Fe_2\ddot{A}s_2+15\dot{H}_2$.

Cubic and tetrahedral; usually ∞O∞, with $\frac{O}{2}$, or ∞O. H. = 2·5; G. = 2·9 to 3. Cl. ∞O∞. Semitransparent to faint, adamantine or resinous. Olive- to emerald-green, yellow, and brown; streak straw-yellow. Pyrognostic. C.c.: arsenic acid, 40 iron peroxide, and 17 water. Carharrack, Gwennap, Tincroft, Huel Unity, Huel Gorland, Huel Gawn, Huel Basset, Huel Alfred, Huel Seton, Huel Damsel, Huel Hope, Huel Crofty, Huel Vor, Huel Trumpet, Huel Rose, Huel Unity Wood, Huel Peever, Huel Providence, Huel Fortune, Huel Grenville, Huel Mexico, Huel Sparnon, Huel Fanny, Huel Jane, Huel Agar, Huel Virgin, Huel Vincent, Huel Rock, Huel Basset Downs, Huel Penhale, Huel Bassick, Huel Bassick Downs, Huel Bassick Vean, Huel Bassick Wood, Huel Bassick Moor, Huel Bassick Hill, Huel Bassick Valley, Huel Bassick Common, Huel Bassick Green, Huel Bassick Lane, Huel Bassick Road, Huel Bassick Bridge, Huel Bassick Farm, Huel Bassick Cottage, Huel Bassick House, Huel Bassick Mill, Huel Bassick Church, Huel Bassick School, Huel Bassick Chapel, Huel Bassick Inn, Huel Bassick Post Office, Huel Bassick Station, Huel Bassick Wharf, Huel Bassick Quay, Huel Bassick Harbour, Huel Bassick Pier, Huel Bassick Lighthouse, Huel Bassick Beacon, Huel Bassick Buoy, Huel Bassick Anchorage, Huel Bassick Roadstead, Huel Bassick Bay, Huel Bassick Creek, Huel Bassick River, Huel Bassick Estuary, Huel Bassick Delta, Huel Bassick Mouth, Huel Bassick Source, Huel Bassick Tributary, Huel Bassick Confluence, Huel Bassick Basin, Huel Bassick Watershed, Huel Bassick Divide, Huel Bassick Ridge, Huel Bassick Valley, Huel Bassick Plain, Huel Bassick Hill, Huel Bassick Mountain, Huel Bassick Peak, Huel Bassick Summit, Huel Bassick Slope, Huel Bassick Foothill, Huel Bassick Piedmont, Huel Bassick Coastal Plain, Huel Bassick Continental Shelf, Huel Bassick Continental Slope, Huel Bassick Continental Rise, Huel Bassick Abyssal Plain, Huel Bassick Trench, Huel Bassick Ridge, Huel Bassick Seamount, Huel Bassick Guyot, Huel Bassick Atoll, Huel Bassick Reef, Huel Bassick Island, Huel Bassick Archipelago, Huel Bassick Peninsula, Huel Bassick Isthmus, Huel Bassick Cape, Huel Bassick Bay, Huel Bassick Gulf, Huel Bassick Strait, Huel Bassick Channel, Huel Bassick Sound, Huel Bassick Inlet, Huel Bassick Lagoon, Huel Bassick Marsh, Huel Bassick Swamp, Huel Bassick Bog, Huel Bassick Fen, Huel Bassick Moor, Huel Bassick Heath, Huel Bassick Down

OLIVENITE, $4Cu^{\cdot}AsO_4 + H_2$

t prismatic. ∞P, ∞ 99° 30′, $P\infty$ (*i*) 110° 50′, $\infty P\infty$ (*a*) 1), also spheroidal mammiform, and ar or fibrous. Cl. $\infty P\infty$ and $P\infty$, im- H. 3; G. 4·1 to 4·6. Pellucid egrees, vitreous, to adamantine or silky olive, or dark leek-green, also yellow wn, streak olive-green or brown the former true, the latter to a dark a tinge of the lead, covered with on charcoal deflagrates, arsenical vapours, and is reduced. acid and ammonia. Cornwall, 65·5 oxide of copper, 29·5 arsenic acid, and 4 But also 1·1 to 6 phosphoric acid ck, Lis Croft, Gwennap, and St ervale, Wheal Moor, Thuringia Stolberg Clubs

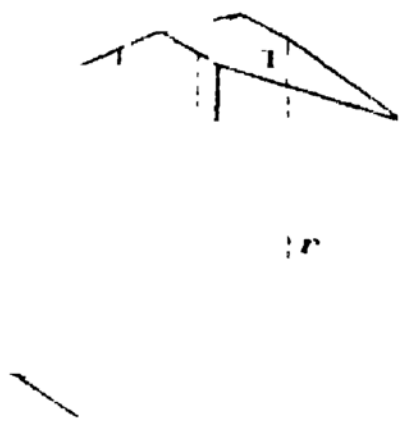


Fig. 431.

VANOXITE, $9Cu, 6Zn, P_2, As_2, 18H$

ne prismatic. C. 103° 50′. H. 3·5 to 4. G. 3·53. Green Cornwall, copper 37·34, 25·20 zinc oxide, 10·41 arsenic acid, sphoric acid, 17·05 water. Moravicza (Banat).

DESCLOIZITE, $2PbV_2 + H_2$.

prismatic. ∞P 116° 25′. H. 3·5. G. 5·86 to 6·1. own to black. Cornwall, 56·13 oxide of lead, 10·6 oxide of zinc, le of manganese, 22·74 vanadic acid. Sierra de Cordoba rgentine Republic.

VOLBORTHITE, $4Cu, Ca, V_2 + H$.

gonal, small tabular crystals. $0P$, ∞P, single or in groups y more or less. H. 3; G. 3·45 to 3·89. Olive-green, almost yellow. B.B. on charcoal fuses easily and forms a like slag, contaminated with traces of copper. Sol. in nitric acid, and ter gives a dark red precipitate. Cornwall, 37 to 38 vanadic 1 to 16 copper oxide, 18·5 to 13 lime, 3·6 to 5 water. Urals, Nijni-Tagilsk, and Friedrichroda in Thuringia.

EVANSITE, $4CuP + 3H_2$.

ne prismatic, but botryoidal and radiating globular masses, or H. 3, G. 4. Emerald-green. Cornwall, 61·7 copper prot- 7·7 phosphoric acid, and 10·5 water. Nijni-Tagilsk, and schberg.

EUCHROITE, $4CuA + 7H$

prismatic. ∞P (M) 117° 20′, $P\infty$ (o) 106° 52′ with $\infty P2$ $0P$ (P) (fig. 432). Brittle. H. 3·5 3·5 to 3·4. Translucent to opaque, vitreous merald or leek-green, streak verd- green. B.B. in forceps fuses to brown crystallised mass. Dis- n acid. Cornwall, 47 copper protoxide, ne acid, and 13 water. Libethen in

Fig. 432 (p. 417).

EUNITE, $5Cu^{\cdot}As_2 + 2H$.

orm and foliated, conchoidal fracture. to 5. G. 4 to 4·1. Translucent on -, dull resinous. Emerald or grass-green, streak similar 9 copper protoxide, 34·7 arsenic acid, and 5·4 water l. *Cornwallite* has 3 or 5 of water.

DIHYDRITE, $5CuP + 2H$.

4. Oxide of copper 63, phosphoric acid 24·7, water 6·25 Libethen and Nijni-Tagilsk.

MELANOCHALCITE, $5Cu, Pb, V + 2H_2$.

Green crusts, streak yellow. H. 3; G. 4·9 oxide of copper 20·4, oxide of lead 7·2, vanadic acid 18·4 Mexico or Cornwall.

LINARITE, $5PbS + H$

pris- oblique, radiating, foliated. H. 1·5 to 2, to 4·7. Translucent on the edges, pearly on the cleavage is green, streak pale. Cornwall, 67 copper protoxide, 24 ric acid, and 9 water. Eisl on the Rhine, Nijni-Tagilsk, n.

PYROMORPHITE, $5PbAs + 2H$.

prismatic. Cl. basal perfect. Botryoidal. Radiate-foliated. H. 1·5 to 2; G. 6·9. Lustre pearly on cleavage face. Colour en and verdigris-green to lavender-blue; streak paler. Sub nt. Cornwall, oxide of copper 5·6, arsenic acid 29·2, water Tyrol, Hesse, Thuringia.

PSEUDO-PHOSPHOCHALCITE (*Libethenite*), $6CuP_2 + 3H_2$.

ne prismatic. Crystals $\infty P2$ (I) 98° 56′, P (Pi) 117° 49′, with $0P$ (a) and $\infty P\infty$ (c) (fig. 433); usually small and in more common in spherical or reniform and radiated-fibrous masses. H. 5; G. = 4·1 to 4·3. Translucent throughout or on the edges; adamantine to resinous. Blackish-, emerald-, or verdigris-green. Cornwall, 70·8 copper protoxide, 21·2 phosphoric acid, and 8 water. Cornwall, Rheinbretenbach, Nijni-Tagilsk.

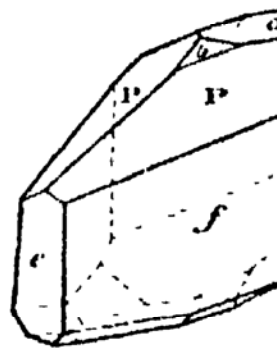


Fig. 433 (sp.

124. CLINOCHALCITE, $6CuA_2 + 3H_2$.

Oblique prismatic. C. 80° 30′. $0P$ (P), ∞P (m) 56°, $^1P\infty$ (o) 99° 30′, (r) 123° 48′ (figs. 434, 435), and hemispherical. Cl. basal, perfect. H. 2·5 to 3. G. = 4·2 to 4·4. ous pearly on cl. Dark verdigris-green to sky-blue; streak blue. Cornwall, 62·6 copper protoxide, 30·3 arsenic acid, 7·1 water. Cornwall, Tavistock, Devonshire.

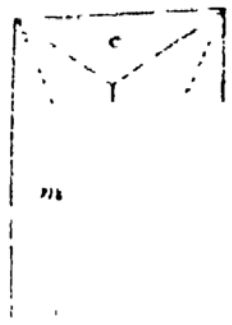


Fig. 434 (sp. 421). Fig. 435 (sp.

125. MIXITE.

Oblique prismatic or anorthic (?). Radiating, centrally granular. ∞P 125° H. 3 to 4, G. 2·66. Lime- dull-green to blue-green, streak paler. Cornwall, 43·21 copper oxide, 13·1 bismuth oxide, 30·45 arsenic acid, 11·1 water. Geistergang, Joach

126. RHAGITE, $5Bi_2O_3, 2As_2O_5 + 8H_2O$.

Grape-like groups of minute crystals. Colour yellowish streak white. Lustre waxlike. Brittle. H. = 5, G. = 6·8 bismuth oxide 79·5, arsenic acid 15·6, water 4·9. Ne near Schneeberg.

127. TROGKRITE, $3UAs_2 + 12H_2$.

Oblique prismatic, C. 80°. Crystals thin tabular. C diagonal, perfect. Lustre pearly. G. = 3·3. Lemon-yellow 65·95 oxide of uranium, 17·56 arsenic acid, 16·49 water. tube gives off water, and becomes golden brown, but again on cooling. Neustadtel.

128. SIDERITE, $(NH_4, 2Mg)P_2 + 12H_2$.

Right prismatic. $\bar{P}\infty$ (o) 63° 7′, $P\infty$ (e) 95°, $4\breve{P}\infty$ (b) $\infty P\infty$ (m), $\frac{1}{2}P\infty$ (m) 123°, $0P$ (a) (fig. 436). Cl. brachydiagonal, perfect. H. 1·5 to 2, G. 1·66 to 1·75. Trans- parent or opaque, vitreous. Colourless, but yellow or brown. Cornwall, 29·9 phos- phoric acid, 16·3 magnesia, 10·6 am- monia, and 44 water. Under St Nicholas church at Hamburg, and in guano from South America.

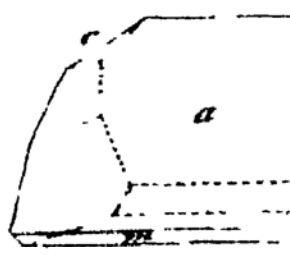


Fig. 436.

129. ARSENIOSIDERITE, $3CaAs_2 + 3Fe_2As_2 + 6H_2$.

Spherical and fibrous, friable. H. = 1·2; G. = 3·52 t Opaque, silky. Golden yellowish brown, streak yellowish peroxide of iron 39·4, lime 13·8, arsenic acid 37·9, w Romanèche near Macon.

130. CHALCOSIDERITE.

Anorthic. Light green crysta G. = 3·11. C.c.: 4 oxide of iron, 8·4 oxide of copper, 4·45 alumina, 30·54 phosphoric acid, 15 water. Cornwall.

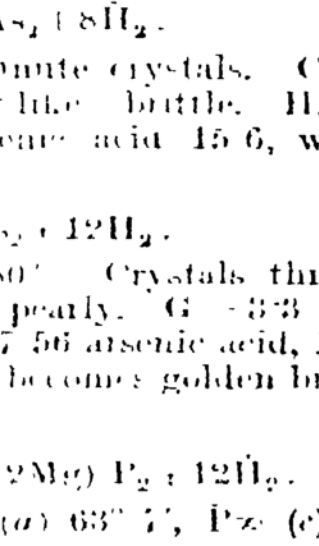


Fig. 437 (sp. 431).

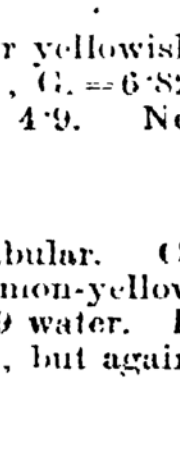


Fig. 438 (

431. LAZULITE, Al_2P_2

$+ (Mg, Fe)_3P_2 + 2H$.

Oblique prismatic, C. 98° 2′. ∞P 90° 33′, $P\infty$ 99° 40′. -1 (p) 100° 20′. Crystals often tabular through distortion, twins on $0P$, and $\infty P\infty$; also massive, in fine splint- ery. Cl. ∞P. H. = 5 to 6; G. = 3 to 3·1. Trans- lucent; vitreous. Indigo- and smalt-blue to greenish white. In closed tube yields water, and loses colour. So acids after ignition. C.c.: 31·7 alumina, 10 magnesia, oxide of iron, 44 phosphoric acid, and 6 water. Salzburg Brazil, Georgia, Lincoln in North Carolina.

HILDRENITE, $2(Fe, Mn)_4\dot{P} + Al\dot{P} + 15\dot{H}$. P—P$_\infty$H H$_2$&c.
prismatic. Polar edges 101° 43′, 130° 10′, middle 98° 44′,
orm $\breve{P}$, $2\breve{P}\infty$, $\infty P\infty$ (e, a, P, fig. 139).
to 5; G. = 3·18 to 3·3. Translucent;
. Yellowish white to wine- or ochre-yellow,
r almost black. C.c.: 30·7 iron protoxide,
nese protoxide, 11·5 alumina, 29 phos-
cid, and 17 water. Tavistock, Crinnis
ington (Cornwall).

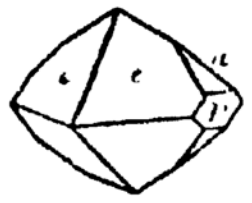


Fig. 439.

OSPHORITE, $(Fe, Mn)_3\dot{A}l_2\dot{P} + 4\dot{H}$.
prismatic. P (p) 133° 32′ and 118° 56′; ∞P (r) 104° 12′,
), $\infty P\infty$ (b), $\infty P2$ (q), $\frac{1}{2}\breve{P}_2$ (q), $2\breve{P}2$ (s) (polar edge 130° 26′
42′) (fig. 440). Cl. macro-
. H. = 5, G. = 3·13. Pale
itreous. C.c.: 22 alumina,
oxide of iron, 23·5 oxide of
ese, 31·5 phosphoric acid,
ter. Fairfield (Connecticut).

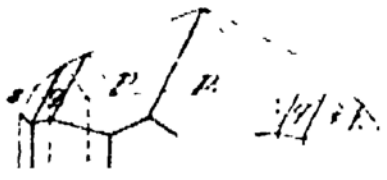


Fig. 440.

LIROCONITE, $Cu_3\dot{A}s_2 + Al\dot{A}s$

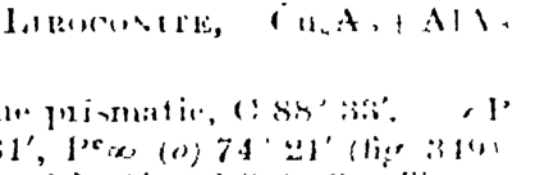


Fig. 442.

ne prismatic, C 88° 33′. ∞P
31′, P^{∞} (o) 74° 21′ (fig. 319)
o 2·5; G. = 2·8 to 3. Trans
vitreous or resinous. Azure
verdigris green; streak paler
·6 protoxide of copper, 11·9
, 26·6 arsenic acid, 21·9 water. Redruth, Herrengrund
gary.

Fig. 443.

HALCOPHYLLITE, $Cu_9\dot{A}s_2 + 12\dot{H}$.
gonal rhombohedral; R 69° 48′ (fig. 141). Cl. basal, perfect;
H. = 2; G. = 2·4 to 2·6.
rent; vitreous to adamantine
n 0R (o). Emerald to gras
gris green; streak pale gr
n acids and ammonia. C.c
e of copper 49·6, arsenic acid 18, water 32·4. Redruth
wall, Saida in Saxony, Moldawa in the Banat.

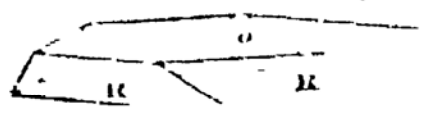


Fig. 444.

RANITE, $(Ca, \overset{\cdot\cdot}{U}_2)\dot{P} + 8\dot{H}$.
prismatic. ∞P 90° 43′, P middle edge 127° 32′, 0P : P
0P : $2\breve{P}\infty$ 109° 6′; 0P : $2\breve{P}\infty$ 109° 19′ (fig. 444). Crys
. Cl. basal, perfect; sectile. H. =
- 3 to 3·2. Translucent, pearly on
lphur-yellow to siskin-green, streak
. C.c.: 15·5 phosphoric acid, 62·6
peroxide, 6·1 lime, and 15·8 water.

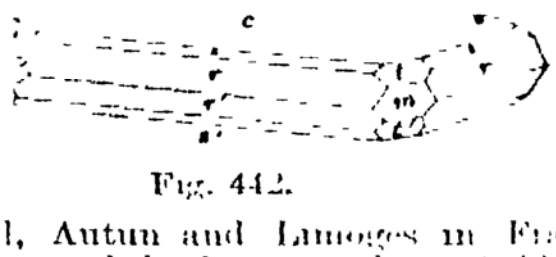


Fig. 445.

Fig. 446.

l, Autun and Limoges in France, Johann Georgenstadt
enstock in Saxony, Chesterfield in Massachusetts.

RANOSPINITE, $(Ca, \overset{\cdot\cdot}{U}_2)\dot{A}s + 8\dot{H}$.
prismatic; quadrangular, scale-like crystals. Cl. basal,
H. = 2·3; G. = 3·45. Siskin-green. C.c.: lime 9·47, sesqui-
uranium 59·18, arsenic acid 19·37, water 16·29. Neu

RANOCHRCITE, $(Ba, \overset{\cdot\cdot}{U}_2)\dot{P} + 8\dot{H}$.
wish green crystals, isomorphous with 437. Cl. basal.
3. C.c.: sesquioxide of uranium 56·86, baryta 14·57, phos
cid 15·71, water 14. Falkenstein in Voigtland.

HALCOLITE, $(Cu, \overset{\cdot\cdot}{U}_2)\dot{P} + 8\dot{H}$.
nidal. P middle edge 142° 8′; $P\infty$ 128° 14′. Crystals
$\infty P\infty$, $P\infty$. Cl. basal, perfect; pearly lustre, brittle.
to 2·5; G. = 3·5 to 3·6. Grass- to emerald or verdigris-
streak apple-green. C.c.: 15·2 phosphoric acid, 6·1
peroxide, 8·5 copper protoxide, and 15·3 water. Red-
d St. Austell, Johann-Georgenstadt, Eibenstock, Schneeberg
ais, Baltimore.

EUNERITE, $(Cu, \overset{\cdot\cdot}{U}_2)\dot{A}s + 8\dot{H}$.
ndal. P middle edge 142° 6′. 0P : P 109° 57′. Crystals
Cl. basal. H. = 2·5; G. = 3·53. Grass-green. Lustre
C.c.: 7·7 oxide of copper, 55·95 sesquioxide of uranium, 14
Huel Gorland in Cornwall, Neustadtel, Joachimsthal,
d, Wittichen.

441. WALPURGITE, $5Bi\dot{A}s + 3\overset{\cdot\cdot}{U}\dot{A}s + 10\dot{H}$.
Anorthic; in scaly crystals. Wax-yellow to pomegra
Adamantine to greasy. H. = 3·5; G. = 5·76. C.c.: sesquo
bismuth 60·4, sesquioxide of uranium 20·4, arsenic acid 1
1·5. Neustadtel.

442. PLOMBGOMME, $Pb_3\dot{P} + 6A\dot{H}_3$.
Reniform or stalactitic; fracture conchoidal and splintery
1 to 1·5; G. = 6·3 to 6·4. Translucent, resinous. Yello
greenish white to reddish brown. C.c.: 38 protoxide of l
dumina, 8 phosphoric acid, and 19 water; but with 2 chlo
lead. Poullaouen, Nussloch near Bampen, Georgia.

COMPOUNDS OF PHOSPHATES, VANADIATES, AND ARSENI
WITH HALOID SALTS.

443. APATITE, $3Ca\dot{P} + Ca(Cl, F)$.
Hexagonal and pyramidal-hemihedric. P 80° 26′. Th
common forms are ∞P (M); $\infty P2$ (a), $0P$ (m). P (x, the
seldom wanting (figs. 92, 95, 96, 97, 98). The crystals ar
prismatic or thick-tabular; also granular, fibrous, o
part. Fracture conchoidal or splintery; brittle.
G. = 3·1 to 3·25. Transparent to opaque, vitreous to r
Colourless and white, but generally light green, grey
violet, or red. C.c.: phosphate of lime 89 to 92·3
chloride (to 11) or fluoride (to 7 %) of calcium, or both. I
nated in granite, gneiss, mica and hornblende slates,
lime-stones, and trap rocks, also in beds and vein. Suth
Ross, and Aberdeen, in granite and limestone, Cumb
Devonshire, and Cornwall, in tin-mines in Saxony, Be
St Gotthard, Tyrol; Kragero in Norway, New York, Canad

444. PYROMORPHITE, $3Pb_3\dot{P} + PbCl$.
Hexagonal, P 80° 44′. Crystals ∞P, 0P, with $\infty P2$, or $P($
fig. 444), occasionally thicker in the middle, or spindle-
also reniform or botryoidal; fracture conchoidal or un
even. H. = 3·5 to 4, G. = 6·9 to 7. Translucent, resin
ous or vitreous. Colourless, but generally grass-, pis
tachio-, olive-, or siskin-green, and clove- or hair-brown,
and scarlet (Leadhills). C.c.: 89·7 phosphate and l
10·3 chloride of lead, but with 0 to 9 arseniate of
lead, 0 to 11 phosphate of lime, and 0 to 1 fluoride of
calcium. Elgin, Wanlockhead, also Cornwall, Derby
shire, Yorkshire, Durham, Cumberland, Wicklow; F
Przibram, Mies, and Ehrenfriedersdorf in Bohemia; Berezoff, Pho
in Pennsylvania, and Mexico.

445. VANADINITE, $3Pb_3\dot{V} + PbCl$.
Hexagonal, P 78° 46′. Forms: ∞P, 0P (o), P (x), 2P, $\frac{1}{2}P(\frac{1}{2}$
∞P, $2\breve{P}2$ (fig. 445). Transparent to
opaque, resinous. Honey-yellow to
greyish brown, streak white. H. = 3,
G. = 6·8 to 7·1. C.c.: oxide of lead 70·5
vanadic acid 19·35, lead 7·2, chlorine
2·62. Wanlockhead, Windischkappel
in Carinthia, Haldenwirth house in
the Black Forest, Bolet in West Got
land, Berezovsk, Zimapan in Mexico,
Cordoba in the Argentine Republic.

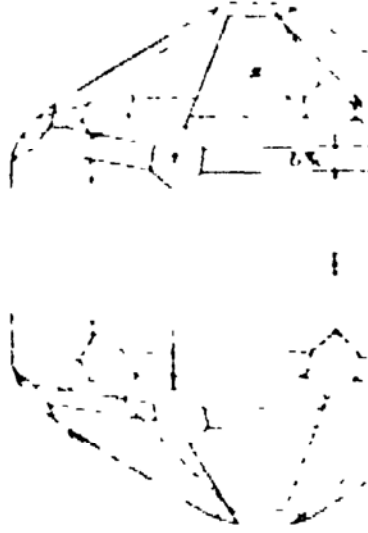


Fig. 446 (p. 44

446. MIMETESITE, $3Pb_3\dot{A}s + PbCl$.
Hexagonal, P 81° 1′. Crystal
∞P, 0P, P (figs. 91, 141), or P, 0P
Cl. P, fracture conchoidal or uneven.
H. = 3·5 to 4; G. = 7·19 to 7·25.
Translucent. Colourless, but usually
honey- or wax-yellow, yellowish green
or grey. C.c.: 90·7 arseniate and
9·3 chloride of lead, but part of the arsenic occasionally rep
phosphoric acid. Leadhills, Huel Alfred and Huel Unity
wall, Roughten Gill and Dry Gill in Cumberland, Beer
Devonshire, Johann Georgenstadt, Zschorlau, Badenwe
Pen in France, Nertschinsk, and Zacatecas in Mexico.

447. WAGNERITE, $Mg_3\dot{P} + MgF$.
Oblique prismatic, C 63° 25′. ∞P 57° 35′. Cl. prism
orthodiagonal imperfect; fracture conchoidal or splintery
to 5·5. G. = 3 to 3·2. Translucent or transparent; resinou
yellow and white. C.c.: 43·3 phosphoric acid, 11·4 fluor
magnesium and 7·7 magnesium; but with 3 to 4·5 iron p
and 1 to 4 lime. Werfen in Salzburg.

448. TRIPLITE, $(Fe, Mn)_3\dot{P} + RF$.
Oblique prismatic; only granular. Cl. in two direc
right angles; fracture conchoidal. H. = 5 to 5·5. G. = 3·
Translucent or opaque; resinous. Chestnut- or blackish
streak yellowish grey. C.c.: iron and manganese protoxid
33 phosphoric acid, and 7 or 8 fluorine. Limoges, Schlagg

ZWIESELITE, (Fe, Mn)$_3$P$_2$ + FeF$_2$.

prismatic, but rarely massive. Cl basal, perfect. H. = 4·5 G. = 3·95 to 4. Brown, streak yellow. Occurs like triplite. in Bavaria.

AMBLYGONITE. Al$_2$P$_2$O$_8$ + (Li, Na)$_2$P$_2$O$_8$ + AlF$_3$ + (Li, Na)F.

blue; crystalline, coarse granular. Cl 90° pearly, meeting at 106° 40′. Fracture uneven and splintery. G. = 3 to 3·1. Translucent, vitreous. Greyish or greenish pale asparagus-green. Occurs as 1, 9 phosphoric acid, 34·5 alumina, 9·2 protoxide of iron, 9·3 soda, and 8·3 fluorine. Penig, Arendal, Chesterfield, Frances, also Hebron and Paris in Maine. Rarely contains no soda.

Triplite (Fe, Mn)$_3$P$_2$O$_8$ + (Fe, Mn)F$_2$.

Occurs in crystalline form (Sp. 669) ∞P 110° 10′, ∞P∞ 125° 10′. Cl perfect. H. = 5·5 to 6. G. = 3·6 to 3·8. Bright orange-red; streak yellowish white. Vitreous. Composition: alumina 17·2, iron protoxide 31·1, soda 1·1, fluorine 7·7. Durango (Mexico).

HERDERITE.

Occurs massive. P polar edges 77° 20′ and 141° 16′, ∞P 115° 24′. Fracture conchoidal. H. = 5. G. = 2·9 to 3. Translucent, inclining to resinous. Yellowish or greenish white. Ehrendorf in Saxony. An anhydrous phosphate of alumina, lime and fluorine.

PHOSPHATES WITH SULPHATES AND BORATES.

SVANBERGITE.

Rhombohedral, R 90° 35′. H. = 5; G. = 2·57. Vitreous to resinous. Honey-yellow, reddish-brown, and rose-red; streak white. Subtranslucent. Composition: 27·8 alumina, 6 lime, 17·3 sulphuric acid, 12·8 soda, 17·8 phosphoric acid, 6·8 water. Horrsjöberg in Wermland.

DIADOCHITE, Fe$_2$P$_2$O$_8$ + 2FeSO$_4$ + 32H.

Botryoidal and stalactitic, fracture conchoidal. H. = 3, G. = 1·9. Resinous; vitreous. Yellow or yellowish brown, streak white. Composition: 36·7 iron protoxide, 11·8 phosphoric acid, 15·2 sulphuric acid, and 30·3 water. Grafenthal and Stalheld.

DUFRENITE, Fe_5S_8 + 2FeAs + 24H.

Botryoidal and tabular, brittle, fracture conchoidal. H. = 2·3; rarely to 2·5. Translucent throughout, or on the edges, resinous to vitreous. Yellowish, reddish or blackish brown, sometimes in stripes, streak light yellow or white. Composition: 35·00 protoxide of iron, 3·00 arsenic acid, 11 sulphuric acid, and 21 water. In many mines, as Freiberg and Schneeberg.

BEUDANTITE.

Rhombohedral; R 91° 18′. H. = 3·5; G. = 4. Vitreous. Olive-green, streak greenish-yellow. Composition: 40·69 oxide of iron, 0·55 oxide of lead, 1·76 sulphuric acid, 8·97 phosphoric acid, 9·77 water. Horhausen in Nassau, Cork in Ireland.

LAZULITE (?Mg, Fe)$_3$P$_2$O$_8$ + Al$_2$(OH)$_6$P$_2$O$_5$.

Masses of fibrous structure. Composition: 25·2 magnesia, 29·8 phosphoric acid, 11·7 boracic acid, 30·23 water. Lunenburg.

ARSENITES.

SCHNEEBERGITE, $Pb_3As_2O_8$ + 2PbCl$_2$.

Monoclinal. Cl. 0P. H. = 2·5 to 3, G. = 7·14. Pale green, passing into grey, resinous on fracture. Composition: 59·67 oxide of lead, 10·39 oxide of copper, 10·39 chlorine, 7·58. Långban in Wermland.

LIROCONITE, $Cu_3As_2O_8$ + 4Al$_2$(OH)$_6$P$_2$O$_5$ + 9H$_2$O.

Monoclinal, P 116° 30′. Blue-green. Lustrous. Copiapo in Chili.

SILICATES.

ANHYDROUS SILICATES OF THE GENERAL FORMULA R_2SiO_4.

OLIVINE GROUP.

OLIVINE AND CHRYSOLITE.

Rhombic prisms, 0P : ∞P∞ (*b*) 130° 0′, P∞ (*o*) 109° 1′, P∞ (*s*) 109° 51′.

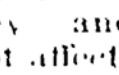


Fig. 446.

Fig. 447.

Granular. Cl *m*; fracture splintery. H. = 7 to 7·5; G. = 3·1 to 3·4. Rolled, vitreous. Grey, green, red, or blue. B.B. infusible. Not affected by acids. Composition: alumina 63·1, silica 36·9. Cl (figs. 446 to 449) and Clova in Aberdeenshire, Marnoch and

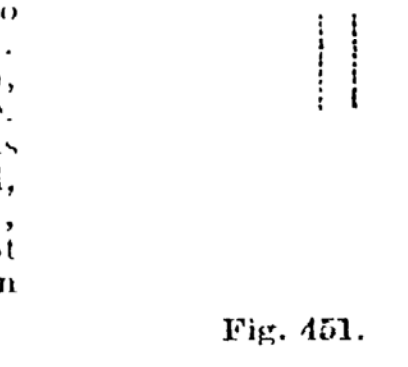
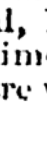


Fig. 448. Fig. 449.

ne in Banffshire, Killiney Bay in Wicklow, Andalusia, Penig, Massachusetts, Litchfield in Connecticut.

Chrysolite. H. = 6·5 to 7·0, G. = 3. Pale grey, yellow, green, red. A compound structure, formed of four double wedge-shaped crystals, arranged in contact with the angles of a square conoidal crystal placed in their centre, and imbedded in a paste of clay slate. The section of the compound structure forms a tesselated cross, the appearance of which varies with the portion of the crystal which is cut. Portsoy (fig. 450) and Boharm in Banffshire, Wicklow, Keswick and Skiddaw, Pyrenees, Maine, New Hampshire, Nova Scotia, Canada.



461. CYANITE (*Disthene*), AlSi.

Anorthic, generally broad-prismatic lengthened crystals by two faces (*m*, *l*). *m* / 106° 15′; *m* : *c* 145° 41′, *p* : *m* 93° 15′ (fig. 451).

Quintuples common, united by *m*. Also radiated. Cl. *m*, perfect, brittle. H. = 7, on *c* plane, 5, G. = 3·5 to 3·7. Pellucid, vitreous. Cl pearly. Colourless, and red, yellow, green, grey and blue. B.B. infusible. Not affected by acids. Cr. same as andalusite. Hillswick in Shetland, Mount Battock, Tarf side (fig. 451), Botriphnie (Banffshire), Tyrol, St Gotthard, Bohemia, Pontivy in France.

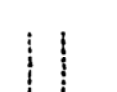


Fig. 451.

462. SILLIMANITE, AlSi.

Right prismatic; ∞P 111°. Crystals fibrous, columnar, radiating. Cl macrodiagonal. H. = 7; G. = 3·2 to 3·26. Translucent, on *c* vitreous. Greyish, greenish, clove, or hair-brown. Cr. and chemical characters like cyanite. Tvedestrand, Chester and Norwich, Connecticut. $Al_2O_3SiO_2$ is thus trimorphous. *Monrolite*, *Xenolite*, *Bucholzite*, *Fibrolite*, and *Bamlite* are varieties.

463. TOPAZ, 5AlSi + AlF$_3$ + SiF$_4$.

Right prismatic. ∞P (*M*) 124° 17′, 2P∞ (*n*) 92° 42′, ∞P3 (*l*) 143° 14′, P (*o*). Crystals always prismatic (fig. 122), often hemihedral, perfect, fracture conchoidal. H. = 8; G. = 3·4 to 3·6. Transparent, vitreous. Colourless, honey-yellow, amber, asparagus-green, blue. Becomes electric by heat or friction; the yellow colours become pink. B.B. infusible. Not affected by acids, by digestion in sulphuric acid gives traces of fluorine. Its formula requires 33·2 silica, 56·7 alumina, 17·5 fluorine, 12·6 of the oxygen must be replaced by fluorine, as the total of this is 107·4. Ben-a-bourd and Arran, Scotland; Mourne Mountains, Ireland; St Michael's Mount, Cornwall; Siberia, Saxony, Connecticut, Australia, Ceylon, Brazil, Peru. The finest crystals are the blue from Scotland and Siberia, the pink, those from Brazil and the colourless from Peru. The last-named may be distinguished at once from diamond by the electricity. *Pycnite* is a massive opaque cleavable variety from Finbo. *Pycnite* is a columnar straw-yellow to reddish variety from Zinnwald in Saxony and Durango in Mexico.

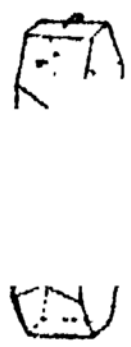


Fig. 452. (Sp. 464.)

464. STAUROLITE, Al, Fe)Si + (Fe, Mg)Si.

Right prismatic. ∞P (*m*) 128° 42′, P∞ (*r*) 70° 46′, ∞P∞ (*a*), 0P (*p*) (fig. 452). Twins common, as figs. 140, 144, 167, 453. Cl. brachydiagonal, perfect; fracture conchoidal to splintery. H. = 7; G. = 3·5 to 3·8. Transparent to opaque; vitreous to resinous. Reddish brown, white. B.B. infusible. Not affected by h. acid, partially by

: silica 30, alumina 48·5, with 5·5 iron peroxide, 12·5 iron toxide, 3·5 magnesia; often impure. Bixeter Voe and Unst in tland, Boharm and Marnoch in Banffshire, St Gotthard, Greiner Tyrol, Finistère, Urals, and North America. *Xantholite* is a ow variety from Urquhart (Inverness).

465. Sapphirite, $4\dot{M}g, 5\dot{A}l, 2\ddot{S}i$.

Oblique prismatic; granular. H. = 7 to 8; G. = 3·4 3·5. reous; pale blue or green; translucent; dichroic. C.c.: mina 2, magnesia 19·3, silica 14·9. Fiskenaes in Greenland.

Tourmaline Group.

466. Tourmaline, $\dot{R}_3\ddot{S}i + \dot{R}\ddot{S}i$.

Rhombohedral; R 133 10′. Crystals of 0R (*c*) ½R; usually g prismatic, and striated (fig. 45, and 249 to 252 Generally himorphic; also radiating and fibrous; fracture conchoidal to ven. H. = 6·5 to 7·5; G. = 3 to 3·3. Black varieties opaque ers transparent; vitreous. Generally black; but colourle ow, brown, blue, green, and rose-red; streak white. Different ours often disposed in layers parallel to the axis; and tions of one crystal differing also in colour along the s. By friction acquires positive electricity, and becomes elec ally polar when heated. Powder insol in h. acid; imperfectly . acid. C.c. complex, but all with water and fluorine, some with acic acid. Coarse black columnar varieties, called *Schorl*, very mmon in granite and gneiss. Black occur at Portsoy in Banff, va, Cabrach, and Rubislaw in Aberdeenshire, Bovey in Devon re, St Just in Cornwall, in Greenland, Arendal, Tyrol, and North erica; blue or *Indicolite* at Uto in Sweden, green at Glen Skiag Cromarty. Crystals ruby-red within, surrounded by green or red one extremity and green at the other, also blue and pink, at auy, Paris, and Hebron in Maine Currant-red or *Rubellite* in ia and Ceylon, also in Siberia and Brazil.

467. Datholite, $Ca\dot{B} + Ca\ddot{S}i_2 + \dot{H}$

Oblique prismatic, C 89° 51′. ∞P 115° 22′, ∞′P ∞ 76° 38′, P) 120°, ·P∞ (*a*) 45° 8′, ∞P∞ 2P∞ (*o*) (fig. 454); or rhombic h *b* : *f* 90°, *b* : *a* 135°, *b* : *c* 141° 9′, *f* : *g* 160° 39′. Fracture uneven, conchoidal. H. = 5 to 5·5; G to 3. Transparent or translucent; reous. Colourless and tinted green yellowish, or pink. In closed e yields water. B.B. intumesces melts easily to a clear glass, colouring the flame green, the der gelatinizes in h. acid. C.c.: 38·1 silic 21·6 boracic acid, 7 lime, and 5·6 water. hopton in Renfrew, Glen g in Perthshire (fig. 455), sbury Crags and Corstor- ne Hill near Edinburgh, ndal, Uto, Andreasberg, sser Alp, Connecticut, New Jersey. Figs. 238, are pseudomorphs of rtz after datholite termed *ytorite*.

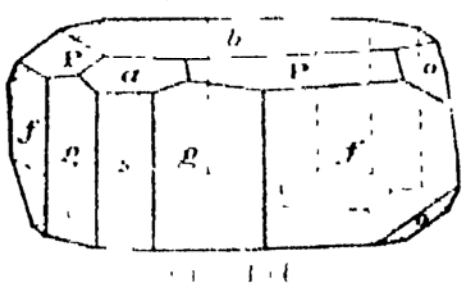


Fig. 454 (c

Fig. 455 (c

468. Euclase, $2\dot{G}l\ddot{S}i + \dot{H}$.

Oblique prismatic, C 79° ∞P″2 (*s*) 115°; 3P″3 (*f*) 5° 49′. Crystals specially of ∞P″2, ∞P″∞ (*l*), 3P″3 Cl. clino- gonal, perfect; very brittle and fragile; fracture conchoidal.

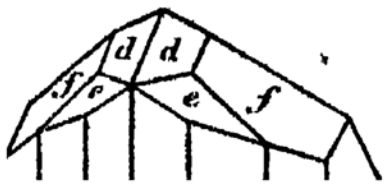


Fig. 456.

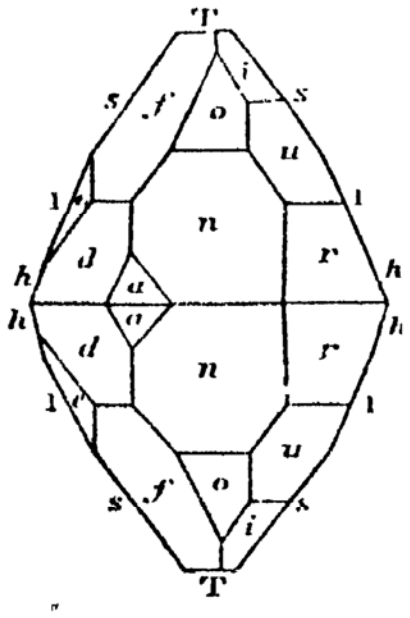


Fig. 457.

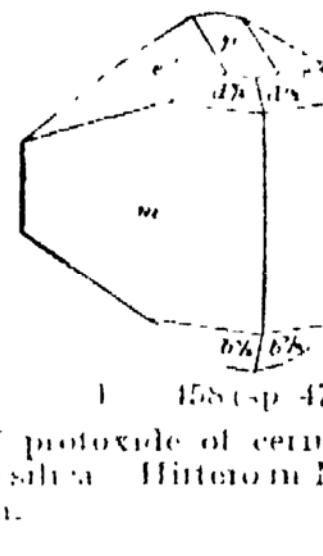
= 7·5; G. = 3 to 3·1. Transparent; splendent; vitreous. Mountain-green, passing into blue, yellow, or colourless. intumesces, becomes white, and melts in thin splinters to enamel. Not affected by acids. C.c.: 42 silica, 35 alum glucina, 6 water. Peru and Brazil, and Southern Urals. be used as a gem on account of its brittleness; whence its

469. Homilite.

Oblique prismatic, C 89° 21′. H. = 5·5, G. = 3·28 Bl brownish black. Vitreous. C.c.: 27·28 lime, 16·25 prot iron, 31·87 silica, 18·1 boracic acid. Stoko and Brevig (N

470. Botryolite.

Fine fibrous, botryoidal, or reniform. Snow-white to hair Chemical and physical characters like datholite, but 10·64 of water,—being 2 equivalents. Arendal.



471. Gadolinite, $(\dot{Y}, \dot{C}e, \dot{F}e)_3\ddot{S}i$.

Oblique prismatic, C 89° 28′. ∞P 116°; P 120° 56′ (fig. 458). Fracture conchoidal, or splintery. H. = 6·5 to 7; G. = 4 to 4·4 Translucent on the edges; vitreous to resinous. Black; streak greenish grey. B.B. the conchoidal (vitreous) varieties incandesce; gelatinizes in h. acid. C.c.: 30 to 51 yttria, 10 to 15 iron protoxide, 5 to 17 lanthanum, 0 to 12 glucina, and 25 to 29 silica. Hitterö in Ytterby, Broddbo and Limbo near Falun.

Fig. 458 (cp 47

protoxide of cerium

Ettlorf Group.

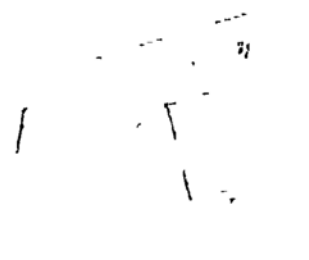
472. Zoisite, $4\dot{C}a, 3\dot{A}l, 6\ddot{S}i + \dot{H}$

Right prismatic. ∞P 116° 26′; ∞P̆2 145° 24′; ∞P̆3 156° 122° 4′; 2P̆∞ 111° 6′ (fig. 459). Cl. brachydiagonal, perfect. H. = 6, G. = 3·2 to 3·4 White, brownish grey, and dark green. B.B. intumesces, and forms a white or yellow porous mass; and on the edges fuses to a clear glass. C.c.: 29·8 alumina, 24·35 lime, 2·8 oxide of iron, 40·3 silica, and 2·1 water. Glen Urquhart, Dalmain, and Allt Gonolan, Inverness; Sterzing in Tyrol, the San Alp in Carinthia, the Ural, and Connecticut. *Thulite*, peach-blossom-red, from Souland in Thelemark (Norway), is similar.

Fig. 459 (cp

473. Ettlorf, $4\dot{C}a, 3\dot{A}l, 6\ddot{S}i + \dot{H}$.

Oblique prismatic, C 89° 27′. ∞P″∞ (*M*), ∞P 2 (*o*) 63° 1′, P″∞ (*T*) 64° 36′, -P (*n*) 70° 25′, P̆∞ (*r*) 63° 42′, P (*s*) 70°. Crystals complex, wit partial forms Hemitropes united by *T*; also columnar and lar Cl. *M*, perfect, also *T*, forming 115° 24′ fracture co to splintery H. 6 to 7; G. = 3·2 to 3·5 Pellucid; Green to yellowish grey. B.B. fuses and swells to a dark brown slag; after fusion soluble with gelatinization in h. acid C.c.: 27·4 alumina, 8·5 iron peroxide, 23·9 lime, 38·3 silica, 1·9 water



Shetland, Glenelg in Inverness, Tilquilly in Aberdeen, in gneiss, in amygdaloid in Mull and Skye; granite at Carrock fell in Cumberland, Arendal, Dauphiné, Greenland, the Urals, North *Withamite* from Glencoe is a red, strongly dichroic variety *monite* or *Manganese Epidote*, brownish violet, from St Marcel 20 per cent. of manganese peroxid

460. Fig.

474. Allanite (*orthite*, *Cerine*), $R_3\ddot{S}i_2 + R\ddot{S}i$

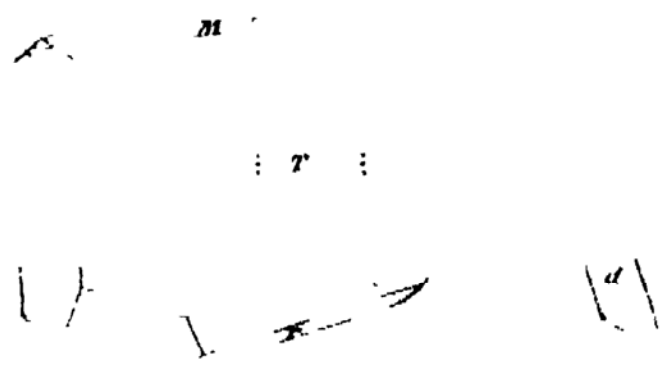


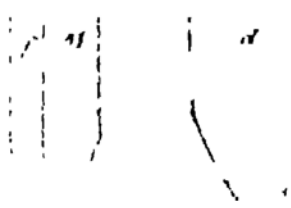
Fig. 462.

Fig. 463

0P (*M*, P∞ (*b*), ∞P∞ (*T*). *M* : *T* 115°, *T* : *n* 111° 21′, ° 18′. Often ... ive of granular fracture conchoidal H. 3·4 to 5·5 ... lucent on edges ... vitreous to resinous. ... brown or greenish; streak brown to grey. B.B. ... froths ... to a brown ... Gelatinous with h. acid. C.c.: 12 to ... me with ... oxide of iron, 13 to 20 oxide of cerium and ... 4 to 20 protoxide of iron, 30 of silica. ... in the syenitic granite of Scotland; as at ... (p. 463), Aboyne and Cruden. In lime- ... (p. 169), Greenland, Hatrurim and Sharon, ... New Jersey. *Cathaite* massive at Finbo, ... Ozark granular at Rockbridge. *Pur* ... notice.

... Mg_2Si + $2Mg_2$

... 164 to 166. Crystals ∞P ∞, ...



... Fig. 466.

... Pyroxene Group. P ... 87° (p. 50, 59, ∞P ... ... cleavages perfect, fracture uneven. H. ... 6·5. Pellucid; vitreous to resinous. Pis- ... yellow, green, white. B.B. fuses easily, ... to green or brown glass. Perth ... ... after ignition totally, gelatinizes ... mina 16, protoxide of iron 7, lime 24, ... and Crathie, Aberdeenshire; in ... ... Skye, Wicklow and Donegal. ... Norway, Malsa, Piedmont, Vesuvius ... ... Lake Baikal (fig. 165). ... ... from copper.

Olivine Group.

... Chrysolite (sp. 173). ... Like olivine (sp. 173). ... White, waxy ... to pearl white. ... (sp. 186). Vermont, ... Massachusetts.

... Mg_2Si

... 49·30 (fig. 46, ... Black, green ... crystalline to resinous ... imperfect. H. 6·5. ... protoxide of iron ... Mourne Mountains ...

... *Peridot* ...

... (p. 177) ...

... 76 of ... ...

... Cl. brachy ...

... Infusible ... with ... ... iron, 40 ... Table ... ... in F ... ... L ... ..., brown or ... and 30 per ... the Kaiserstuhl, ... the Lherzolite ...

Tephroite, Mn_2Si ... 168 (p. 178).

... prismatic, granular, with ... cleavages. Ash- ... red. Adamantine, ... H. 5·5 to 6; G. ... ... protoxide of manganese 70·2, ... 29·8. Franklin ... New Jersey.

480. KNEBELLITE, $Fe_2Si + Mn_2Si$.

Massive. Grey, brown, green, black. Glistening; bri... H. = 6·5; G. 3·71. C.c.: protoxide of iron 35·5, protoxi... manganese 35, silica 29·5. Ilmenau, Dannemora in Sweden.

481. MONTICELLITE, $Ca_2Si + Mg_2Si$.

Right prismatic. P (*r*) 110° 43′ and 97° 55′, ∞P (*s*) 98° 7′, ... (*n*) 133° 6′, P∞ (*k*) 81° 57′, ½P∞ (*h*) 120° 8′, P2 (*e*) 141° 47′ and ... ½P∞ (*b*) (fig. 469). Vitreous. Grey, yellowish and greenish, and white; streak white. Translucent. H. = 5 to 5·5, G. = 3 to 3·25. C.c.: lime 35, magnesia 21·9, protoxide of iron 5·6, silica 37·5. Sol. in h. acid, gelatinizes. Somma, Monzoni.

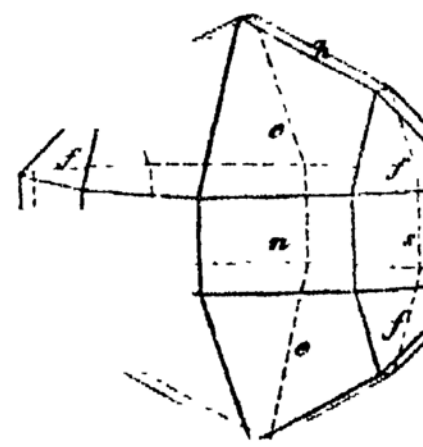


Fig. 469 (sp. 481).

482. CHONDRODITE (*Humite*), Mg_3Si_2.

Right prismatic. P (*r*) marble edge 156° 28′, polar edge (*o*) 84° 34′ and 54° 28′. Also 170 to 172°. Crystals monoclinic in habit, often granular massive. H. 6·5, G. 3·1 to 3·25. Translucent, vitreous to resinous. Yellow, red, brown, green, black. Streak white. B.B. infusible. Decomposed by acids.

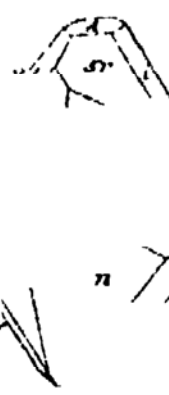


Fig. 472.

... theate of magnesia, with 2 to 3 of fluorine. From limeston... Loch Ness (?), Pargas, Finland, Gullsjo and Aker, Sweden; York, Sparta, New Jersey. *Humite*, from Somma.

483. LIEVRITE, $3Fe, Ca_3Si + FeSi + H$.

Right prismatic. P (*r*) polar edges 139° 30′ and 117° 27′ ... 18′, P∞ (*d*) 112° 49′, ∞P2 (*s*) 106° 15′. Crystals (fig. 12... long-prismatic and vertically striated; also radiated, columna... fibrous, brittle. H. = 5·5 to 6; G. = 3·9 to 4·2. Opaque; res... or imperfect metallic. Brownish or greenish black; streak b... B.B. fuses easily to a black magnetic globule. Sol. in h. ... forming a yellow jelly. C.c.: 29·3 silica, 19·6 iron peroxide, ... iron protoxide, 13·7 lime, and 2·2 water. Rio in Elba, Fos... Kupferberg, Rhode Island, and Greenland.

484. CERITE, $Ce_3Si_2 + H$.

Hexagonal, 0P, ∞P, in low six-sided prisms. Generally ... granular, fracture uneven, splintery; brittle. H. = 5·5; G. ... to 5. Translucent on the edges; dull, adamantine, or resi... Clove-brown, cherry-red or pearl-grey. Sol. in h. acid, le... gelatinous silica. C.c.: 20·5 silica, 73·5 protoxide of cerium ... didymium and lanthanum, and 6 water. Bastnaes near Ri... Ceritan.

485. GALMEI, $Zn_3Si + H$.

Right prismatic, and hemimorphic; 2P2 (*P*) with polar ... 101° 35′ and 132° 26′, ∞P (*d*) 103° 50′, P∞ (*o*) 117° 14′, P... 128° 55′ (fig. 16), common form ∞P∞ (*s*), ∞P, P∞. ... columnar, fibrous, granular, and earthy. Cl. prismatic along ... very perfect; along P∞ perfect. H. = 5; G. = 3·3 to 3·5. T... parent to translucent. Vitreous and pearly. Colourless or w... but often light grey, also yellow, green, brown, and blue; be... electric by heat. B.B. decrepitates slightly, but is infusible; ... cobalt solution blue and partly green; readily soluble in acid... gelatinizes. C.c.: 25 silica, 67·5 zinc oxide, and 7·5 water. ... lockhead, Mendip Hills, Matlock, Raibl and Bleiberg in Cari... Aix-la-Chapelle, Iserlohn, Nertchinsk, Pennsylvania, Vir... Used as an ore of zinc.

Willemite Group.

486. WILLEMITE, Zn_2Si.

Rhombohedral, R 116° 1′. Cl. basal, and prismatic, ... brittle. H. = 5·5, G. = 3·9 to 4·2. White, yellow, brown, an... Vitreous lustre. C.c.: oxide of zinc 73, silica 27. Alte... Liége, Greenland, New Jersey.

TROOSTITE $ZnSi + MnSi$.

bohedral; R 116°. Cl. prismatic, $\infty P2$; brittle. H. = 5·5. Asparagus-green, grey, and reddish brown. Vitreous ide of zinc 58, oxide of manganese 13, silica 28. New Jersey.

CENTROLITE $(PbMn)Si$.

prismatic; ∞P 115° 18'. Form ∞P, P, $\infty \breve{P} \infty$. H. = 5; Red-brown. Cl. prismatic; splendent on P. Southern

PHENACITE, Gl_2Si.

gonal and tetartohedral; R (*b*) 116° 36' (*a*) = 473). Crystals 2, $\frac{3}{4}P2$. Twins with axes, and intersecting nd $\infty P2$; fracture con- H. = 7·5 to 8; G. = Transparent or trans- vitreous. Colourless, e yellow or brown when ut colour soon lost on . B.B. infusible; not by acids. Ce., glucina ica 54·2. Framont in Takovaya in Urals, Durango in Mexico.

Fig.

DIOPTASE, $CuSi + H$.

gonal and rhombohe- R 125° 51', $2R(r)$ 95° 2, $2R\frac{3}{5}(s)$ (fig. 474). perfect; brittle. H. = 5, G. = 3·2 to 3·4. Trans-parent or ent; vitreous. Emerald-green, inclining to verdigris-green or blackish-green; streak green. Ce. = 38·7 silica, 50 copper protoxide, and 11·3 water. Altyn-Tubeh in the Kirghis Steppe; Mooch noya, Copiapo.

71 (*s*) : 293*a*.

491. CHRYSOCOLLA, $CuSi + H$.

Botryoidal or mammillated; fracture conchoidal. H. = 2 to 3; G. = 2 to 2·2. Trans-lucent; resinous. Verdigris-to emerald-green or azure-blue; streak green or white. Ce. = 34·83 silica, 44·94 copper protoxide, and 20·23 water. Leadhills, Lan-ark-shire in England; Cornwall, Saxony, Hungary, Spain, Urals, Australia, Chili.

492. BOGOSLOVSKITE (*Kupferblau*).

Massive, fracture conchoidal, brittle. H. = 4 to 5; G. = 2·56. Sky-to ultramarine-blue; streak smalt-blue, and shining. A silicate of with 45·5 per cent. copper oxide. Schapbach Valley in Bogoslowsk in the Ural. *Dx*

GARNET GROUP

GARNET, $R_3Si_2 + RSi$.

; most common forms ∞O and $2O2$ (*e*) (fig. 10, 60, 475) annular. Cl. dodecahedral; fracture conch 5 to 7·5; G. = 3·5 to 4·3. Pellucid s or resinous. Rarely colourless or generally red, brown, black, green, or B.B. in general fuses to a glass, black in those containing much iron, green wn in the others, and often magnetic. ctly soluble in h. acid. Ce. ex-ly variable, but generally forming two according as R_2O_3 is chiefly alumina or iron peroxide; and these are again according as RO is more especially lime, iron pro magnesia, or a similar base. The more important varieties

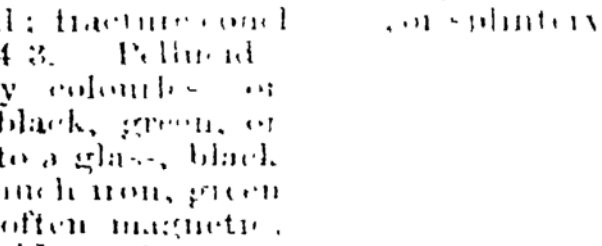


Fig. 475.

Lime-Alumina Garnet, $Ca_3Si_2 + AlSi$, with 40 silica, 23 a, and 37 lime. To this subdivision belong

Water Garnet.—Colourless to white. Craig Mohr, Aberdeen; hauk in Norway.

Grossular.—Olive- to gooseberry-green. Craig Mohr; Wilui America.

Cinnamon Stone.—Hyacinth-red to orange-yellow. Glen (Aberdeen), Allt Gonolan and Old Ban (Inverness), Ceylon, and. *Romanzowite*, from Kimito (Finland), is the same ariety when polished is often sold as *Hyacinth*.

Common Lime Garnet.—Here one half of the alumina is d by iron peroxide. Colours red, brown, yellow. Piedmont, us, the Urals.

Magnesia-Alumina Garnet; RO chiefly magnesia. Arendal.

(3) *Manganese-Alumina Garnet*; RO = MnO; reddish- Spessart (Bavaria), Sweden.

(4) *Magnesia Iron-Lime-Alumina Garnet, Pyrope.*—Colou wine to purplish red. Elie in Fife, Zoblitz in Saxony, Bol

(5) *Iron-Alumina Garnet, Almandine, Noble Garnet.*— lime-red, inclining to violet, blood-red, and reddish Common in mica-slate, gneiss, and granite. Shetland, Inverness, Aberdeen, Fahlun, Arendal, Tyrol, the Urals, America, Pegu, and Ceylon.

(6) *Lime-Chrome Alumina Garnet.* $Ca_3Si_2 + (Cr, Al)Si$, *ite.* Emerald green; with 22 per cent. chrome oxide. and Kyschtimsk in the Urals, India, and California.

(7) *Lime and Iron Garnet*, $Ca_3Si_2 + Fe_2Si$. This includ

(*a*) *Common Iron-Garnet, Kolophite, Melanite.* Subtran or opaque. Green, brown, yellow, or black, with white, yellow streak. Sweden and Arendal.

(*b*) *Melanite.* Black, opaque; in thin splinters trans streak grey, chiefly magnetic. Albano near Frascati, V Frames, Lappmark.

(*c*) *Colophonite.* Yellowish brown to pitch-black, also re red, resinous, streak white. G. = 3·43. Arendal.

The red varieties when cut *en cabochon*, are termed *Carb*

494. AXINITE, $(Al, Fe)_2Si_3 + (Ca, Fe)Si$.

Anorthic. Crystal unsymmetrical. $a : b : c = 0·492 : 1 : 0·491$; α 38', β = 133° 15' 48", γ = 136° 13'. Cl. distinct along plane cating the sharp edge between *l* and *a* and *l'* in fig. to 7, G. = 3·2 to 3·3. Pellucid, vitreous. Clove brown, inclin mole grey or plum blue, but often cinnamon brown in co tion, dark violet blue in a second, and pale olive-green in (*Oisanite*). B.B. colour flame-green, intumesces, and fuses to a dark green glass, becoming black in the O flame, not acid till after ignition, when it gelatinizes. Ce. = 45·9 sil boric acid, 17·6 alumina, 9·3 iron (with manganese) pr and 21·4 lime. Botallack and other mines in Cornwall (Corsain in Dauphiné, Kongsberg, Arendal, Nordmark in S Pyrenees, St Gotthard, Tyrol, Thann in Saxony, Ural, an America.

495. DATOLITE, $CaSi + BSi$.

Right pr-matic. ∞P 114° 32', $\infty P2$ (*o*) 91° 52', $P\infty$ 2, $4P\infty$ (*n*) 54° 58', $0P$ (*c*) : P (*o*) = 129° 29', $2P\infty$ (*p*) : ∞P (*o*) =

Fig. 476. Fig. 477. Fig. 478.

Cl. basal, fracture uneven to sub-conchoidal; very brittle. H. = 7 to 7·5, G. = 2·9 to 3·0. Pale yellow to brown. Translucent, brittle. Ce. = 22·5 to 23·5 lime, 28·4 to 28·6 48·76 silica. Danbury in Connecticut, Kilsaith in New Yo

HELVINE GROUP.

496. HELVINE, $MnS + 3R_3Si_2$.

Cubic and tetrahedral. $\frac{O}{2}$ or $\frac{O}{3}$ or $\frac{O}{4}$. H. = 6 to 6·5, G. = 3·1. Translucent on the edges. Lemon-yellow, green, or yellowish brown. B.B. in the red flame intumesces to a yellow or clove-brown bead; soluble in h. acid, sulphuretted hydrogen separated. Ce. = 31 silica, 10 8 iron protoxide, 7 glucina, 4 protoxide, and 5 sulphur enberg in Saxony, and near Modum in Norway.

497. DANALITE, $FeS + 3R_3Si_2$.

Cubic. Octahedra, with striated dodecahedral planes to 6, G. = 3·4. Vitreous to resinous. Flesh-red to grey lighter. Translucent; brittle. Ce. = protoxide of iron manganese 6·5, of iron 19, silica 31·5, sulphur 5·5. Massachusetts.

498. EKMANITE, Bi_2Si_3.

Cubic and tetrahedral. $\frac{2O2}{2}$ and $\frac{2O2}{4}$. The crystals small, and often with curved faces; fracture conchoidal to G. = 6·9 to 7·1. Transparent and translucent. Clove brown, yellow, grey, or white; streak white or grey. 16·2 silica and 83·8 bismuth peroxide. Schneeberg and dorf near Freiberg.

Scapolite Group.

Sarcolite, 8Ca, 3Al, Na, 9Si.

nidal. P 102° 54′; ∞P∞; 0P, P, and other faces as in fig. any of the faces being alternately hemihedral. H. = 5·5 . = 2·93. Vitreous. Grey to rose-red. Translucent; very C. c.: alumina 21·5, lime 32·4, soda 3·3, silica 40·5. to a white enamel; gelatinizes with acids. Somma.

Fig. 480 (sp. 499).

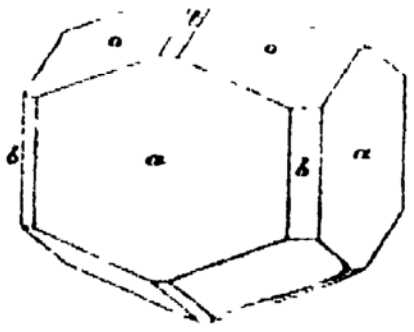


Fig. 481 (sp. 500).

Melonite, 6(Ca, Na), 4Al, 9Si.

ndal. P (o) 65° 42′; P∞ (l), ∞P (a), ∞P (b) (fig. 481). nohexagonal. H. = 5·5 to 6; G. = 2·6. Vitreous. Colourless or white. ent. Much cracked. C. c.: 31·9 , 26·2 lime, 41·9 silica. Gelatinizes. Somma.

Fig. 482 (sp. 501).

Lizzonite, 6(Ca, Na), 1Al, 1½Si.

ndal, P 64° 4′ (fig. 482). Similar to . C. c.: alumina 23·8, lime 8·8, silica 54·7. Insoluble in h. acid.

Scapolite, 3(Ca, Na)Si + Al_2Si_3.

ndal. P 63° 42′; ∞P∞; P; ∞P; also massive. Cl. perfect, and ∞P. H. = 5 to 5·5, G. = 2·6 to 2·8. Trans- translucent; vitreous, pearly, or resinous. Colourless, but grey, green, yellow, or red. B.B. melts with effervescence ular glass, in the closed tube may show traces of fluorine, ution of cobalt becomes blue. Sol. in h. acid. C. c.: 49 alumina (with iron peroxide), and 23 lime (with soda). cotland), Arendal, Tunaberg, Pargas, Massachusetts, and k. Known by its rectangular cleavage, resinous lustre on l surfaces, and action B.B. *Dipyre*, P 64° 4′, is a variety.

Melilite (*Humboldtilite*), 2(Ca, Mg)Si_2 + (Al, Fe)Si.

ndal. P 65° 30′, 0P, ∞P∞. Cl. basal, perfect. H. = 5 . = 2·91 to 2·95. Translucent on edges, vitreous to resin honey-yellow, orange-brown, and yellowish white. C. c. 7 magnesia, 9 alumina, 7 iron peroxide, 40 silica. Capo and Vesuvius.

Gehlenite, (Ca, Fe)$_2$Si + (Al, Fe)Si.

ndal. P 59°, 0P; ∞P∞, ∞P3; 2P. Cl. basal. H. = 5·5 . = 2·9 to 3·1. Translucent on edges. Dull resinous n, leek-, or olive-green, and liver-brown. C. c.: 22 , 5 iron peroxide, 35 lime, 4 magnesia, 31·4 silica. Monte Fassa Valley.

Nepheline Group.

Leucite, Al_2Si_4 + KSi.

ortahedral. Combination of the ditetragonal pyramid (*i*) with the ube, standard (*a*), and 2P∞ (*o*) with ∞P∞ (*m*). Hemitropes united

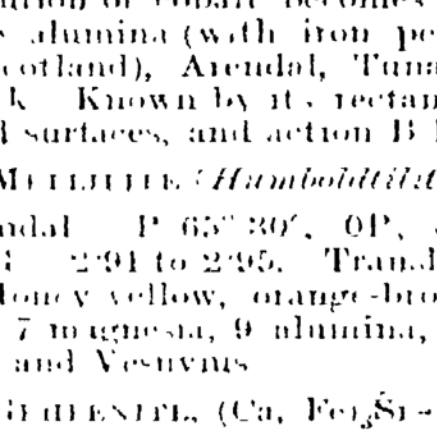


Fig. 483.

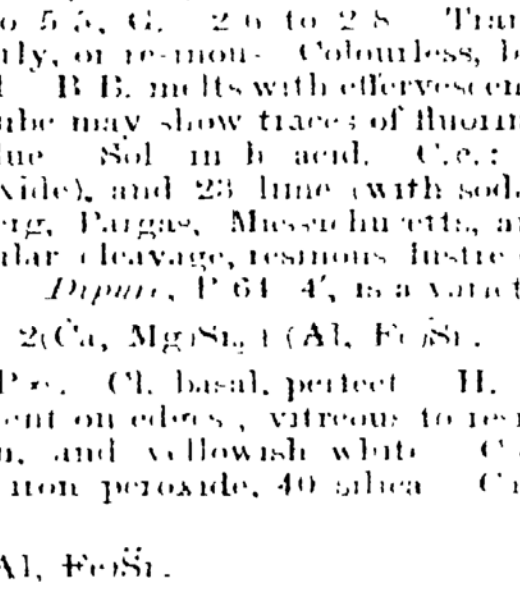


Fig. 484.

Fracture conchoidal. H. = 5·5 to 6, G. = 2·4 to 2·5. Trans- to translucent on the edges, vitreous inclining to resinous. ss, but greyish, yellowish, or reddish white; streak white. nfusible; with cobalt solution become blue. Sol. in h. acid, without gelatinizing. C. c.: 54·9 silica, 23·6 alum 21·5 potash. Abundant in the lavas of Vesuvius, the tu Rome, and the peperino of Albano; also at the Kaiserst near Lake Laach. Readily distinguished from analcime b fusibility, and by never showing faces of the cube.

506. Nepheline (*Elæolite*), $\dot{A}lSi + 4(\dot{N}a, \dot{K})Si$.

Hexagonal. P 88° 10′. ∞P, 0P, P common; also Crystals imbedded, or in druses; also massive-granular; fracture conchoidal, or uneven. H. = 5·5 to 6; G. = 2·58 to 2·64. Transparent or translucent; vitreous and resinous. Colourless or white (nepheline); or opaque, dull resinous, and green, red, or brown (elæolite). B.B. melts difficultly (nepheline), or easily with slight effervescence (elæolite), into a vesicular glass. Sol. and gelatinize in h. acid. C. c.: 41·2 silica, 35·3 alumina, 17 soda, 6·5 potash. Nepheline at Monte Somma, Capo di Bove, Katzenbuckel in the Odenwald, Aussig, and Lusatia. Elæolite in the zircon-syenite at Laurvig, Fredriksvarn, Brevig, and Miask.

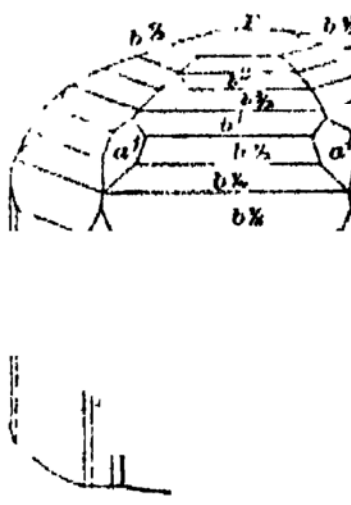


Fig. 485.

Davyne, with P 51° 16′, seems only a variety; as also *nite*, bright blue, and with some carbonate of lime.

507. Micro-sommite, $\dot{R}Si + AlSi + NaCl$.

Hexagonal. ∞P; 0P, ∞P2; ∞P⅔. Cl. ∞P. H. = 6; G. = to 2·53. Colourless to yellow; lustre silky. Somma and V

508. Sodalite, $3(AlSi + NaSi) + NaCl$.

Cubic, ∞O, and fig. 486; generally distorted; also mas granular. Cl. ∞O; fracture conchoidal or uneven. H. = 5·5; G. = 2·13 to 2·29. Trans- lucent; vitreous. White, grey, and rarely green or blue. C. c.: 37 silica, 31·8 alumina, 19·2 soda, 4·7 sodium, and 7·3 chlo- rine. Greenland, Vesuvius, Ilmen Hills, Fredriksvarn, and Litchfield in Maine.

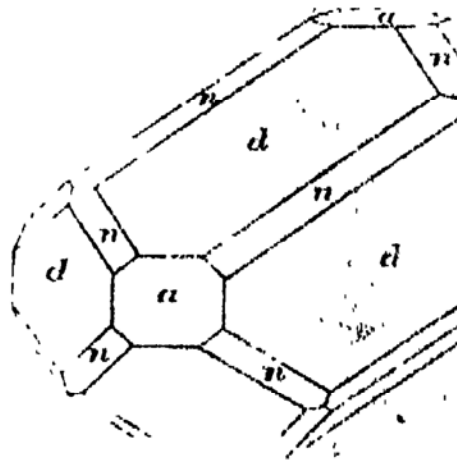


Fig. 486 (sp. 508).

509. Nosean, $3(AlSi + \dot{N}aSi) + \dot{N}aS$.

Cubic, and granular. H. = 5·5, G. = 2·28 to 2·40. Trans- lucent, vitreous to resinous. Ash or yellowish grey, sometimes blue, brown, or black. sites, 31 alumina, 25 soda, and 8 sulphuric acid. Lak and Rieden near Andernach, on the Rhine. Occurs in ph in minute crystals.

510. Hauyne, $2(AlSi + NaSi) + \dot{C}a\dot{S}$.

Cubic, chiefly ∞O; also fig. 487; but more common i Cl. ∞O. H. = 5 to 5·5; G. = 2·4 to 2·5. Semitransparent lucent, vitreous or resinous. Azure- or sky-blue, streak bluish white. C. c.: 34·2 silica, 28·5 alumina, 11·5 soda, 4·3 potash, 10·4 lime, and 11·1 sulphuric acid. Vesu- vius, Mount Vulture near Melfi, the Cam- pagna of Rome, and Niedermendig near Andernach.

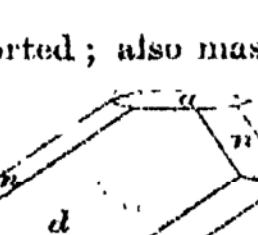


Fig. 487 (sp.

511. Lapis-lazuli.

Cubic; ∞O, generally massive, granu- lar. H. = 5·5, G. = 2·38 to 2·42. Trans- lucent on edges; dull resinous or vitreous. Ultrama azure-blue; streak light blue. B.B. fuses readily to porous glass. In h. acid the powder is dissolved and go evolving sulphuretted hydrogen. C. c.: 45·50 silica, phuric acid 31·76 alumina, 9·09 soda, 3·52 lime, 0·86 i chlorine, 0·90 sulphur, 0·12 water. Near Lake Baikal Tibet, Tartary, Monte Somma, and Chili. It is used for tal purposes, and in the preparation of ultramarine. T both in it and hauyne seems due to some compound o with sodium and iron.

Mica Group.

512. Biotite (*Magnesia-Mica*), $Al_2Si_2 + (Mg, K, Fe)_2Si$.

Oblique prismatic, C 89° 59′. 0P (*c*), 98° 41′ P (*m*), ∞P∞ (*b*), P∞ (*r*), -⅔P∞3 (*z*). Cl. basal, perfect; sectile; th elastic. H. = 2·5 to 3; G. = 2·85 to 2·9. Transparent, but o

thin plates. Generally uniaxal, sometimes with diver-
56°. Metallic, pearly. Usually dark green, brown, or black;
reenish grey or white. B.B. difficultly fusible to a grey or
ass. Completely sol. in concentrated s. acid, leaving white

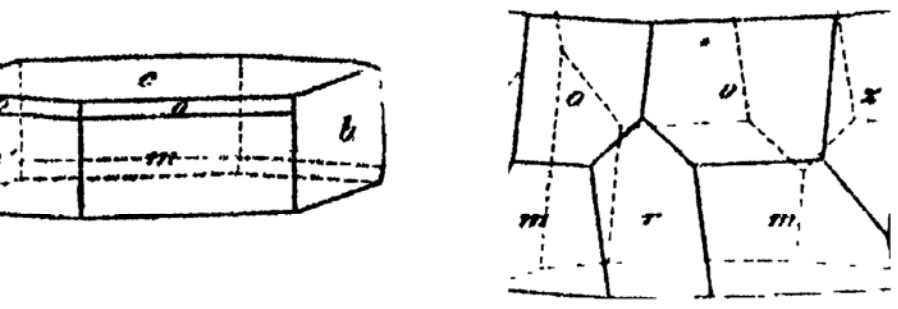


Fig. 488.

lates of silica. C.c.: 39 silica, 17 alumina, 10 iron protoxide,
nesia, 9 potash. Hillswick, Shetland, in gneiss, Sutherland,
averness, in limestone; Skye and Fife in trap; Parsa, Boden
reenland, New York. *Rubellan* is a decomposed variety

HAUGHTONITE, $(Al,Fe)\ddot{S}i + (Fe, K)\ddot{S}i$

ue prismatic. Cl. basal, perfect. H. = 3; G. = 3·1. Vitreous
iantine. Chocolate-brown to black. Weathers pale green
ry. Difficultly soluble in acids. B.B. fused with difficulty
hly magnetic bead. C.c.: silica 36, alumina 18, ferric oxide
rous oxide 18, magnesia 9, potash 8, water 3. Common in
nites of Scotland. Black Forest, Harzburg, Tyrberger.

LEPIDOMELANE, $(\dot{A}l,Fe)\ddot{S}i + (Fe, \dot{K})\ddot{S}i$

ue prismatic. Cl. basal, perfect; brittle. H. = 3. G. = 2·97.
s; transparent to opaque. Rich brown to raven black.
ses easily to a black feebly-magnetic bead. Sol. in h
aving pearly scales of silica. C.c.: 37 silica, 17 alumina, 24
roxide, 3 protoxide of iron, 8 potash, 10 magnesia, 1 water.
n gneiss, Scotland; common in granite, Ireland, and Pers-
weden.

ANOMITE, $12\dot{M}g, 3\dot{A}l, 2\dot{K}, H, 12\ddot{S}i$.

ue prismatic. $c : m$ 98° 42′. Forms c, m, o, b (see fig. 188),
nce of optic axes 12° to 16°. Monroe (New York), Lake Baikal.

PHLOGOPITE, $(\frac{3}{5}\dot{R}_4 + \frac{1}{5}\dot{R})\ddot{S}i_3$.

ue prismatic. 0P (*c*), P (*m*), −3P (*o*), ∞P∞ (*b*). *c* : *m* 98°30′
Cl. basal, perf. Pearly
netallic. Yellowish brown with copper-like reflexion, also
white, and colourless. Transparent. Divergence of optic
to 20°. C.c.: 14 alumina, 2 protoxide of iron, 28 mag-
·6 potash, 2·57 fluorine, 41 silica. B.B. whitens, and fuses
es. Decomposed by s. acid, leaving the silica in scales.
(Finland), Fassa Valley, New York, Canada, Ceylon. Char-
ic of serpentine and of dolomitic limestones.

ZINNWALDITE.

ue prismatic. Forms as in figs. 490, 491; also 2P∞ (*H*) and
). *m* : *c* 98° to 99°. Divergence of optic axes 65°. G.
3·2. C.c. similar to muscovite (sp. 519), but with 4 to

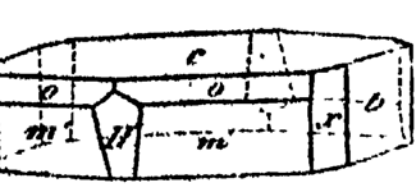


Fig. 490.

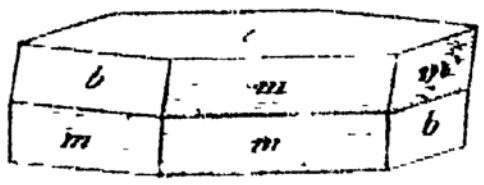


Fig. 491.

ine, 2 to 5 lithia, and traces of rubidium, cæsium, and thal-
Altenberg and Zinnwald, St Just and Trewavas in Cornwall.
yllite from Cape Ann in Massachusetts is similar.

LEPIDOLITE.

que prismatic. Forms like muscovite. Divergence of optic
° to 77°. Cl. basal, perfect. H. = 2·5 to 4; G. = 2·84 to 3.
massive; scaly granular, coarse or fine. Lustre pearly. Colour
d, violet, lilac, yellow, greyish white. Contains 5 to 6 per
ithia, with rubidium, cæsium, and thallium, also fluorine.
olours flame red. Mourne Mountains, Rozena (Moravia), Uto
n), Ekaterinburg, Maine.

MUSCOVITE (*Muscovy-Glass*), $3\dot{A}l\ddot{S}i + \dot{K}\ddot{S}i$.

t prismatic, with monoclinic habit. 0P (*c*); ∞P (*M*); ∞P∞
(*m*); 2P∞ (*y*). ∞P nearly 120°. Twin-face *c*. Cl. basal,
; elastic. Angle of optic di-
ce from 44° to 77°. Metallic,
. Colourless, and tinged of
shades to black. B.B. fuses to
que enamel. Not affected by
C.c.: 36·6 alumina, 11·8 pot-
5·1 silica, 4·5 water, with traces
orine. Shetland, Loch Glass in Sutherland, Glen Skiag
ls 15 inches in length) and Struay Bridge in Ross, Aber-

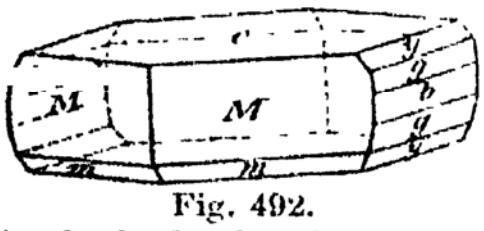


Fig. 492.

deen, Cornwall, St Gotthard, Norway, Sweden, Siberia.
over a yard in diameter in China, where it is used for w
Fuchite, bright green, has 6 per cent. of chrome oxide. *M*
dite contains 4 to 6 water. *Gilbertite*, Cornwall, may be d

520. PARAGONITE (*Soda-Mica*), $3\dot{A}l_2\ddot{S}i_3 + (\dot{N}a, \dot{H})\ddot{S}i$.

Massive; foliated. Lustre pearly. H. = 2·5 to 3; G. = 2·7
Yellowish, greyish, and greenish. C.c.: 40·1 alumina, 6
47·75 silica, 4·6 water. Monte Campione, St Gotthard.

521. SANDBERGERITE (*Baryta-Mica*).

White minute scaled aggregates. G. = 2·894. C.c.: 30·2 a
4·9 magnesia, 5·9 baryta, 7·6 potash, 42·6 silica, 4·43
Pfitsch Valley in Tyrol, and the Swiss Alps.

522. MARGARITE (*Lime-Mica*).

Right prismatic. Cl. basal perfect. H. = 3·5 to 4·5, G. =
3·1. Lustre of cl. pearly. Lateral planes, vitreous. Snow
reddish white, and pearl grey. Lamina brittle. Opti
angle 109° to 129°. C.c.: 51·2 alumina, 11·6 lime, 2·6 so
silica, and 4·5 water. Greiner in Tyrol, Naxos, Asia Minor,
Pennsylvania, North Carolina. *Diphanite* is similar.

523. EPHYLLITE $(\frac{3}{5}\dot{R}_3 + \frac{1}{5}\dot{R})\ddot{S}i_3 + \frac{1}{5}\dot{H}$.

Like muscovite, but lamina not easily separable. H. = 3
G. = 2·83 to 3. Lustre of cl. pearly to adamantine. W
colourless. Transparent to opaque. Lamina brittle. Opt
angle 71½°. C.c.: alumina 42·3, lime 1·5, potash 3·2, so
silica 41·6, water 5·5. Unionville in Pennsylvania.

524. CLINOPTILE, $(\frac{3}{5}\dot{R}_3 + \frac{1}{5}\dot{R})_2\ddot{S}i + \frac{1}{2}\dot{H}$.

Oblique prismatic; in hexagonal tables, or massive foliate
basal, perfect. H. = 5 to 5·5, G. = 3·15. Translucent, p
metallic on the cleavage. Angle of the optic axes 3°
Reddish brown to yellow. C.c.: 39·7 alumina, 21·1 magne
lime, 19·2 silica, 2 protoxide of iron, 4·9 water. Amity in
wick in New York. *Brandisite* is similar.

XANTHOPHYLLITE.

Oblique prismatic, C about 90°. Crystalline aggregates
lamellar. H. = 4·5 to 6, G. = 3·1. Lustre pearly. Colour y
to copper-red. Angle of optic axes 0 to 20°. C.c. alumi
lime 13, magnesia 17·5, silica 16·9, water 5·1. Zlatoust.

526. CHLORITOID, $\dot{F}eSi + A\dot{H}$.

Right prismatic; in foliated crystals; brittle. Cl.
Lustre greasy to pearly. H. = 5·5 to 6; G. = 3·52 to 3·56
green; streak greenish white. C.c.: 40 alumina, 27 prot
iron, 25 silica, 7 water. B.B. infusible, but becomes m
Decomposed by s. acid. Hillswick in Shetland, Pregr
Tyrol, Ekaterinburg, Canada.

530. ASTROPHYLLITE.

Right prismatic, with oblique habit. In long tabular
and in stellate groups. Cl. basal, perfect. H. = 3·5; G
Submetallic to pearly. Tombac-brown to gold-yellow.
Axial divergence 113° to 124°. C.c.: peroxide of iron 9·3, p
23·6 protoxide of manganese 10, soda 3·9, potash 5·9, tu
7·90, silica 39·2. Brevig, El Paso in Colorado.

CHLORITE GROUP.

531. CHLORITE, $2\dot{R}\ddot{S}i + \dot{R}_2\dot{A}l + 3\dot{H}$.

Hexagonal. P 106° 50′; crystals tabular, of 0P, ∞P
(fig. 493); often in comb-like or other groups;
generally foliated and scaly. H. = 1 to 1·5; G. = 2·78
to 2·96. Leek-green to blackish green; streak
greenish grey. C.c.: 21 alumina, 20 protoxide
of iron, magnesia 18, silica 24, water 11. Tar-
side, Bute, and Jura in Scotland. Cornwall, Cumberland
Fassa Valley, Urals, America.

Fig

PLAGIOCLASE, 4M, Si Mc, Al 5H.

...gonal, thombohedral, R 65° 28′. Crystals chiefly very acute ...hedron with or without the base. Lustre resinous. H. ...4. 2·6 to 2·7. Streak greenish white. B.B. exfoliates, ... white, and fuses on the edges to a white enamel. Com... sol. in warm ... acid. C.c.: 35·6 silica, 14·4 alumina, ... to 10·0 water, but with 5 to 6 iron protoxide re... ...ommon ... ...dpar in Harris, Glen Lochy in Perthshire ... in V... Tyrol, Val di Strela in Piedmont, Manléon ... *Leuchtenbergite* is the name *Kammererite* with ... ...ron oxide, is violet-blue or green. Ural, Siberia, ... *Texalite* and *Tale-ode* are also varieties.

...ITE, 3(Mg,Fe)SiO₃ + Mc,Al 4H.

... prismatic ∞P 91° 46′, ∞P 121° 28′, 0P P 110° 55′, ... 8′, ... P, 119° 2′, 0P ∞P, P, fig. 491). ...mmon. Bronze-like, vitreous or pearly. H. 5·0 ... 6·0 to 6·5. B.B. become white and ... thin edges to a greenish yellow enamel. ... silica, 1·3 alumina, 10·3 magnesia, and ... Lherzolite and Blue Atholite in Scotland, ... Piedmont, Kupferberg in Upper Silesia, West ... Pennsylvania. *Chrysolite-like*, *Pyrallolite* and *Korsakowite* are varieties.

Fig. 491.

...ITE, 3(Mg,Fe)SiO₃ + Mc,Al 4H. Fig. 491

...prismatic. Cl. basal, perfect; fracture uneven; brittle. H. 5, G. 2·7 to 2·8. Pearly, translucent. Apple- and grass-green. C.c.: alumina 13·4, chrome oxide 1·4, ... of iron 4·0, magnesia 21·6, silica 57, water 11. Tortosa in Elba, Ozark.

...ITE, 3(Mg,Fe)SiO₃ + H.

... massive, fine-granular and globulite-radiated. H. 2·5 to ...91. Weak dull. White, with yellowish-spots, greenish ... 1·1 alumina, 22·6 magnesia, 12·6 lime, 35·7 silica, 9·8 ... B.B. fuses easily, with intumescence, to a grey glass. In ... hydrochloric acid, with separation of silica. Glenmore in Ayrshire, ...

...ITE, 3(Mg,Fe)SiO₃ + H.

...granular aggregates. Cl. along two clinodiagonal faces, fracture splintery. Greyish white to brownish red. Vitreous to ... H. 5·0 to 6·0, G. 2·6 to 2·7. C.c.: alumina 29·3, magnesia ...6, potash 1·1, silica 56, water 2·8. Waldheim in Saxony.

...ITE, 3(Mg,Fe)SiO₃ + H. Fig. 492

... massive, fracture splintery; sectile. H. 2·5. Translucent. ... Red, with white streak. C.c.: 57 silica, 37·6 magnesia, ... 11·4 water. Capo di Bove near Rome.

...ITE.

Massive. H. 2·0 to 3, G. 1·9 to 2·2. Translucent; ... Dull orange-yellow. C.c.: 41 silica, 37 magnesia, 22 water. ... Passau, Texas, Barchill near Baltimore. *Nickel-Gymnite* ... nickel oxide, replacing the water. Unst, Texas, Pennsylvania.

...ITE, 3(Mg,Fe)SiO₃ + (Al,Fe)SiO₃ + 3H.

Massive, sectile, and very soft. H. = 1·5; G. = 2·2 to 2·3. ... orange-yellow, pale green, and reddish brown. Feels greasy; ... adhere to the tongue, falls to pieces in water. C.c.: silica, ... alumina 7·3, ferric oxide 3·9, magnesia 20·6, water, 22·7. ... In all the above colours in the later igneous rocks of Scotland, ... monly. Unst and Point and St Clear in Cornwall, and Dalecarlia, Sweden. *Pencatite* has 2·8 oxide of nickel.

SERPENTINE, $2MgSiO_3 + Mg(OH)_2$.

Crystallization uncertain, pseudomorphic after olivine, ... generally massive, and granular or fibrous; fracture ... conchoidal, uneven, or splintery; sectile, and slightly ... H. 3 to 3·5, G. 2·5 to 2·7. Translucent to opaque; dull ... ours. Green, grey, yellow, red, or brown, often in spots, ... or veins; streak white, shining. Feels greasy, and does not ... to the tongue. In the closed tube yields water, and becomes ... C.c.: 43·5 silica, 43·5 magnesia, and 13 water; but with 1 to ... protoxide, and also carbonic acid, bitumen, and chrome oxide. ...

Varieties are—(1) *Noble Serpentine*, brighter coloured, ... and more translucent. (2) *Precolite*, or fibrous (H. = 3·5 to ... 3; *Common*, or compact, (4) *Chrysotile* (*Baltimorite*, *Metaxite*), ... fine asbestiform fibres, easily separated, with a metallic ... lustre (G. = 2·219).

Common in Shetland, Unst, Portsoy, Ballantrae; ... Point in Cornwall, Norway, Sweden, North America. Chrysotile ... at Colaburth and Unst, Shetland, Portsoy, Towanreiff, ... land; Reichenstein in Silesia, the Vosges Mountains, and ... America. Serpentine often a product of decomposition, or ... morph of various minerals, as augite, hornblende, olivine, ... enstatite, garnet, &c. It forms whole rocks and mountains, ... manufactured into various ornamental articles.

...ITE, $3MgSiO_3 + 2Mg(OH)_2$.

Oblique prismatic, often foliated. H. = 2·5 to 3; G. = ... 2·47. Lustre pearly. Greenish white, bluish white, and ... green. C.c.: silica 42·1, magnesia 38·5, water 17·5. ... In serpentine of Urquhart and Portsoy (Scotland) Cornwall, Hoboken.

ANTIGORITE.

Thin flat lamina. H. = 2·5; G. = 2·6. Translucent. Green, ... brown spots, streak white. C.c.: silica 40·8, magnesia 36·2, ... oxide of iron 5·8, water 12·4. Antigorio in Piedmont.

Sutherland, Portsoy, and near Kirkcaldy, Scotland; the ... Point, Cornwall; Briançon, Wunsiedel. Savage nations ... steatite into culinary utensils.

Potstone is a mixture of talc, chlorite, and other minerals.

541. PICROPHYLL, $3RSiO_3 + 2H$.

Right prismatic. H. = 2·5; G. 3·75. Dark green. F... shining. C.c.: magnesia 30·1, protoxide of iron 6·9, silica ... water 9·8. Sala in Sweden.

542. PICROSMITE, $2MgSiO_3 + H$.

Right prismatic, but massive. Cl. $\infty P\infty$ perfect, less so ... directions, sectile. H. 2·5 to 3; G. 2·5 to 2·7. Transl... opaque, vitreous, but pearly on $\infty P\infty$. Greenish white, ... blackish green, streak colourless. Yields a bitter odour ... breathed on, hence the name. C.c.: 55·8 silica, 36·1 magnesia, ... 8·1 water. Predazzo in Bohemia, and Greiner in Tyrol.

543. MONRADITE, $4(Mg,\frac{1}{2}Fe)SiO_3 + H$.

Massive, foliated, translucent, and yellowish-grey. H. = ... 3·27. C.c.: silica 56·5, magnesia 31·9, protoxide of iron 8·... 4·1. B.B. unfusible. Bergen in Norway.

544. MEERSCHAUM, $2MgSiO_3 + 4H$.

Fracture earthy, cohesive. H. 2 to 2·5; G. 0·8 to 1·... almost nearly 1. Opaque, dull. Yellowish and greyish white, ... slightly shining. Feels rather greasy, and adheres strongly ... tongue. C.c.: 51 silica, 21·7 magnesia, and from 9 to 21 ... Negropont, Anatolia, near Madrid and Toledo, Moravia, ... land.

545. ARTHROPHYLL, $4MgSiO_3 + H$.

Soft and earthy. G. = 2·21. Milk-white; opaque. C.c.: ... silica, 3·03 magnesia, 11·9 water. Langban (Sweden), Elba.

546. STADAITE, $Mg_2SiO_3 + 4H$.

Massive, fracture splintery; sectile. H. = 2·5. Trans... resinous. Red, with white streak. C.c.: 57 silica, 31·6 ma... 11·4 water. Capo di Bove near Rome.

547. GYMNITE.

Massive. H. 2·0 to 3, G. 1·9 to 2·2. Translucent; ... Dull orange-yellow. C.c.: 41 silica, 37 magnesia, 22 water. ... Passau, Texas, Barchill near Baltimore. *Nickel-Gymnite* ... nickel oxide, replacing the water. Unst, Texas, Pennsylvania.

548. SAPONITE, $\frac{1}{2}(CaMg_3Si_4O_{12}) + (Al,Fe)Si + 13H$.

Massive, sectile, and very soft. H. = 1·5; G. = 2·2 to 2·3. ... orange-yellow, pale green, and reddish brown. Feels greasy; ... adhere to the tongue, falls to pieces in water. C.c.: silica, ... alumina 7·3, ferric oxide 3·9, magnesia 20·6, water, 22·7. ... In all the above colours in the later igneous rocks of Scotland, ... monly. Unst and Point and St Clear in Cornwall, and Dalecarlia, ... Sweden. *Pencatite* has 2·8 oxide of nickel.

549. SERPENTINE, $2MgSiO_3 + Mg(OH)_2$.

Crystallization uncertain, pseudomorphic after olivine, ... generally massive, and granular or fibrous; fracture ... conchoidal, uneven, or splintery; sectile, and slightly ... H. 3 to 3·5, G. 2·5 to 2·7. Translucent to opaque; dull ... ours. Green, grey, yellow, red, or brown, often in spots, ... or veins; streak white, shining. Feels greasy, and does not ... to the tongue. In the closed tube yields water, and becomes ... C.c.: 43·5 silica, 43·5 magnesia, and 13 water; but with 1 to ... protoxide, and also carbonic acid, bitumen, and chrome oxide. ...

Varieties are—(1) *Noble Serpentine*, brighter coloured, ... and more translucent. (2) *Precolite*, or fibrous (H. = 3·5 to ... 3; *Common*, or compact, (4) *Chrysotile* (*Baltimorite*, *Metaxite*), ... fine asbestiform fibres, easily separated, with a metallic ... lustre (G. = 2·219).

Common in Shetland, Unst, Portsoy, Ballantrae; ... Point in Cornwall, Norway, Sweden, North America. Chrysotile ... at Colaburth and Unst, Shetland, Portsoy, Towanreiff, ... land; Reichenstein in Silesia, the Vosges Mountains, and ... America. Serpentine often a product of decomposition, or ... morph of various minerals, as augite, hornblende, olivine, ... enstatite, garnet, &c. It forms whole rocks and mountains, ... manufactured into various ornamental articles.

550. MONRADITE, $3MgSiO_3 + 2Mg(OH)_2$.

Oblique prismatic, often foliated. H. = 2·5 to 3; G. = ... 2·47. Lustre pearly. Greenish white, bluish white, and ... green. C.c.: silica 42·1, magnesia 38·5, water 17·5. ... In serpentine of Urquhart and Portsoy (Scotland) Cornwall, Hoboken.

551. ANTIGORITE.

Thin flat lamina. H. = 2·5; G. = 2·6. Translucent. Green, ... brown spots, streak white. C.c.: silica 40·8, magnesia 36·2, ... oxide of iron 5·8, water 12·4. Antigorio in Piedmont.

Hydrophite, $(\dot{M}g, \dot{F}e)_4\ddot{S}i_3 + 4\dot{H}$.

ive and fibrous. H. = 3 to 4; G. = 2·65. Mountain green to ack; streak paler. C.c.: silica 36·2, magnesia 21·1, protoxide 22·7, water 16. Taberg in Sweden, New York.

Villarsite, $2\dot{M}g_2\ddot{S}i + \dot{H}$.

t prismatic; crystals P, 0P, meeting at 136° 32′, often twins e combination; also granular. H. = 3; G. = 2·9 to 3. Trans Greenish to greyish yellow. C.c.: silica 39·6, magnesia rotoxide of iron 3·6, water 5·8. Totaig, Ross-shire; Traver iedmont; Forez, France.

Pyrallolite.

que prismatic, C 72° 56′; columnar and granular. Cl nd hemidomatic, meeting at 91° 36′; fracture splintery. H. = 3·5 to 4; G. = 2·6. Translucent on edges; colours h to yellow-grey. C.c.: silicate of magnesia and water d in Finland.

Dermatine, $(\dot{M}g, \dot{F}e)\ddot{S}i + 2\dot{H}$.

form; stalactitic; fracture conchoidal, brittle. H. = 2·5; . Resinous. Blackish green, streak yellow. Does not to tongue. C.c.: silica 38, magnesia 22, protoxide of iron er 23. Waldheim in Saxony.

Chlorophaeite, $\dot{R}\ddot{S}i + \dot{R}_2\ddot{S}i_2 + 4\dot{H}$.

ive, rarely reniform. Coating or filling openings in amygd cavities. H. = 2·5; G. = 2·02 to 2·4. Scaly to fracture-con . On first exposure transparent and olive-green to orange- but soon changes to black and opaque, [illegible] Vitreous to shining. B.B. melts to a black [illegible] C.c.: 36·2, alumina 6·9, peroxide of iron 13·8, protoxide of iron ne 3·8, magnesia 10, water 24·8. Rum and Canna in the es, Giant's Causeway. The original mineral from Rum has on peroxide and no alumina.

Forchhammerite, $\dot{F}e\ddot{S}i + 6\dot{H}$.

ular massive. Subresinous to dull. Dark green. H. = 2, 8. C.c.: silica 32·8, protoxide of iron 21·6, magnesia 3·4, 2·2. Faroes.

Kirwanite.

druses in amygdaloids with divergent sheaf-like crystals. G. = 2·9. Opaque. Olive green to dark green. C.c.: silica lumina 11·1, protoxide of iron 2·39, lime 19·8, water 14. aa in Mull; Mourne Mountains in Ireland.

Glauconite.

nd grains. Dull resinous. Light green. C.c.: silicate of de of iron and potash. Ashgrove near Elgin; green sand land, France, Germany, and America.

Celadonite, $3\dot{R}\ddot{S}i_2 + \dot{R}_2\ddot{S}i_2 + 5\dot{H}$

ive, forming crusts, as of agate. Earthy-subtile. H. = 1 3. = 2·6 to 2·8. Opaque, shining. Bright green. Feels C.c.: silica 54, alumina 3·8, ferric oxide 11·9, ferrous oxide agnesia 6·8, potash 7·9, water 10. Orkney, Rum, and re in Scotland. Giant's Causeway, Verona, Faroes, Iceland, , Bohemia.

Stilpnomelane, $2(\dot{F}e, \dot{M}g)\ddot{S}i + Al\ddot{S}i + 2\dot{H}$.

sive or radiating-foliated. One cl. perfect; brittle. H. = 3 to 3·4 to 3·4. Opaque; vitreous to pearly. Greenish black. C.c.: lica, 6·9 alumina, 38·3 iron protoxide with 2 to 3 magnesia, 5 water. Zuckmantel in Silesia and Wellburg in Nassau.

Chamoisite.

tic and massive. H. = 3; G. = 3 to 3·4. Greenish grey to streak paler. C.c.: silica 11·3, alumina 7·8, protoxide of 0·5, water 17·4. Chamoison (or Chamoson) in Valais, the . *Berthierine* has 75 protoxide of iron and 5 of water; e.

Augite and Hornblende Group.[1]

ublende and augite rather represent groups of mineral sub- than single species. They are best distinguished when ectly formed, by the cleavage and angles of the prisms.

Enstatite (*Chladnite*), $\dot{M}g\ddot{S}i$.

[1] Hornblende and augite agree so closely in crystalline forms and chemical com that it has sometimes been proposed to unite them in one species. They, r, differ too widely to justify their union. Hornblende is more fusible, ges lower in specific gravity (hornblende from 2·93 to 3·45, augite 3·625). Though both possess a cleavage parallel to their vertical yet these differ in angular dimensions: hornblende 124° 12′, augite 87° y also occur in distinct geognostic positions – hornblende in rocks con- quartz or free silica, and mostly with minerals that are neutral compounds , as orthoclase and albite; augite in rocks that do not contain free silica, tly with minerals that are not neutral silicates, as labradorite, olivine, and Hence there are two distinct series of massive or igneous rocks: the nde series, including granite, syenite, diorite, diorite-porphyry, and red y; and the augite series or hypersthene rock, gabbro, dolerite, nephe- ugite-porphyry, and leucite-porphyry.

Right prismatic. ∞P 92° to 93°; crystals ∞P∞ (*a*) ∞P (*m*), ½P∞ (*l*), ⅓P∞ (*q*), ¼P∞ (*ψ*), ⅓P (*τ*) (fig. 497). Usually imbedded, or indistinct granular masses. Cl macrodiagonal very perfect, prismatic ∞P distinct, brachydiagonal imperfect. H. = 5·5; G. = 3·1 to 3·3. Translucent throughout, or only on the edges, vitreous or pearly on the more perfect cleavage-planes. Colourless, greyish or greenish white, yellowish, or brown. Not affected by acid. B.B. almost infusible. C.c.: 60 silica and 40 magnesia, but with 6 to 8 iron pe 1 to 2 alumina, and 1 or 2 water. In olivine and cr rocks in Moravia, the Harz (Baste), and the Pyrenee

561. Bronzite (*Schiller Spar, Bastite*), (Mg, Fe)Si.

Right prismatic. ∞P 91° only granular and foliated brachydiagonal perfect, prismatic less so; fracture uneven tery. H. = 4 to 5. G. = 3 to 3·5. Translucent on thin metallic pearly. Green, inclining to yellow or brown. Is tly sol. in h. acid wholly in c. acid. B.B. becomes m and fuses in very thin splinters. C.c.: 43 silica, 26 magne lime, 7·4 iron protoxide, 3·3 iron peroxide, 2·4 chrome ox alumina, and 12·4 water. *Bastite* is specially altered o Belhelvie and Black Dog in Aberdeenshire, Baste in Tyrol, B Styria.

565. Paulite (*Hapalotrope*), Fe, Mn, S.

Right prismatic. ∞P *nn* 93° 30′, P2 (*o*) 2P2 (*n*) ∞P2 (*m*), ½P2 (*h*), ∞P2 (*g*), ∞P∞ (*b*), 2P∞ (*x*) Granular or disseminated. Cl brachydiagonal very prismatic ∞P distinct, macrodiagonal very imperfect. G. = 3·3 to 3·4. Opaque or translucent on thin edges. V mmons, but metallic pearly on the cleavage-planes of white copper-coloured to violet or silvery black and greyish-black, steel-green or pinchbeck-brown inclining to copp Not affected by acids. B.B. melts

Fig. 498.

less easily to a greenish-black glass, often magnetic. C.c. ally 46 to 58 silica, 0 to 1 alumina, 11 to 20 magnesia, lime, 13 to 31 iron protoxide, 0 to 6 manganese protoxide and Craig Buroch in Banffshire, Barra Hill in Aberdeenshire Island, Labrador, and Greenland. Crystals occur in s bombs at Lake Laach (*Unkel Spar*) and in meteorites of Bach. Hyper-thene rock in Norway, Eläal in Sweden, C ro, the Harz, and Canada. Chemically enstatite and pau into one mother, the essential difference is that the axial di is uniformly p- e in the former, and the opposite in the la

566. Wollastonite (*Tabular Spar*), CaSi.

Oblique prismatic, C 84° 30′. ∞P 87° 18′, oP ∞ ∞P∞ (*x*, 93° 42′), ∞P (*m*, 110° 7′), ∞P2 (*o*, more 51°), P∞ (*r*) 11 °′, 2P∞ (*z*, 69° 56′) (fig. 500). Rarely crystallized, mostly broad prismatic or lamellar. Frequently fibrous. Cl along oP and ∞P∞ perfect, but plane uneven or rough; meet at 95° 23′. H. = 4·5 to 5; G. = 2·8 to 2·9. Translucent; vitreous or pearly on cleavage. White, inclining to grey, yellow, red, or brown; steel

Fig. 500.

resces with heat or friction; gelatinizes in h. acid. B.B. ly fusible to a semitransparent glass. C.c.: 51·7 silica 3 lime, but with 0 agnesia and 0 to toxide. Glen Gair &c.,

Urquhart in Inver- ye, Banat, Finland, Vesuvius (fig. 501, mineral

Fig. 501 (n. 566)

Arendal (*Lavrovite*

Mt. Hosta.

o prismatic, C 74° 11 6, P : s 120° 48 131° 30', 21° 00' 95 ∞P, ∞P∞. In fig. 130 ∞P (*M*), ∞P∞ (*a*), ∞P∞ also various twins and hemitropes of same form (figs. 503). Almost always prismatic, imbedded, or attached; niar, columnar, and scaly. Cl. prismatic along ∞P (with

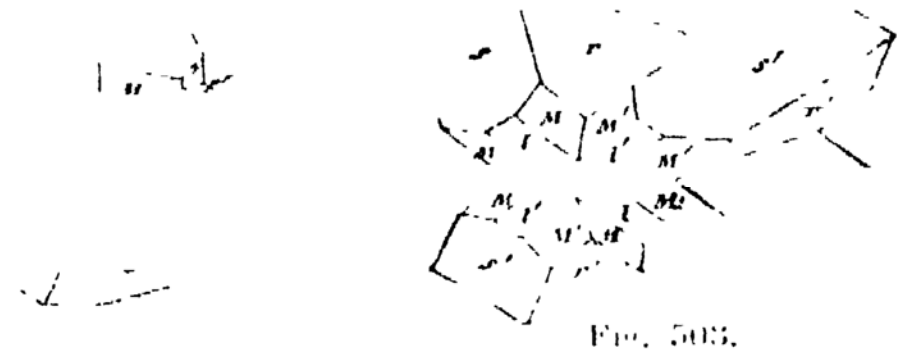


Fig. 503.

f 87° 6' and 92° 54'), generally rather imperfect, ortho- and clinodiagonal imperfect. H. 5 to 6; G. 3 to 3·5. n all degrees vitreous; in some pearly on ∞P∞. Colour- wh , b , ally gray gr , bl , erally mperfectly soluble in acids. C.c. generally as follows:

	Silica	Lime	Magnesia	Iron
nesia augite	56·22	25·51	18·24	...
nesia iron augite	52·72	21·81	8·50	14·97
augite	49·06	22·29		28·65

gives 17 to 56 silica, 20 to 25 lime, 5 to 15 magnesia, iron protoxide, with 0 to 3 manganese protoxide and 0 to 8 The diamma, chiefly found in very dark green or bla l may in some replace either silica or part of the silicate nore important varieties are

ite Greyish or greenish white, to pearl-grey or leek-green, white Crystallized or broad columnar, or concentric Transparent to translucent on the edges. Not affected B.B. fuses to a whitish semitransparent glass. C.c. y lime 26 and magnesia 18·5, with 55·5 silica Mussa Alp and Ala (*Ialite*) in Piedmont, Schwarzenstein in Tyrol, avia, Finland, Urals, and North Amer a.

olite, Sahlite White, green, rarely yellow, brown, or red, hite. Translucent, or only on vitreous, inclining to pearly crystallized, mostly columnar

Fig. 504.

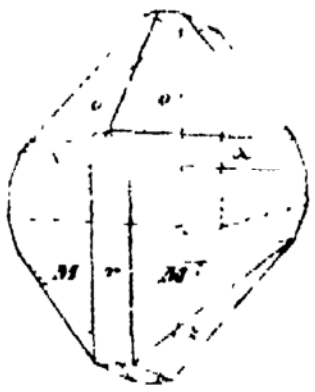


Fig. 505.

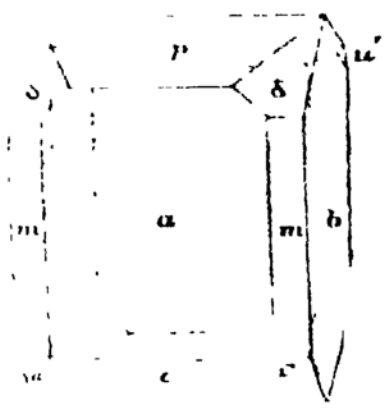


Fig. 506.

llar. B.B. melts to a green- l glass. Malacolite common in limestones in Scotland, as at s, Ledbeg (fig. 505), and Glen Fassa Valley (*Fassaite*) Piedmont, Arendal, Philipstadt in Sweden; Lake Baikal (*Baikalite*); near Lake Lherz in the P (*Lherzolite*); Sala (or Sahla) in Sweden (*Sahlite*); Shinne 504, 506), Glenelg, Tiree, in Scotland; Tyrol; North A *Coccolite* is a granular sahlite or augite.

Augite.—Leek-green, greenish black, or velvet-black brown; streak greenish grey. Vitreous to resinous; tra or opaque. Only slightly affected by acids. B.B. fuses to often magnetic glass. An essential component of many as basalt, dolerite, clinkstone, and augite porphyry; G Auvergne, Vesuvius; St Kilda, Rum, Tiree, Dalnain, and U in Scotland. Augite crystals in basalt often contain very m croscopic crystals and glasses; also pores with fluid carbo

Hudsonite.—Cleavable lamellar, and jet-black, with gree and bronzy tarnish, from the Hudson river; the most high ginous variety

Amianthus—Some asbestiform minerals are augite, greater number hornblende.

Breislakite—Fine yellowish or brown woolly crystals. V and Capo di Bove near Rome

568. Diallage, (Ca, Mg, Fe) Si.

Like augite, and only a variety with very perfect cle the clinodiagonal, which forms with a second cleavage an 87°. Lustre metallic pearly; colour grey or pinchbeck H. = 4; G. = 3·23 B.B. melts easily to a greyish or enamel. C.c. 50 to 53 silica, 1 to 5 alumina, 15 to 23 m 11 to 20 lime, and 5 to 20 manganese protoxide. Consti the augite rock of the Cuchullins in Skye and of the gabbro and Ayrshire. Baste in the Harz, Silesia, the Alps, Ap and Urals. *Vanadine Bronzite*, containing soda and vana is similar. At Craig Buroch (Banffshire) diallage passes in

569. Jeffersonite

Oblique prismatic. Cl. prismatic ∞P' 87° 30', and orthod H. = 4·5, G. = 3·3 to 3·5. Dark olive-green, brown to black greasy. A manganese and zinc augite, with 10·2 prot manganese, and 10·15 oxide of zinc. Sparta in New Jerse

570. Acmite, $2Fe\dot{S}i_2 + 3R\dot{S}i$.

Oblique prismatic. Crystals long often acute-pointed ∞P 87° 15', ∞P∞ (*x*), P(*s*), 6P (*o*), $6P^c3$(*z*) (figs. 507, 50 like augite. H. 6 to 6·5, G. = 3·4 to 3·6. Nearly opaque; vitreous. Brownish or greenish black, streak greenish grey. Imperfectly soluble in acids. B.B. fuses easily to a black magnetic glass. C.c. 52 silica, 30 iron peroxide, 5 iron protoxide, and 13 soda, but with 1 to 3 manganese peroxide, and also 3 to 4 titanic acid. Eger and Porsgrund in Norway.

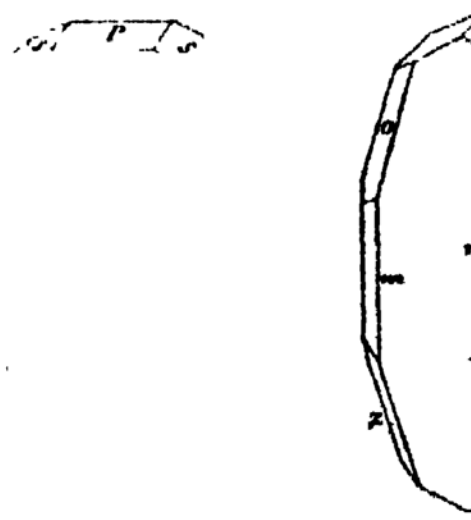


Fig. 507. (Sp. 570.)

571. Ægerine, $R_2Si_3 + R\dot{S}i + 2Na\dot{S}i$

Oblique prismatic: striated or reed like prisms of 86 feet, less distinct clinodiagonal, and prismatic. H. = 5 G. = 3·4 to 3·5 or 3·6. Vitreous, translucent on edges, or Greenish black. B.B. fuses easily, colouring the flame Scarcely affected by acids. C.c.: 49 silica, 31·7 iron 6·6 iron (and manganese) protoxide, and 12·7 soda, wit magnesia and potash. Has the same relation to augite a sonite to hornblende. Near Brevig and Barkevig in Norw

572. Spodumene, $4\dot{A}l\dot{S}i_2 + 3(\dot{L}i, \dot{N}a, \dot{K})\dot{S}i$.

Oblique prismatic, C 69° 40' ∞P 87° (fig. 509). Cl. prism and orthodiagonal, perfect, chiefly massive or foliated. H. = 6·5 to 7; G. = 3·1 to 3·2. Translucent; vitreous or pearly. Pale greenish grey or white to apple-green; streak white. B.B. intumesces slightly, tinging the flame momentarily purplish red, and fuses easily to a colourless glass. Not affected by acids. C.c.: 65 silica, 28·7 alumina, and 6·3 lithia. Killiney near Dublin, Uto in Sweden, Tyrol. *Killinite* (sp. 651), from Killiney, seems to be decomposed spodumene.

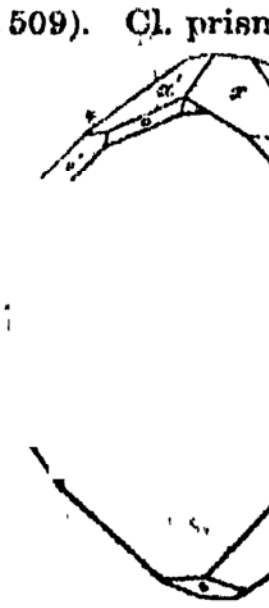


Fig. 509 (sp.

573. Petalite (*Castor*), $4\dot{A}l\dot{S}i_6 + 3(\dot{L}i, Na)\dot{S}i$.

Oblique prismatic. Castor has C 67° 34' and ∞P 86° 20', in irregular rect- angular prisms, petalite being massive and coarse granular. C basal, distinct; in a second

at 141½°) less so. H. = 6·5; G. = 2·4 to 2·5. Greenish, or reddish white to pale red. Translucent; vitreous or B.B. melts easily into a porous obscure glass, colouring red. Not affected by acids. C.c.: 78·3 silica, 17·4 alu- 2 lithia, and 1·1 soda. Utö, Bolton in Massachusetts, Canada. *Castor* in Elba. *Milarite*, valley of Milar, nd.

RHODONITE (*Manganese-Spar*), $\dot{M}n\ddot{S}i$.

ic. $\infty\breve{P}\infty$ (*a*); $\infty P\infty$ (*b*); 0P (*c*); $\infty\breve{P}'$ (*u*); $\breve{P}'\infty$ (*k*); $\breve{P}\infty$ (*s*), $m'\breve{P}'\infty$ (*l*); *a* : *b* 111° 9′; *c* : *a* 93° 28′, *n* : *a* 106° 19′; but assive or granular. and 0P, meeting 8′, perfect; brittle. 5·5; G. = 3·5 to nsluecent; vitreous ly pearly. Dark bluish red, or red- own. Not affected s. B.B. fusible ·8 silica and 54·2 se protoxide, with ne and 0 to 6 iron protoxide. St Marcel, La burg, the Harz, and New Jersey. *Rodonite* or reddish grey, with 14 lime, Mexico; *Fowlerite* ith 7 to 11 iron protoxide; and *Pajsbergite*, Swed *Hydropite*, *Photicite*, *Allagite*, and *Horse-flesh* mixtures.

Fig. 510.

SABINGTONITE, $2(Ca, Fe, Mn)\dot{S}i + Fe\ddot{S}i_3$

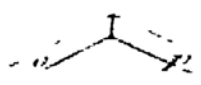
ic. Crystals very low eight-sided prisms, small, at 24′; *c* : *a* 87° 27′; *a* : *b* 112° *d* 81° 8′; *c* : *d* 150° 10′ (fig. l. basal (*c*), very perfect; also H. = 5·5 to 6, G. 3·3 to n lamina translucent. Splen reous; black. Not affected by B.B. fuses easily with effervesc- a black magnetic bead. C.c.: a, 11 iron peroxide, 10·3 iron e, 7·7 manganese protoxide, 3 lime, in the Arendal speci- one from Nassau gave about roxide, with protoxides only 11 (Banffshire), Arendal, Nassau and Gouverneur (New

Fig. 511

Tongue (Sutherland)

SZABOITE, $11Fe\ddot{S}i_3 + 2Ca\ddot{S}i$.

nic. $\infty\breve{P}'$ (*l*); $\infty'P$ (*m*) 88° 40′; $\infty\breve{P}\infty$ (*n*); $\infty\breve{P}\infty$ (*a*); $\breve{P}'$ (*p*); $\breve{P}\infty$ (*y*); $2\breve{P}'\infty$ (*x*) (fig. 512). H. = 3·5. Brownish red to reddish Pleochroic. C.c.: silica 52·4, pro iron 44·7, lime 3·1. Slightly sol d, more so in h. acid. Calvario on ont Dore.



ANTHOPHYLLITE, $3Mg\ddot{S}i + Fe\ddot{S}i$.

prismatic. ∞P 124° 30′. Cl. agonal, perfect. Clove-brown to brown and leek-green. Trans radiating and foliated. Pearly on . H. = 5·5; G. 3·2. C.c.: silica toxide of iron 16·7, magnesia 27·8 B.B. very difficultly Hillswick, Shetland; Kongsberg and Modum, Norway; nd, and the United States.

HORNBLENDE.

e prismatic (figs. 513 to 517; see also fig. 193). Distinct in several directions. H. = 4 to 6, but generally 5 (will with knife); G. = 2·5 to 4·0, but mostly high. Mostly . Lustre vitreous, in some silky or metallic pearly. Sol very readily, in acids; more or less easily fusible. C.c. us silicates and aluminates of lime, magnesia, iron pro- more sparingly of soda, yttria, and manganese protoxide. ef species form by their decomposition highly fertile

Hornblende.—Oblique prismatic, C 75° 10′. ∞P 124° 30′, P . The crystals short and thick, or long and thin prismatic; especially by ∞P (*m*), $\infty P'\infty$ (*x*), and bounded on the iefly by 0P (*p*) and P (*r*). Twins common, with the s the twin axis. Very often radiated, fibrous, or columnar, ular. Cl. prismatic along ∞P 124°, very perfect; agonal and clinodiagonal very imperfect. H. = 5 to 6, te 3·4. Pellucid in all degrees: vitreous, but sometimes r silky. Colourless or white, but usually some shade of grey, green, brown, or black. B.B. fuses, generally intumescing ling, to a grey, green, or black glass. Those containing most iron are most fusible, and are also partially sol. in which scarcely affects the others. C.c. very variable; th is partly replaced by alumina, specially in the green o varieties; RO is chiefly MgO, CaO, and FeO. Lime is th

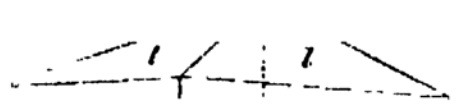


Fig. 513.

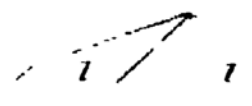


Fig. 514

constant element, m most from 10 to 12; magnesia and iron p replace each other, the one increasing as the other dim With 4Si and R = 2Mg + 1Ca + 1Fe, the average composition thea, 17·8 magnesia, 12·5 lime, and 16·1 iron protoxi

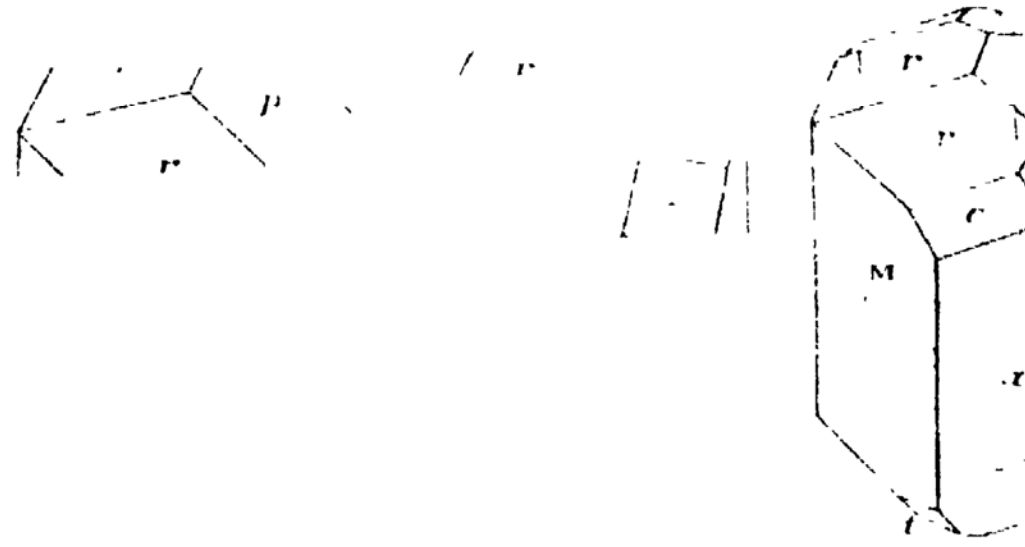


Fig. 515

Fig. 516.

Fig. 517

analyses give 40 to 60 silica, 0 to 17 alumina, 0 to 30 m 10 to 13 lime, 0 to 36 iron protoxide (or peroxide), and manganese protoxide, 0 to 8 soda, 0 to 3 potash, and fluorine with a little water.

The more important varieties are—

Amianthus, *Asbestos*, and *Byssolite*, $2M_2\ddot{S}i + Ca\ddot{S}i$. Fine White, grey, or green. The fibres often easily separable, and flexible. Unst, Shimness, Portsoy, Savoy, Tyrol, Cors

Tremolite, *Grammatite*, $3Mg\ddot{S}i + Ca\ddot{S}i$, with 58·35 silica magnesia, and 13·26 lime. White, grey, green in long p crystals, often striated longitudinally. Pearly or silky transparent or translucent. B.B. fuses easily to a white colourless gla- Loch Shin (Sutherland), Glen Elt, Tyree, Cornwall, Cumberland, Sweden, the Alps, Pyrenees, Siberia, North America.

Nephrite or *Jade*, tough, compact, fine-grained tremol H. = 6 to 6·5, G. = 2·9 to 3·1. Fracture close splintery tenacious. Translucent, dull to vitreous. Leek-green to green. Feels slightly greasy. Formerly made into ring amulets, idols, and war-clubs. New Zealand, China, Mexi Balta (Shetland).

Actinolite, *Asbestus*, or *Strahlstein* (Ca, Mg, Fe) Si green, inclining to black, grey, or brown. Translucent out, or only on the edge. Long prismatic crystals, or columnar masses. B.B. melts to a greenish or blackish Fetlar (Shetland), Colabera and Hillswick (Shetland), Orom Ben (Inverness), Sweden, Tyrol, North America.

Hornblende $nCaSi + R_2Si_3$. Green or black, seldomer grey. G. = 3·1 to 3·4. B.B. fuses rather easily to greenish, or black coloured. Three varieties are distinguish The noble or *Pargasite*, pale celadon- or olive-green, an pearly or vitreous lustre, at Pargas in Finland, Tyree in S Common hornblende, dark leek or blackish green, weak greenish grey. A constituent of many rocks, as in the Alps, and Scottish Highlands (Ballater, Ben Arthu bucket, Colaforbe). (*c*) Basaltic, foliated, with bright even opaque, velvet-black, streak grey or brown. Generally alumina (9 to 15) and much (5 to 11) iron peroxide. In b volcanic rocks. Etna, Vesuvius, Rhineland, Bohemia.

ARVEDSONITE $Ca_2Fe_5Si_8O_{24}$

e prismatic ∞P, ∞P∞; P, 91° 2′ 120° 21′, 91° Cl. ∞P perfect, also oP. Massive. Black, opaque. Vitreous ; 3·44. C: chrome 1·3, alumina 1·5, peroxide of iron oxide 31·1, protoxide of iron 37·0, soda 5·0. Streak dark bluish-grey. ; powder in the flame of a candle B.B. intu- readily to a black magnetic globule. Not sol. ; Brevik in Greenland, Frederiksvarn, Arendal, ; ;

; $4MgSi_2O_6 \cdot Al_2Si_2O_6 \cdot 15H_2O$

ite fibrous, more or less dense. Cream-yellow to ; tenacity tough; absorbs water like a sponge ; ; texture varies considerably, and to trivial names as mountain paper, mountain ; leather, rock cork, &c. *Mountain Paper* occurs in ; Boyne Castle mine Banff, *Mountain Leather*, Burn ; Glenelg), Tod Head (Kincardineshire), Leadhills, ; *Rock Cork*, Portsoy and Boyne Castle ; ; and ; ; ther 31·0, alumina 5·0, ferrous oxide 2·88, ; 10·5, water 23·5.

; $(Ca,Fe,Na_2,M)_3Si_4O_{11}$.

; easily separable, but tough fibres; cl. ; 3. Translucent, silky. Indigo-blue, ; easily to a black magnetic glass. C: ; 33, magnesia 2·2, soda 6·7, water 2·0 ; averages Greenland. Ashburton yellow mineral from Orange river, ; ; has been referred here, its fibres are not separable. ; ; *Varvacite* of ; a very similar mineral of blue ; ; near Inverness.

; $Ca_3Al_2Si_3O_{12}$.

; prismatic. Cl. prismatic, perfect, fracture conchoidal ; G. 3·4. Translucent, vitreous to pearly. Indigo- ; ; blush-black. B.B. become brown, but are easily ; ; ; C: silica 36·6, alumina 12·2, protoxide ; , magnesia 3·8, soda 9·3. Island of Syra.

; $MnSiO_3$.

; and arborescent. Rose-red. G. 3·4. C: protoxide ; ; 45·7, silica 48·9, lime 2, magnesia 2·4. Cummington ; ; Huntsville.

; FeSi.

; form. G. 6·7. Brown, alkaline. C: protoxide of ; , silica 46·6. Middle Mountain (Vat

; ; *Chrysolite*, *Olivenite*, $Al_2Si_2O_7$, $Al_2Mg_2Fe_2Si_3$

; prismatic, ∞P, *P* 119° 10′, middle edge of P 96° 06′ ; P (*P*), ∞P2 (*g*), 0P (*c*); and this with ∞P2 (*l*), ; P2 (*n*), and 3P3 (*s*), fig. 515), short prismatic. Cl. ; distinct, traces also P∞; fracture conchoidal or uneven. ; 2·5, G. 2·5 to 2·7. Trans- ; ; translucent, vitreous, inclining ; ; Colourless, but chiefly dark ; violet-green, brown, yellow, and ; often with distinct trichroism, on ; , on ∞P∞ grey, and on 2P∞ yel- ; B.B. fuses difficultly to a clear ; ; lightly affected by acids. C: 18 ; ; ; 29 to 32, alumina 8 to 15, magnesia ; , iron protoxide. Cause the Green ; Tyrol, Odenwald (*Vesuvian*), Ortelsburg in ; (*Ala*), Norway, Sweden, ; North America, and Siberia. ; ; Crystals of an intense blue colour ; ; ; , found in Ceylon, are the ; *Sapphire*, the *Oriental Emerald*, and the ; ; ; ; considered cordierite ; ; ; ;

l most mineralogists now take a similar view, regarding se, albite, and anorthite alone as true species, of which the e mixtures. Those consisting essentially of potash and soda mechanical mixtures of orthoclase and albite, the distinct being visible by the microscope; those again that contain ly lime and soda together are, sometimes at least, chemical, omorphous compounds of albite and anorthite in various ons, and with corresponding transitions in crystallographic sical properties. Notwithstanding this, these intermediate regarded as independent mineral species, ina much as they cally typical of certain rocks, and have characteristic forms from each other in angular inclination.

Orthoclase, $\dot{A}l\ddot{S}i_3 + K\ddot{S}i_3$

ne prismatic, $C = 63° 57'$. ∞P (T and l $118° 47'$ $P\infty$ $21° 7'$ (n) $90° 11'$; $21°\infty$ (y) $35° 45'$. The common forms are ∞P, oP, $P\infty$ and $\infty P\infty$ (M), ∞P, oP, P figs. 520 to 527). When ∞P predominates the crystals

Fig. 520.

Fig. 521

Fig. 522.

Fig. 523.

t rhombic prisms; $\infty P\infty$ predominates e tabular; when d $\infty P\infty$ predomiy are short hexaprismatic, when oP $P\infty$ they are rectprismatic, often engthened. Twins ry frequent, and according primarily ar laws. *First*, revolution of one half or of a whole crystal, then forming etrating twins round a vertical axis (fig. 524). In the case hemitropic revolution one of the external faces becomes a union. According as the right or the left half or whole is conceived to be that which has been revolved the crystals ed right and left, as in figs. 183, 189. *Second*, by revolution half around an axis normal to M; in such twins the com is not evidenced externally except by sutures. *Third*,

Fig. 528.

Fig. 529.

Fig. 530.

h revolution round an axis normal to P, forming orthorhombic which show a herring-bone lineation, through the meeting of ommonly present upon the face M parallel to the intersection dge with the face T (fig. 528). *Fourth*, by revolution round normal to $21°\infty$ (n); this also forms a prism the section of is nearly square (fig 529). Compound twins on this last e formed of 3 to 4 and 8 crystals (fig. 530).

rs also massive, and coarse or fine granular. Cl. basal (P), erfect; clinodiagonal (M), perfect ($P : M = 90°$); fracture idal or splintery. H. = 6; G. = 2·53 to 2·58. Transparent slucent on the edges; vitreous but pearly on cl.; and also ent, with bluish or changing colours. Occasionally colourt generally red, yellow, grey, or green. B.B. fuses with difficulty to an opaque vesicular glass. Not affected by acids. 64·6 silica, 18·5 alumina and 16·9 potash, but generally 1 potash, 1 to 4 soda, 0 to 1·3 lime, 0 to 2 iron peroxide. V are:—

(1) *Adularia* and *Ice spar*, transparent or translucent, spl and almost colourless. Some with bluish opalescence are *Moonstone*: St Gotthard, Mont Blanc, Dauphiné, Arendal, land, and Ceylon.

(2) *Common Felspar*, generally white or red, especially fl is a common constituent of many rocks. Crystals at Ba Lago Maggiore, Pommitz in Silesia, Monzoni Mountains and low in Ireland, Aberdeenshire (at Rubislaw 6 or 8 inches Scotland and at Carlsbad and Elnbogen in Bohemia. *Sunstone*, verdelite-green, from Sutherland, L. Le Huron, and C and *Murchisonite* golden or greyish yellow, from Arran and I are varieties.

(3) The *Glassy Felspar* or *Sanidine* ($C = 64° 4'$, ∞P 119° tains 3 to 12 potash and 3 to 10 soda. Crystals and vitreous, transparent, and often much cracked, Arran, Ea other parts of Scotland, Drachenfels, Auvergne, and other co

Orthoclase occurs in granite, gneiss, and porphyry m country. It is commonly associated with quartz, sometim in the *Granite Gneiss* of Sutherland. Hurlet, and Port letter like combination of the latter. It is very liable to d position, when it is converted chiefly into Kaolin, a manufacturing porcelain and stoneware. The adularia or stone and the green amazon-stone are cut as ornamental *Leaks*, from Baldoran near Banff in Aberdeenshire and Grythy Sweden, is a somewhat obscurely banded variety of the bluish-coloured pearl variety. *Perthite* and *Hoganite* are similar but more *Microcline* is a variety with angle distorted by interstitial p tion, by oligoclase Sutherland, and by albite Frederiksvar

590. Albite, $AlSi_3 + NaSi$.

Anorthic. oP (P), $\infty P'$ (M) $86° 24'$, ∞P (T), ∞P (l) but angles variable. Crystals, generally like those of or are tabular or prismatic (fig. 197). Hemitropes common, united by a face of $\infty P\infty$ (figs. 531, 532) the re-entering a

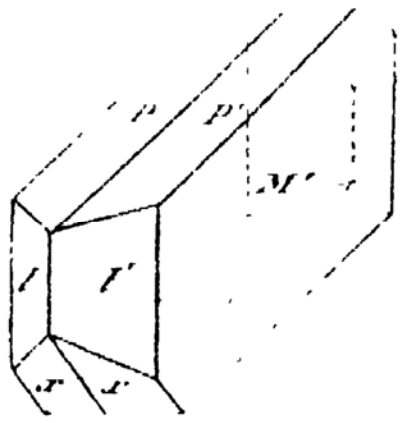


Fig. 531

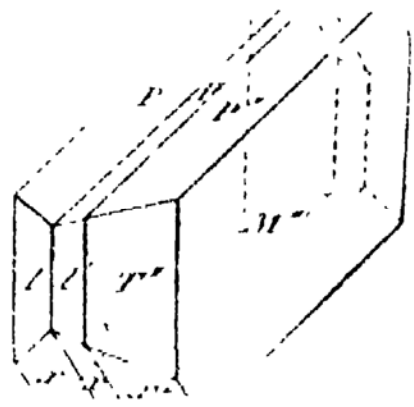


Fig. 532

tween the faces of oP (P and P') $17°$. Is hence very charac Fig. 19 is another common hemitrope. Massive, and r ing plates. Cl. basal and brachydiagonal, distinct; fracture conchoidal or uneven. H. = 6 to 6·5. G. = 2·6 Rarely transparent, vitreous, pearly on the cl. Colourless, generally white, grey, red, or yellow, rarely white

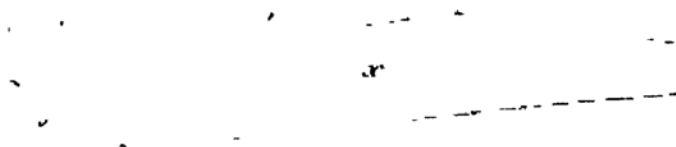


Fig. 533

difficultly fusible, tinging the flame yellow, to a white semi-opaque glass. Not affected by acids. 68·6 silica, 19·6 alumina with 0·1 to 1 iron peroxide, and 11 soda with 0·3 to 1 lime, 0 to 2·5 potash. Hence albite and orthoclase both soda and potash only in different proportions. Albite easily recognized by its frequent re-entering angles, its fusibility, and the obliquity ($86° 30'$) of its cleavage planes, often with striæ. *Peristerite* is a variety of which fig. 533 is a form.

Albite is a constituent of many "green stones," as at Corstorphine, Edinburgh, and of granite, syenite, gneiss, porphyry, and t Crystallized at Minnock's Cairn, Aberdeen, to form the felspar of the red granite of Scotland. Dauphiné, St G Tyrol, Salzburg, and Arendal.

Albite is a compact variety, similar in appearance to *J*

591. Anorthite, $AlSi + CaSi$.

Anorthic. oP (P) : $\infty P'$ (M) $85° 50'$, $\infty P'$ (l), ∞P $30'$. Hemitropes common on both M and l. Angle between l and l' $180° 24'$. Cl. basal and brachydiagonal, perfect

to 2·78 Transparent or translucent; vitreous. Colourless or B.B. fuses to a clear glass; soluble without gelatinizing in acid. C.c.: 43 silica, 36·9 alumina, 20·1 lime, sometimes

Fig. 534.

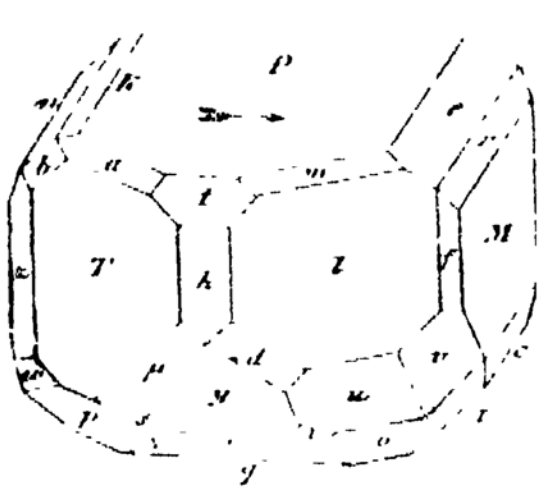


Fig. 535.

...gioclase and soda. Fetlar in Shetland; Londalloot in Ayr-...gabbros, Monte Somma, Iceland, Java. *Lepolite* and *Dau-*...are varieties. In *Latrobite* the greater part of the lime i... by potash. Glen Garn and Labrador. At both localities

Oligoclase, $2AlSi_4+(Na, Ca)_3Si_3$

...ine oP : ∞P : ∞P 86° 10′, oP : P 111°, oP : ∞P 113° ...with $g : g'$ 173° 1′, $l : l$ 120° 36′, $y : y$ 179° 9′, $x : x$ 145° 59′ ..., perfect; brachydiagonal, less so. H. = 6, G. = 2·62 to 2·84 ..., in mass on the cl. White with a tinge of green, grey, ... B.B. melts easier than orthoclase or albite to a clear glass; ...ted by acids. C.c.: 63 silica, 23·4 alumina, 8·4 soda, and ...; thus nearly 3 albite and 1 anorthite. Distinguished ...by twinning striæ on the faces, less readily from ...but more fusible and G. higher. The common associate of ...se in the Scotch grey granites, especially in vein granite, as ...ond and Ben Loyal (figs. 536, 537) in Sutherland, and at

Fig. 536.

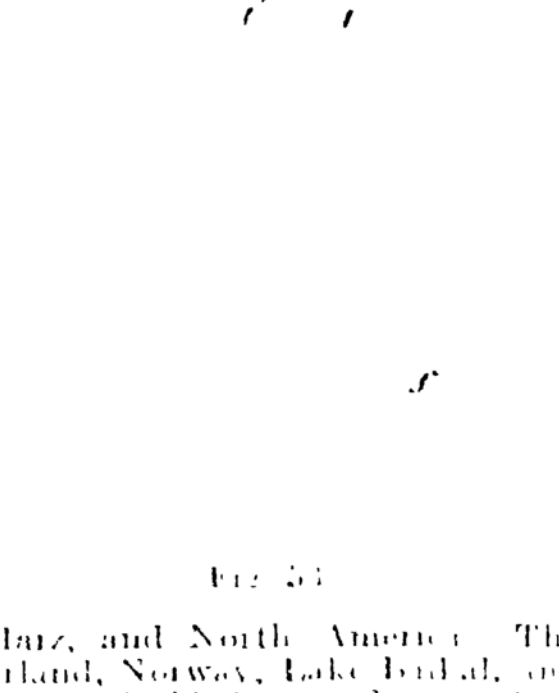


Fig. 537.

...w Scammaven, Urals, Harz, and North America. The ... from Fossaven in Sutherland, Norway, Lake Ladoga, and ...with a play of colour due to imbedded crystals of colour... white, belong to this species.

Labradorite, $AlSi_4+Ca, NaSi$.

...al ... P : ∞P ... 86° 10′, oP : ∞P 111°, oP : ∞P 113° ... ∞P ... ∞P 129° ... ∞P 117° ... type ... according to the first la... , that is, vertical revolution and face of ... and one half with reunion on the face ∞P∞,

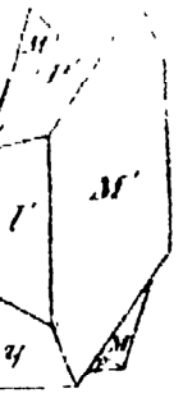


Fig. 538.

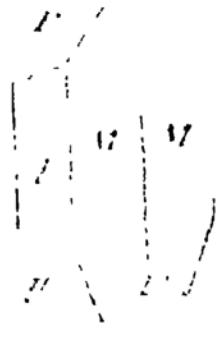


Fig. 539.

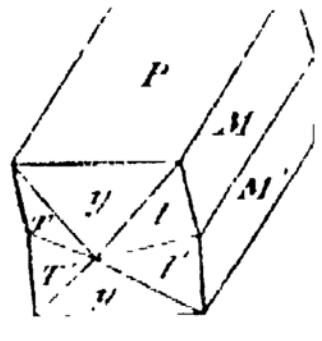


Fig. 540.

...g. 539; (3) with twin face P, as in fig. 540. Hemitropes of ...form also occur in which the lower half consists of a hemi-...rmed according to the second method. Crystals imbedded in rocks consist generally of repeated twins affording an ... 173° 20′. Cl. basal, perfect, brachydiagonal, less so; both ... striated on account of the above twinning. H. = 6; G. = 2·68 ... Translucent; vitreous, on the cl. resinous. Grey, passing into green, yellow, or red. The faces of ∞P∞ often exhibit very ...ful changing colours—blue, green, yellow, red, or brown—...times bands intersecting at certain angles. B.B. fuses more ...than orthoclase to a compact colourless glass. Sol. in h. acid. ...52·9 silica, 30·3 alumina, 12·3 lime, and 4·5 soda. It is t... albite and 3 anorthite. Common constituent of dolerite, ... and hypersthene rocks. In Scotland, Labrador, Finland, ...Tyrol; also at Etna and Vesuvius.

Anorthite, $AlSi_4+(Na, Ca)Si$.

Anorthite. Crystals similar to albite and anorthite. Tw... *M*. Crystals generally formed of repeated plates. G. = 2·67 ... Physical properties like albite; more easily fusible to a porou... glass. In acid sometimes dissolves out alternate lamine of c... C.c.: 59·7 silica, 25·6 alumina, 7·7 soda, and 7 lime, and thus ... 1 of albite and 1 anorthite. Typical of the primary lim... and a granite belt thereon in Scotland, as at Shinness, Ur... Dalnain, &c. In the Andes, the Vosges, and Iceland.

Hyalophane, $AlSi_4, KSi_4+AlSi, BaSi_2$.

Oblique prismatic, resembles orthoclase; crystals and ... nearly the same. Cl. oP, perfect. H. = 6 to 6·5; G. = 2·8 ... Transparent. Lustre vitreous. Colourless, white, and fle... C.c.: silica 52·7, alumina 21, baryta 15·1, potash 7·8, so... B.B. difficultly fusible to a blebby glass, not acted upon by ... Binnen in Valais, Jakobsberg in Sweden.

Barsowite, $AlSi+CaSi$.

Right prismatic, or oblique prismatic. H. = 5·5 to 6; G. ... Snow-white, translucent. Fracture granular. Pearly. C.c.: ...42·2, alumina 36·4, lime 19·8. Gelatinizes in h. acid, dif... fusible. A dimorphic form of anorthite. Barsovskoi in the

Saussurite.

A massive, granular, translucent, white or pale green fel... mineral of the nature of anorthite mixed with labradorite. H. ... 7; G. = 3·26 to 3·4. Probably a mixture. Occurs in loose bloc... Geneva, and in Corsica. In China and in India is carved un... name of Oriental jade (nephrite). Seems to be confound... with zoisite, and perhaps with vesuvian (prehnite). *Jadeite* is sim...

Zeolite Group.

The... crystallize in all the systems except the anorthic, and ... ...lves present great variety of development. Mostly hyal... white, rarely red, grey, or yellow. Cl. generally distinc... yield water in closed tube; all fusible B.B. most easily, an... intumescing, all sol. in acids, and mostly gelatinize or ... silica. They are hydrated silicates of alkalies, or alkaline ... mostly with silicates of alumina, but rarely contain ma... Some mineralogists regard the water as basic, in union with ... and Kenngott gives the formula in that form, thus:—

Analcime, $(NaAl)Si_2+2(H, Si)$,

Natrolite, $(NaAl)Si+2(H, Si)$,

Stilbite, Ca, Al_2+6H, Si_4,

and the others similar. They are generally found in amygd... cavities or fissures of trap or plutonic rocks, apparently as d... from water percolating into them, and are thus probably p... of decomposing nepheline or felspars, or hydrated felspars ... solve. They never form constituents of rocks. Na... -olite, thomsonite, and the connected varieties are mar... stilbite and heulandite b...

broad f...

Prehnite, $4CaSi+NaSi_2+H$.

Oblique p... ...P∞ (*e*); 0P (*u*) 95° 23′

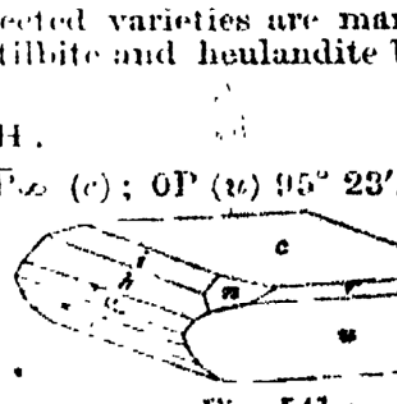


Fig. 541.

...l... Tw... ... chiefly spher... and radiating fibrous. H. = 5; ... G. = 2·74 to 2·88. Translucent; ... crystals pearly. Fibres silky. Pale ... green to yellowish white. Sol. in ... h. acid leaving silica. C.c.: 54·2 ... silica, 33·7 lime, 9·4 soda, and ... 2·7 water. Ratho Corstorphine, Castle Rock, and Arthur ... Edinburgh, Kilsyth, Stirling; Knockdolian and Lendalfoo... shire, Skye, Monte Baldo; Monzoni Valley in Tyrol.

Wollastonite, $4CaSi+MgSi=NaSi_2+2H$.

Like pectolite, but columnar. H. = 4·5; G. = 2·7. Flesh-c... Lustre pearly to greasy. C.c.: silica 53·7, lime 28·6, m... 5·1, soda 7·9, water 4·6. Corstorphine Hill, Burntisland.

Xonotlite, $4CaSi+H$.

Massive. H. = 6; G. = 2·6 to 2·7. Pink, white, and grey.

conchoidal and splintery. C.c.: silica 49·8, lime 43·5, de of manganese 2·3, protoxide of iron 2·9, water 3·7. hen and Torosay (Mull), Xonotla (Mexico).

TOBERMORITE, $3(Ca_4, H)\dot{S}i_5 + 2\frac{1}{2}\dot{H}$.

ive, fine granular; translucent; fracture hackly. H. ·5; . Pale pink. C.c.: silica 49·8, lime 37·2, water 12·9. ory (Mull), Dunvegan (Skye).

OKENITE, $Ca\dot{H}Si_2 + \dot{H}$.

t prismatic. ∞P 122° 19′. Usually fine fibrous; radiating; G. = 2·28 to 2·36. Pellucid; slightly pearly. Yellowish sh white. In powder easily sol. in h. acid, leaving ous flakes after ignition. C.c.: 56·6 silica, 28·1 lime, and er; an apophyllite without the fluorine. Disco Island, and Iceland.

APOPHYLLITE, $8(CaSi + 2\dot{H}) + KF$.

nidal. P 120° 56′. P, $\infty P\infty$ (*m*), 0P (*c*), $\infty P2$ (*r*). lamellar. Cl. *c*, perfect. Brittle. H. 4·5 to 5; 3 to 3·4. Transparent; vitreous. On *c* pearly (*Ichthyophthalite*). Colourless, rarely pink, green, red, brown, and yellow. cfoliates, intumesces, and melts to white enamel. Sol. in , leaving silica. C.c.: silica 50·3, lime 24·7, water 15·9,

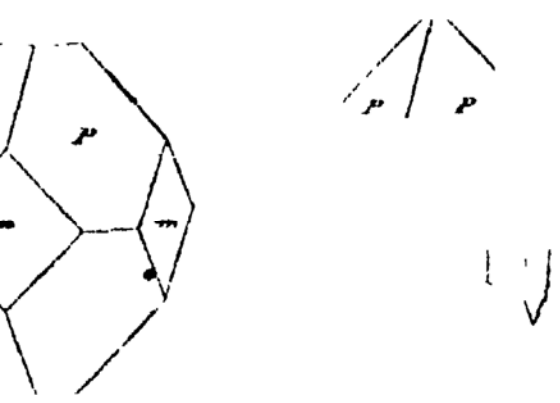


Fig. 542.

543.

Fig.

um 4·3, fluorine 2·1. Dunvegan and Storr, Skye (fig. 544), , Fife; Corstorphine (fig. 542) and Ratho, near Edinburgh, a, Bowling, Kilpatrick; Port Rush, Ireland. In the form 79), grass-green at Oxhaven, Iceland (*Okenite*), Uto, n; Andreasberg and Faroes (pink), Faroes, and Poonah in green). Internal structure tesselated, being built up of wedge ticular forms with varying refractive indices, hence exhibit- eautiful structure with polarized light.

GISMONDITE, $(\frac{1}{2}Ca + \frac{1}{3}\dot{H})\dot{S}i + \dot{H}$.

llar, radiate, spherical, and investing. H. 3 to 4. Pearly white to cream-coloured. Transparent, rapidly becoming . C.c.: silica 53·3, lime 32·9, water 13·8. Quiraing, e, and Storr, Skye; Loch Scredden and Carsaig, Mull, Canna; nt, Niakornak, and Disco; Faroes, Nova Scotia.

ANALCIME, $\dot{A}l\dot{S}i_2 + \dot{N}a\dot{S}i + 2\dot{H}$.

e. $\infty O\infty$; 202. Fracture uneven. H. 5·5; G. 2·1 to 2·28. less, white, flesh red, scar- itreous; transparent. B.B. without frothing to a clear ar glass. Decomposable gelatinization in h. acid. 54·5 silica, 23·3 alumina, oda, 8·2 water. Walls, ; Talisker, Skye; Sanda, abrides generally. Trans- at Eigg, and Elie, Fife; at Bowdens, Kincardine; white at Glen Farg, ary Crags, and Dumbarton; s Causeway, Seisser Alp in Cyclopean Islands (fig. 545), Faroes, Iceland, and Nova *Eudnophite* is a variety. Petto . 598) occurs pseudomorphous after ne, in large crystals of *a*, *n*, at Edinburghshire.

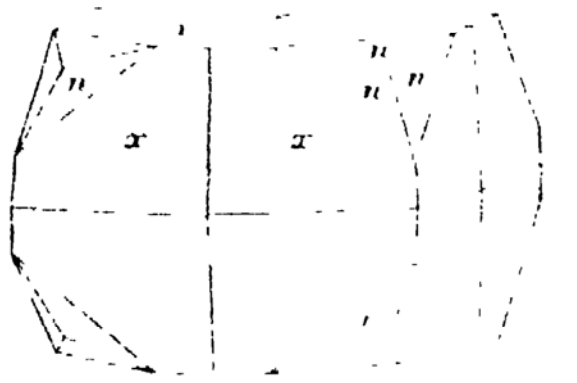


Fig. 546 (sp. 606).

POLLUX, $3(\dot{A}l\dot{S}i_2 + (\dot{C}s_{\frac{3}{4}}, \dot{N}a_{\frac{1}{4}})\dot{S}i) +$

ic. $\infty O\infty$; 202 (fig. 546). Also e. Gum-like externally. Brittle, races of cleavage. Fracture con- l. H. = 5·5 to 6·5; G. = 2·86 to Colourless. Vitreous. Sol. in n. C.c.: silica 44, alumina 16, oxide ium 34, soda 2·5, water 2·4. Elba. The only mineral which as cæsium in quantity.

607. FAUJASITE, $2\dot{A}l\dot{S}i_3 + (Ca\dot{N}a)_2\dot{S}i_3 + 18\dot{H}$.

Cubic; in octahedrons with the icositetrahedron $\frac{4}{3}O\frac{4}{3}$. Fr uneven; brittle. H. = 7; G. = 1·92. Transparent; vitreo adamantine. White to brown. Sol. in h. acid. C.c.: 46·8 16 alumina, 4·4 lime, 4·8 soda, 28 water. Kaiserstuhl in Annerod near Giessen, Eisenach, Marburg.

608. CHABASITE (*Lime Chabasite*), $\dot{A}l\dot{S}i_3 + Ca\dot{S}i + 6\dot{H}$.

Rhombohedral, R 94° 46′. $\frac{1}{2}R\frac{1}{2}$; $\frac{1}{2}R$ (*r*); - 2R (*e*); ∞ Twins very common (generally intersecting), on faces ∞

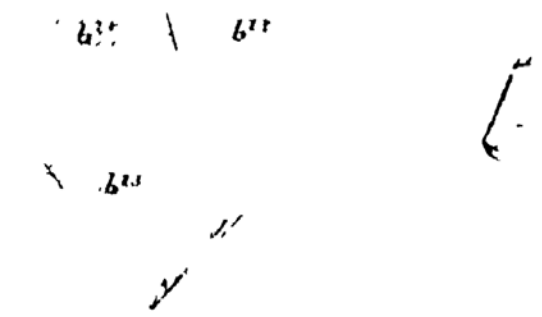


Fig. 547.

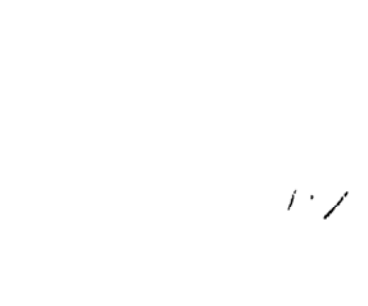


Fig. 548.

Fig. Primary rhombohedron is sometimes twinned with a with faces *e*, *e*, . Cl. *r* perfect. H. 4 to 4·5. G. 2·1 Transparent or translucent; vitreous. Colourless, and bro

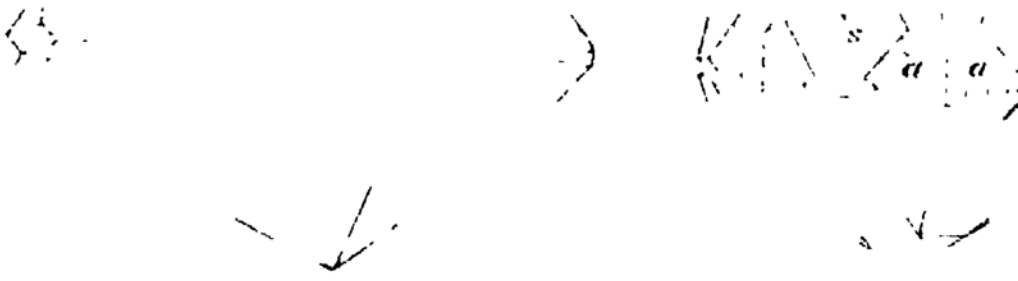


Fig. 549.

Fig. 550.

yellowish, brick-, and flesh-red. Sol. in h. acid, leaving C.c.: silica 47·8, alumina 20·8, lime 10·7, water 21·3. L (figs. 547, 548, 549), Talisker (figs. 176, 550, sometimes

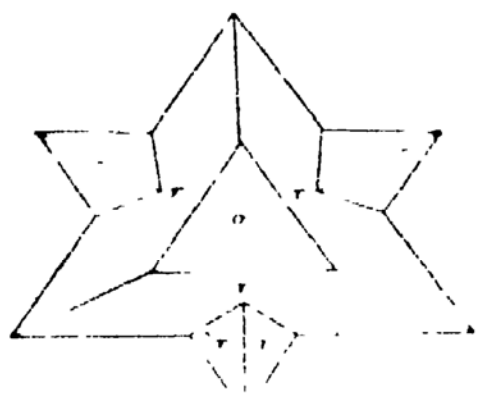


Fig. 551.

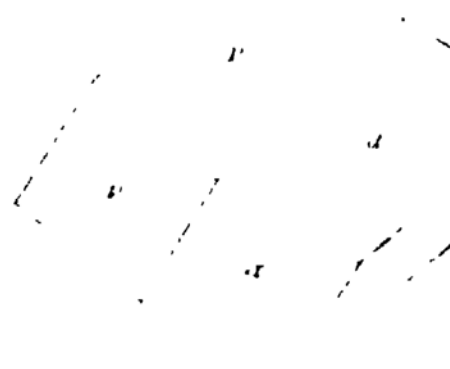


Fig. 552

colour), and Storr, Skye (figs. 547, 548), Port Glasgow ar malcolmite and brown), Grant's Causeway and Mageo (red), Faroes, Iceland, Aussig, Andreasberg (fig. 551). *Herschelite* in twinned rhombohedra, with f = 95 to 97 and p = 150 to 160 (antrum, fig. 552), from Faroe and Maryland, is similar. *Phacolite* is chabasite in twins of $\infty P2$, $\frac{1}{2}P2$, R, $\frac{1}{2}R$ at the Giant's Causeway (fig. 554). At Richmond in Victoria they occur as in fig. 553, 2R (*r*), $\frac{1}{2}R$ (*r*), $\infty P2$ (*t*), 0P (*c*); polar edges $\frac{1}{2}P2$ 14 this, half of the lime is replaced by soda.

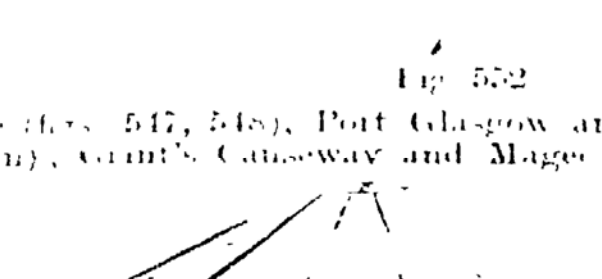


Fig. 553.

609. GMELINITE (*Soda-Chabasite*), $\dot{A}l\dot{S}i_2 + Na\dot{S}i + 6\dot{H}$.

Hexagonal. R 112° 26′; P 79° 54′. Combination P, 0

4, 556). Face of P striated parallel to the polar edge, those
rism horizontally (fig. 555). Cl. ∥ P distinct. Gelatinizes

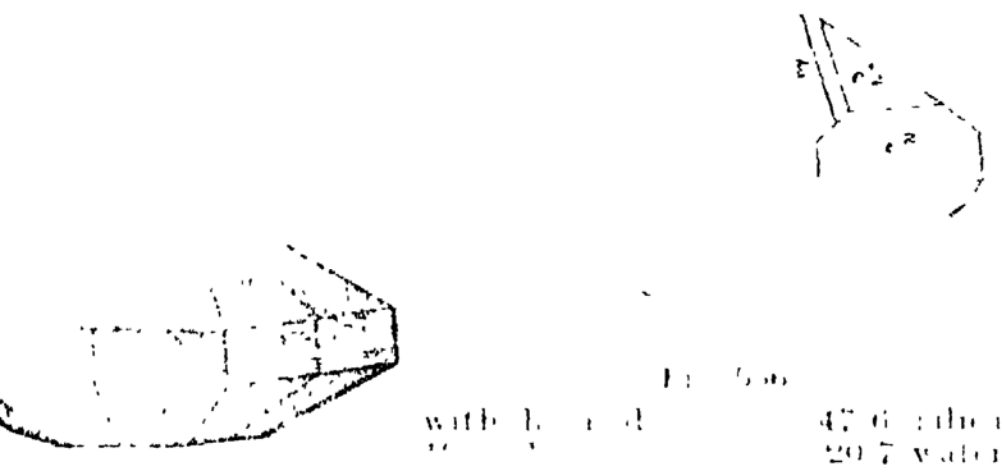


Fig. 558.

with L
47·6 silica
20·7 water
C
ne to indicate
Glenarm in
Table
Skye (twin
Vesuvius, Pargo
Cape Blomidon in Nova

ELVASITE, $AlSi_2 + CaSi_2$

Oblique
Bo
79° 20′,
to
OP (
form
twins as in fig. 559
2 to 2·2. Colourle
Ca
silica 4·5, alumina
Skye (
Ireland (
Island Magee, London
Ireland. Dalmeny per
on the Lorne

HARMOTOME, $AlSi_2$

mon
mounted
hedral pyramid of
and

6, striated hori
Cl
fracture con
transparent, vitreous
colourless. H. 5·5;
Ca
silica 47, alu-
lime 6·2, soda 4·8, potash 2, water 14·6. Aci
and Palagonia in Scotland, Varna in Austria

LAUMONTITE (*Leonhardite*), $AlSi_2 + CaSi_2 + 4H$

Oblique prismatic, C
P
P
P
P
P
P
Twin face
Cl
very brittle. H. 3 to 3·5; G. 2·2
Pellucid when fresh, vitreous, pearly
White
Rapidly throws off water. Bl
and melts first to a white enamel.
Gelatinizes in h
silica 50·9, alumina 21·4, lime
16·3. Rapidly loses 3 equivalents
per cent. of water, and becomes fri
Kilmacolm, Mull (fig
Quarries Skye (hypo
Bl
Strontian, Glen Farg (rarely
Hue
Faroe, Faluns, Iceland,
Fig. 559.
from Tuscany has only 3

Fig. 560.

Cas
H
Rapidly
P
P
P
P
P
P

ng individuals fall nearly into one plane, presenting the . 570; when long, fig. 190. Brittle; fracture uneven. G. = 2·15. Gelatinizes in h. acid. C.e., silica 48·6, 20·2, lime 7·3, potash 6·2, water 17·7. Giant's Causeway, Marburg, Cassel, Capo di Bove, Vesuvius, Iceland.

ARMOTOME, $AlS\dot{i}_4 + BaS\dot{i}_2 + 5\dot{H}$

ic prismatic, C 55° 10′. 2P (s); ∞P∞ (b); 0P (c). like phillipsite, but more frequently in simple twins. properties like phillipsite, but G. = 2·3 to 2·5, and fu

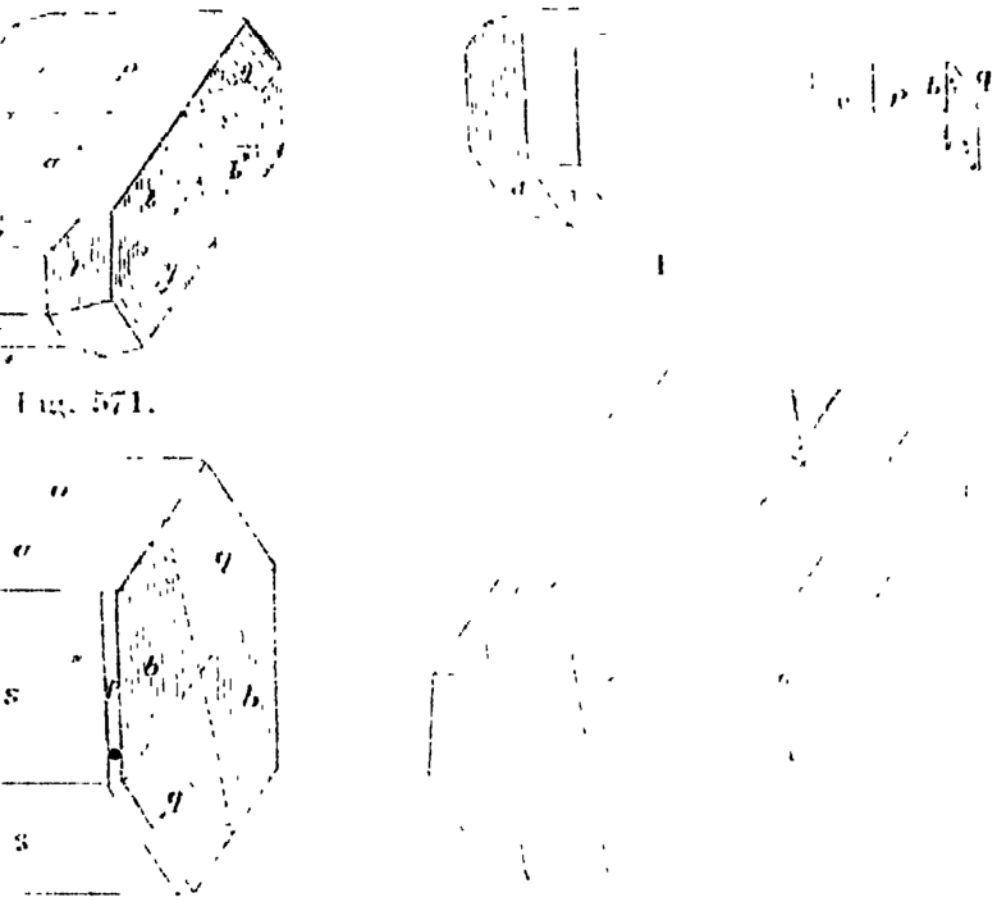


Fig. 571.

Fig. 573

Fig. :

ficulty. Difficultly on ... acid. C ... 46·5, ... 15·9, ... 23·7 baryta, and 13·9 water. Strontian (in pris... (*a*, fig. 572) and opaque (fig. 571, 5...). Glen Arbuck (in ... Bowling in Dumbarton. Co-torphine near Edinburgh; ...berg, Kongsberg, Oberstein.

STILBITE, $AlS\dot{i}_3 + CaS\dot{i} + 6\dot{H}$.

ne prismatic, but with right prismatic habit. C 50° 19′. ...(*a*); ∞P2 (*b*); P (*o*)... *p* ... *a*, perfect. ... to 4; G. = 2·1 to 2·2. Transparent, vitre... early on *a*. Colourless, white, yellow, pale ...brick-red. Decomposed by h. acid, leaving C.e.: silica 57·5, alumina 16·4, lime 8·9, ... 7·2. Storr and Talisker in Skye (*a*, *b*, *p*, ...s, and in Hebrides (coloured *o*), Arran and ...colm (pale brown); Long Craig, Dumbarton; ...Kinneff (Kincardine) (thin bed); Iceland, ...Andreasberg, Vindhya Mountains, Wellington ...ins (Australia), Nova Scotia.

PFEFFERITE, $AlS\dot{i}_4 + Ca_2S\dot{i}_3 + 5\dot{H}$.

...ous globular concretions, with vitreous surface. ... G. = 2·21. Greyish white. Transparent ...ilica 52·8, alumina 16·3, lime 11·2, water ... Pullatsch in the Seisser Alp (sp. 615).

EDINGTONITE, $4\dot{A}lS\dot{i} + 3BaS\dot{i} + 12\dot{H}$

...midal; hemihedral with inclined faces. P 87° 19′; ...P (*o*) ... ∞P (*a*); polar edges ...1′ (fig. 576). Cl. *a*, per... racture uneven. H. 4. ... G. = 2·7 to 2·71. Trans... vitreous. Colourless ...lica 37·3, alumina 23·75, ...26·52, water 12·46. Kil... Hills in Dumbarton.

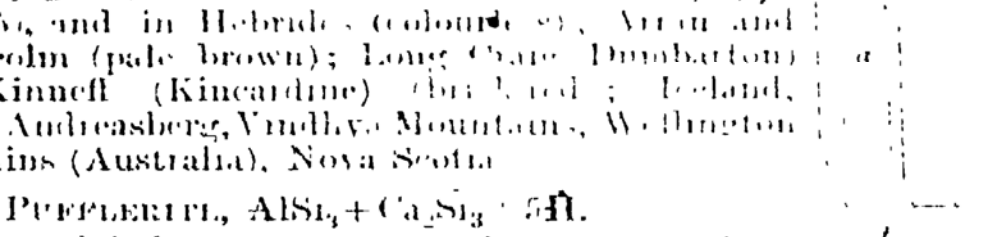


Fig. 576 (sp. 620).

FORESITE, $2\dot{A}lS\dot{i}_3 + (Ca_3)S\dot{i}_2 + 6\dot{H}$.

...t prismatic. ∞P∞; ∞P2; 0P. Cl. brachydiagonal, ...; lustre thereon pearly. G. 2·4. White. C.e.: silica ...umina 27·4, lime 5·5, soda 1·4, water 15·1. San Piero ...a.

NATROLITE, $\dot{A}lS\dot{i}_3 + \dot{N}aS\dot{i} + 2\dot{H}$.

...t prismatic. ∞P (*m*) 91°; P (*o*); polar edges 143° 20′ and ...0′, middle edge 53° 20′; ∞P∞ (*b*); ∞P∞ (*a*). Radiating ... acicular crystals, often fibrous. Cl. ∞P, perfect. H. = 5 ... G. = 2·17 to 2·26. Pellucid; vitreous. Colourless, ochre ...reddish. Is not pyro electric. B.B. melts quietly to a clea... colouring flame yellow. Sol. in oxalic acid. C.e.: 47·2

-granular); Rathlin and Magee Island, Ireland; Faroes,
s (fig. 581), Sicily, Bohemia, Tyrol,
rotia.

lite is a variety with 12·5 of silica
es thomsonite generally in Tertiary
rocks, occurring at Storr and else-
n the Hebrides, Faroes, Iceland
aScotia. The angle of the vertical
within 6′ of that of thomsonite. It
ains accident more silica.

Fig. 582 (sp. 636).

P(
P(c) = 26°, (P : c) 90° 32′, ∞P∞

Cry tals either tabular at c, or prismatic along
ical and the brachydiagonal axes, hence varying much
Often fan-shaped and botryoidal aggregations. Cl
perly thereon, vitreous
H. 6 to 7; G. 2·8 to 3.
ent to translucent. Colour

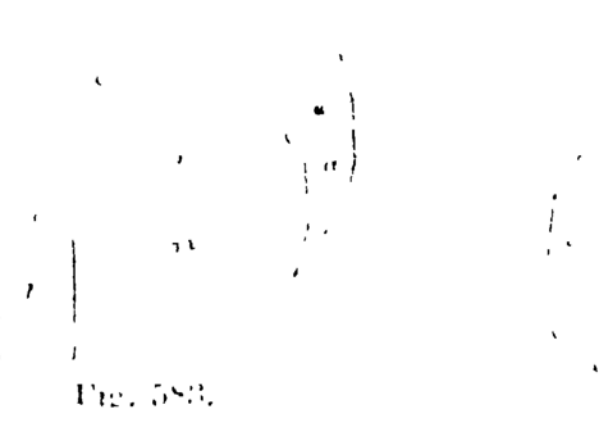


Fig. 583.

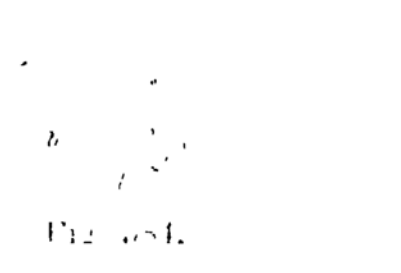


Fig. 584.

generally green of bright but pale tints, also lemon yellow
electrically polar by heat. B.B. intumesces greatly,
to a porous enamel. Decomposed by hydrochloric acid
o, rumina 24·9, lime 27·1, water 14. Glen Gairn, Aber
shire, Skye and Mull. Corstorphine Hill (green and
a the Rock (white), and Salisbury Crags (yellow), Edin
Pirsky Hall, Dumbartonshire (fig. 581), Hartfield Moss,
botryoidal), Cornwall, Dauphiné, Tyrol, Cape of Good
ima, &c.

CELADONITE. $Mg_2Si_3 + 2H$.

hohedral, R 120° 12′. OR; ∞R. Earthy habit, and in
aggregates. Cl basal, perfect. H. 1 to 2. G. 2·1. Rose-
pale green streak. Colour due to silica 56, protoxide of manganese 53,
5, water 7·9. Adervielle on the N.E. of Lez on the Pyrenees.

Hydrous Silicates of Alumina

are probably for the most part products of decomposition
under atmospheric exposure.

ALLOPHANE (*Porcelain Earth*, $AlSi_3 + 2H$.

e; in beds and veins. Fracture uneven, luster earthy, very
le, and friable. H. 1, G. 2·2. Opaque, dull. White or
hing to blue, green, yellow, or red. Feel meagre, not
hen dry, and plastic when wet. B.B. infusible.
by hydrochloric acid, but decomposed by warm sulphuric acid, leaving silica
variable, but approximately to 46 silica, 40 alumina, and
Chiefly a product of the decomposition of orthoclase, or
te, porphyry, and other rocks containing that mineral.
and Devonshire in England are the chief European localities
ey is largely used in manufacturing porcelain.

ordinarily varieties of kaolin, mixed with quartz sand, car-
e of lime, magnesia, and ferrous hydrate of iron. Often 40
ina, 13 to 20 water, and 1 iron peroxide,
ent proportions. In the fire they are infusible, burning
ome cases, very compact and friable, of white, yellow,
, or various other colours. Their specific gravity varies
to 2·7. The following are varieties. *Pipe clay*, greyish
with white, greasy feel, adheres strongly to the
when wet, bakes and contracts, and in the fire
white. Abundant in Devonshire and in the Trough of
Dorset-here in large beds. Bohemia, and Germany. Used
manufacturing tobacco-pipes and similar articles. *Potter's*
d, yellow, green, or blue, becoming yellow or red when
more easily fused than the former, and often effervesces
ds. That used in the potteries in England comes chiefly
evonshire. *Loam*, coarser and more impure, with more
d consequently less plastic. *Shale* or *Slate Clay*, grayish
and much mixed with bituminous or carbonaceous
Bituminous Shale, known by its burning resinous streak
Bath, with more carbon, leaves a black mark on paper. *Iron*
Clay contains much peroxide of iron, is reddish-brown, and
the basis of many amygdaloids and porphyries.

630. NACRITE, $Al\dot{S}i_2 + 2\dot{H}$.

Right prismatic; minute six-sided tables in fan-like group
scaly. H. = 0·5 to 1; G. = 2·35 to 2·6. Glimmering to pearly,
white or yellowish white. C.c.: silica 46·3, alumina 39·8,
13·9. A crystalline form of kaolin. Fins in Allier, Mons, Fre
Pennsylvania, and coal formation commonly.

631. LITHOMARGE.

Kaoline substances, compact, earthy, and pseudomorp
H. 2·5 to 3, G. = 2·4 to 2·6. White, yellow, or red. Greasy, a
to tongue. Klausthal, Harz, &c. Similar are *Carnat*, *M*
Meloposite.

632. HALLOYSITE, $Al\dot{S}i + 4\dot{H}$.

Massive and reniform. H. = 1·5 to 2·5; G. = 1·9 to 2·1.
lucent when moist. Bluish white, green, or yellow. C.c.: 41·5
34·4 alumina, 24·1 water. Hospital Quarry near Elgin, C
Tweed, Liége, Tarnowitz, Eitel (*Lenzinite*). *Fuller's Earth* m
an impure ferruginous variety. Maxton in Scotland, Reigat
Maidstone in England, Saxony, Bohemia, &c.

633. GLAGERITE, $Al_2Si_3 + 6\dot{H}$.

H. 1, G. 2·3. Bergenerseuth. *Malthazite*, from Stein
near Bautzen, has less alumina.

634. KOLLYRITE, $Al_2Si + 9\dot{H}$.

H. 1 to 2, G. 2. Also similar. Schemnitz, Pyrenees
Saxony. *Scarbrite* from Scarborough has $10\dot{H}_2O$.

635. MILOSCHITE.

Conchoidal or earthy. H. 2; G. 2·1. Indigo-blue to ce
green, has 2 to 4 chrome oxide. Rudnik in Servia.

636. MONTMORILLONITE, $Al\dot{S}i_2 + 2\dot{H}$.

Massive. Rose-red. Montmorillon and elsewhere in F
Podhrancz in Transylvania.

637. RAZOUMOFFSKINE, $Al\dot{S}i_2 + 3\dot{H}$.

From Ormethy. *Chrome Ore*, with 2 to 10 per cent. of c
oxide, from Waldenburg in Silesia and Creusot in France, is si

638. CIMOLITE. $Al\dot{S}i_2 + 6\dot{H}$.

Pseudomorphous after augite. Bilin, Limburg, Kaiser
Argentiera and Milo.

639. ALLOPHANE, $Al\dot{S}i + 5\dot{H}$.

Botryoidal and reniform. Fracture conchoidal, brittle. I
G. 1·8 to 2. Pellucid: vitreous. Pale blue, white, gre
brown. Colour due to copper. Charlton, Woolwich, Bade
Bonn.

640. PYRODMALITE, $Al\dot{S}i_4 + \dot{H}$.

Right prismatic, but radiated, foliated. Cl. perfect; fle
ectile. H. 1, G. 2·8 to 2·9. Translucent, pearly. Light
ous green to yellowish white. B.B. swells up with many twi
to a white infusible mass. C.c.: 67 silica, 28 alumina,
water. Upsala Spa, Morbihan, Westana in Sweden, Carolin
Brasil. *Tuesite*, from Heathcote in Victoria, has silic
alumina about equal.

641. ANAUXITE, $Al\dot{S}i_4 + 3\dot{H}$.

Granular. H. 2 to 3; G. 2·2 to 2·4. Translucent,
Greenish white. C.c. 60·5 silica, 26 alumina, and 13·5
Bilin in Bohemia.

Hydrous Silicates of Zirconia, Thoria, &c.

642. MALACONE, $3Zr\dot{S}i + \dot{H}$.

Pyramidal. P 83° 30′. Typical form ∞P∞, P, ∞P. I
G. = 3·9 to 4·1. Conchoidal fracture. Lustre vitreous. C.c
carbon, but with 3 of water in the Hittero variety and ov
alt from Finland. Has a surface opalescence, and may be
green. Hittero, Chantelouhe near Limoges, near Dresden,
dal, Finland, Miask.

643. ERDMANNITE.

Right prismatic (?). H. 4·5 to 5; G. = 4·39. Lustre
Bluish brown, streak brown. Translucent on edges. Fr
uneven, brittle. C.c. very complex: silica 16, thoria 36,
protoxide 5·6, peroxide 6, lanthania 2·4, yttria 4·3, erbi
titanic acid 1·3, ferric oxide 1·25, alumina 1·8, water 9. Ba
near Brevig.

644. THORITE, $Th\dot{S}i + 2\dot{H}$.

Pyramidal. ∞P : P 133° 30′. Generally massive. H
to 5. G. = 5 to 5·4. Lustre brilliant vitreous; when wea
resinous. Fracture conchoidal when fresh, splintery
weathered. Brownish black to clove-brown. C.c. comple
essentially 18 silica, 73 thoria, 9 water. In syenite at L

Hacon, and in a boulder on Ben Bhreck in Sutherland, in crystals (fig. 585); Löwö near Brevig, Norway. *Uranothorite*, from Arendal, has 50 per cent. thoria and 10 uranous oxide; found also at Hitterö and at Champlain (U. S.)

Fig. 585 (1/1).

645. Orangite, $3\dot{T}h\ddot{S}i + 2\dot{H}$.

Massive. Orange-yellow to cinnamon-red. Other characters like thorite. C.c.: 17 silica, 75 thoria, 7 water. Ben Bhreck, Langesund near Brevig. The mineral from Ben Bhreck passes gradually into thorite, which thus would appear to be altered orangite.

646. Tritomite, $\dot{R}_2\ddot{S}i_3 + 4\dot{H}$.

Cubic. In tetrahedra. H. = 5·5; G. = 3·9 to 4·66. Lustre vitreous. Dull brown; streak yellowish grey. Subtranslucent. C.c. complex: silica 21, alumina 2·5, ceria 40, lanthana 15, yttria 4·6, lime 4, water 8. Lamö near Brevig.

Magnesian Silicates.

647. Agalmatolite (*Figure Stone*), $4\dot{A}l\ddot{S}i + K\ddot{S}i_3 + 3\dot{H}$.

Massive or slaty. Fracture splintery, rather sectile. H. = 2 to 3; G. = 2·8 to 2·9. Translucent; glimmering. Green, grey, red, and yellow. Feels somewhat greasy, but does not adhere to the tongue. Sol. in s. acid. C.c.: 55 silica, 33 alumina, 7·6 potash, and 5 water; but in many localities magnesian. Callgang in Sutherland, China, where it is cut into various work. Unkel, also Nagyag in Hungary, and Saxony.

648. Oncosin, $2\dot{A}l\ddot{S}i_2 + (\dot{K}, \dot{M}g)\ddot{S}i + 2\dot{H}$.

Fracture uneven or splintery; sectile. H. = 2; G. = 2·8. Translucent; slightly resinous. Apple-green or brown. Sol. in s., not in h. acid. Salzburg.

649. Liebenerite.

Hexagonal. ∞P; $0P$. Cl. prismatic, perfect, fracture hackly. H. = 3·5; G. = 2·8. Oil green, bluish green, and greenish grey. Greasy lustre. C.c.: silica 44·7, alumina 36·5, potash 9·9, water 5·5. Monte Viesena near Forno, Predazzo in Tyrol.

650. Giesekite.

Hexagonal. ∞P; $0P$. Fracture splintery. H. = 3 to 3·5; G. = 2·7 to 2·9. Kangerdluarsuk in Greenland. Diana in New York.

651. Killinite, $2\dot{A}l\ddot{S}i_2 + R\ddot{S}i_2 + 3\dot{H}$.

Crystalline, foliated. Cl. along a prism of 155° 11′. G. = 2·65. Greenish grey, yellow, or brownish green. C.c. 48 silica, 31 alumina, 2·3 protoxide of iron, 6·5 potash, 10 water. Killiney near Dublin.

652. Hydrophilite.

Scaly. H. = 2 to 2·5; G. = 2·7. Greenish grey. Lustre and feel greasy. C.c.: silica 48·4, alumina 32·1, protoxide of iron 3·3, potash 5·7, water 9. Sol. in h. acid. Halle on the Saale.

653. Bravaisite, $\dot{R}_2\ddot{S}i_3 + 2\dot{A}l\ddot{S}i_3 + 4\dot{H}$.

Aggregates of thin plates. H. = 1 to 2; G. = 2·6. C.c.: silica 51·4, alumina 18·9, peroxide of iron 4, magnesia 1·3, potash 6·5, water 13·3. Noyant in Allier.

654. Pinitoid.

Massive. Leek- and oil green. H. = 2·5; G. = 2·8. C.c.: silica 48·5, alumina 28, protoxide of iron 3, potash 5·8, water 4·5. Freiberg and Chemnitz in Saxony.

655. Bole.

Earthy, in nests and veins. Conchoidal. H. = 1 to 2; G. = 2·2 to 2·5. Opaque; dull resinous; streak shining. Brown, yellow, or red. Feels greasy; some adhere strongly to the tongue, others not at all. In water crackles and falls to pieces. C.c. hydrous silicates of alumina and iron peroxide, in various proportions. Scotland, Ireland, Dransfeld, Clermont in Auvergne. *Stolpenite*, *Red Soap*, *Plinthite*, *Yellow Earth* or *Felinite*, *Fettbol*, and *Ochran* are varieties.

656. Carpholite, $\dot{A}l\ddot{S}i + \dot{M}n\ddot{S}i + 2\dot{H}$.

Right prismatic. P 111° 27′. Radiating stellated. H. = 5 to 5·5; G. = 2·9. Translucent; silky; straw- to wax-yellow. B.B. intumesces and fuses to an opaque brown glass. C.c.: silica 38, alumina 29·4, protoxide of iron 2·9, peroxide of iron 4, protoxide of manganese 11·8, water 10·8. Schlaggenwald, Wippra in the Harz, Monville in the Ardennes.

657. Nontronite, $\dot{F}e\ddot{S}i_3 + 5\dot{H}$.

Massive; fracture uneven. H. = 2 to 3; G. = 2 to 2·3. Opaque; dull or glimmering; streak resinous. Straw-yellow or siskin-green. B.B. decrepitates, becomes black and magnetic, but without fusing; sol. and gelatinizes in warm acids. C.c.: 43 silica, 36 iron p and 21 water, with 3·5 alumina and 2 magnesia. Nor France, Harz, and Bavaria. *Chloropal* is similar. B.B. Unghvar in Hungary, and Passau.

658. Pinguite.

Massive; fracture splintery; sectile. H. = 1; G. = 2·3. dark green. Lustre vitreous. Feels greasy. C.c.: silica 30 oxide of iron 29·5, protoxide of iron 6·1, water 25·1. Wolk Suhl.

659. Hisingerite, $Fe_2\ddot{S}i_3 + 2\dot{F}e\ddot{S}i + 9\dot{H}$.

Reniform, and in crusts. H. = 3·5 to 4; G. = 2·6 to 3. resinous. Brownish or bluish black; streak liver-brown or y brown. C.c. various, but 32·5 silica, 33·5 iron peroxi iron protoxide, and 19 water, in the *Thraulite* from Bod Also Gilling and Riddarhyttan in Sweden, and Brett (*Polyphyllite*).

660. Bucholz.

Fine fibrous, glimmering lustre. Wood-brown to green. C.c. silica 55·5, peroxide of iron 19·5, magnesia 15, wat Stenzing in Tyrol. *Velite*, probably from the Urals, is sim

661. Umbite.

Massive; fracture conchoidal. H. = 1·5, G. = 2·2. Liver streak shining. Mixtures of peroxide of iron, oxide of man and alumina with water. Cyprus. *Hapsonanthite* and *Si* similar.

662. Kittelite, $(R_6\ddot{R}_4\ddot{S}i_9 + R_2\dot{H}_2)$.

Compact. H. = 5 to 5·5, G. = 3·5. Liver brown to black yellow brown. C.c.: silica 25, peroxide of iron 4, sesqui manganese 57, water 9. Klappernd in Dalecarlia, Herbo Dillenburg.

663. Wolkonskoite.

Amorphous. Horny, bluish green to grass green. Fract choidal, brittle. C.c. silica 36, alumina 3, sesquioxide of ch 19, ferric oxide 10, water 21. Okhansk in Siberia.

664. Rötticite, $3\dot{N}i\ddot{S}i + 4\dot{H}$.

Amorphous and reniform. Apple-green to emerald green to 2·5; G. = 2·35 to 2·37. C.c. silica 43·7, nickel oxide 35· 11·2. Rotts near Reichenbach in Saxony. *Konarit* is si

665. Uranophane, $3\dot{C}a\ddot{S}i + \dot{U}_2\ddot{S}i_3 + 4\dot{H}$.

Right prismatic. ∞P 146°, $\infty P\infty$, $P\infty$; with polar an Crystals honey yellow, when massive leek-green. H. = 2 2·6 to 2·8. C.c. silica 17, alumina 0·1, oxide of uranium lime 5·1, water 15·1. Kupferberg in Silesia.

666. Uranotile, $\dot{C}a\ddot{S}i + 4\dot{U}_3\ddot{S}i_2 + 9\dot{H}$.

Right prismatic. ∞P 164°. In stellate groups. Lemon G. = 3·96. C.c. silica 13·8, oxide of uranium 66·75, hy water 19·67. Wolsendorf in Bavaria, Joachimsthal, Mitche in North Carolina.

667. Bismutoferrite, $\dot{B}i_2\ddot{S}i_3 + 2\dot{F}e_2\ddot{S}i$.

Crypto-crystalline; oblique prismatic. Straw to olive H. = 3·5; G. = 4·18. C.c.: silica 24, oxide of bismuth 42·8, of iron 33·1. Schneeberg. *Hypochlorite* is a containing 13 of bismuth. In a third variety, from Bra antimony replaces bismuth.

Silicates with Titanic, Niobic, &c.

668. Sphene, $\dot{C}a\ddot{S}i_2 + \dot{C}a\ddot{T}i$.

Oblique prismatic, C. So. 22°. ∞P (*l*) 133°2′; $\frac{1}{2}P\infty$ 21′; $P\infty$ (*u*) 31° 21′, $\infty P\infty$ (*q*) 61°, *l* on *l* 90°; $\infty P3$ (*M* $P\infty$ (*r*) 113° 30′, $P\infty$ (*o*) 136° 12′; 41°4 (*s*) 67° 57′. vary extremely in form, being generally apparently oblique-tabular, from predominance of *n*, which are hemihedral in alternate position on opposite ends, also, but rarely, pre ite, the dominance of *l* and *M*. Twins frequent. Twin face and formed by revolution either (*a*) on an axis normal to (or *b*) on a vertical axis, the former very common and usually produces thin tables with re-entering angle along one side, and sometimes elongated. Occasionally in double twins. Sometimes granular or foliated. Cl. in some (*l*), in others (*r*). to 5·5, G. = 3·4 to 3·6. Semitransparent; adamantine or

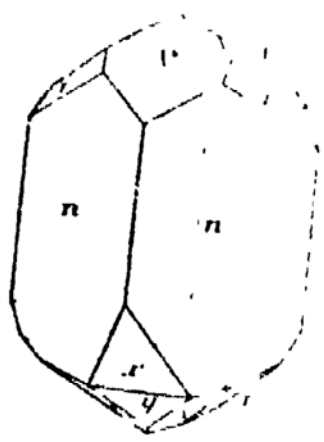


Fig. 586.

Fig. 58

brown, and green. B.B. fuses with micro-salt in the red. ves reaction for titanic acid. C.c.: silica 30·6, titanic acid e 28·6. In sections, typical of syenites and primary lime- In minute brown crystals in the first; as at Larg and, Arkansas (Arkansite), and Crifiel (Kirkcud-

Fig. 588.

Fig. 589

to 6·5. In the latter often in highly complex to brown, at Shinness (fig. 589), Urquhart Torgam & c., also with ilmenite and allanite in schistia of grey granite. Dauphiné, Mont Blanc, St Gothard, Arendal, Amherst. *Greenovite*, flesh-red from Glen Coe Ross-shire (fig. 590), and St Marcel in Piedmont; contain s at the latter locality.

Fig. 590 (p. 672).

Titanite (*Vitreotitanite*), $5(CaY)(SiTi)+(AlFe)(SiFe)_2$. e prismatic, C 5° ∞P 111° 0′ 21′, 13′ to 3′. ∠ Blackish brown, streak greenish yellow. B.B. to brown blood-red glass in the red flame; other features en C.c.: 29·7 silica, 28·7 titanic acid, 21·1 lime, 10·8 alumina, and 6·5 iron peroxide. Near Arendal.

Schorlomite (*Ferrotitanite*), $Ca_3Si+Fe_2Si_3+CaTi$, ∞O and 202, ∞ metallic massive. fracture conchoidal 7·0, G 3·8. Black, streak grey black, vitreous. C.c.: titanic acid 23·3, peroxide of iron 20, lime 29·4. Arkansas, uhl Iwaara in Finland. Perhaps a titaniferous garnet.

Loewigite.

ve, fracture conchoidal. H 5 to 5·5, G 4·5. Vitreous, pendent. Velvet black, streak dull brown. tumesces greatly, becomes porous and undescent; in white heat fuses to black. chlorizes with h acid. C.c.: 21 silica, e acid, 11 iron protoxide, 4·5 peroxide, m metals with perhaps thoria, lime 4. Vorosmedel.

Mosandrite.

a prismatic, C 71° 24′. ∞P ∕ 58° P∞ ∞, ∞P∞ (a²), P (c) 124° P, q, ∞P∞, ∕ a 134° 18′, a : a 152° a 138° 6′. Twin face the orthopinacoid ly massive. Fracture uneven. H = 4; 5 to 5. Yellowish or reddish brown, ak green. Vitreous to resinous lustre. h 29·9, titanic acid 9·9, oxide of cerium 2·5, lime 12, water 8·9. Brevig and nethood.

Fig. 590 (p. 672).

Eudialyte (*Eukolite*), $6RSi_2+RZr$. ochedric R 7·5° 10′. R (*p*), 6R (*a*₁), ∞P2 (*d*₁), ½R (*a*₂), ; ⅔R, ⅓R, 2R, −2R, R5, ∞P2 to occasionally massive, granular ocks; fracture uneven. H. 5 5·5. G. 2·9 to 3·0. Peach-blossom- brownish red and white. Trans- Vitreous. Fuses easily to a translucent glass; colours in flame. C.c.: silica 50·1, zirconia 15·9, soda 12. dium 6·5, iron protoxide 6·5, lime 5·5, and in Greenland, Stoffovet and in Wermland, Sweden. *Eukolite* Laggit Cove in Arkansas.

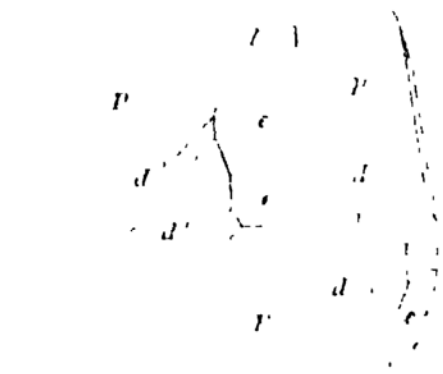


Fig. 591 (p. 673).

Catapleiite. N 2 Si_2O_5+2H gonal. P 111° 1′. OP, ∞P, P, th 2P, and 3P. Isomorphous with Cl prismatic angle 120° 3′. Cleavage H 6, G 2·8. Yellowish brown to pale green; streak lustrous. C.c.: silica 59·6, zirconia 29·6, soda 10·8, water ving.

Gerstleyite.

nidal. P 84° 25′. P ∕ P, ∕ P∞. Like arcon. H = 5·5; 5·3. Lustre adamantine. Reddish brown. C.c.: silica 19·7, of zirconia 68·96, water 5·6. Arendal.

676. Wöhlerite. $9RSi+3R\dot{Z}r+R\dot{N}b$.

Oblique prismatic, C 70° 45′. ∞P 90° 14′; ∞P∞2 127° 43′ 18′. 0P : ∞P∞ 109° 15′; P∞ : ∞P∞ 136° 42′; 0P : ∞P 103° 31′. Crystals tabular and prismatic. Cl clinodiagonal; fracture conchoidal. H 5 to 6, G 3·4. Light yellow, honey yellow to brownish grey, streak yellowish white. C.c.: silica 28, zirconia 19, niobic acid 12·9, lime 27·8, soda 8·3, protoxide of iron 3. B.B. fuses to yellowish glass. Sol. in h. acid. Langesundfiord, Brevig.

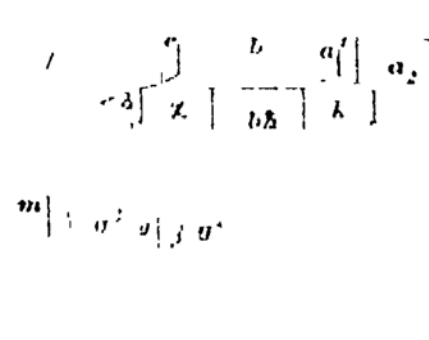


Fig. 592.

677. Arrhenite.

Right prismatic. ∞P 131° 2′, P∞ 112° 24′; P⅔; ∞P⅔; ∞P∞ ∞P∞ crystals like elvanite. Cl. brachydiagonal ∞P. H 6·5 to 7. G 3·62. Yellow to yellow brown. Die brittle. C.c.: silica 47·8, alumina 21, protoxide of manganese lime 2·2, magnesia 1·3, vanadic acid 5·2, arsenic acid 6·3, wa Office in the Ardennes (Luxemburg).

678. Rowlandite.

Foliated masses, sometimes stellated. H. = 1; G. = 2·3 1 Dark green to greenish blue. Pearly lustre. C.c.: silica vanadic acid 22, alumina 14·1, magnesia 2, potash 7·6, wa Lidorado in California.

TITANATES WITH NIOBATES.

679. Titanomorphite $CaTi_2$.

Oblique prismatic. Like sphene. ∞P, 0P, ½P∞, P∞2. C.c.: titanic acid 74·3, lime 25·3. Lampersdorf in S Wermland.

680. Perowskite $CaTi$.

Right prismatic. In complicated twins, often distorted, p cubic. H. = 5·5; G. 4·0 to 4·1. Lustre metallic- adamantine. Pale yellow, reddish brown to iron-black, streak grey. C.c.: 58·8 titanic acid, 41·2 lime. B.B. with micro-salt in outer flame gives a bead greenish while hot, colour- less on cooling, in inner flame grey green when hot, violet blue when cold. Decomposed by boiling h. acid. Ziatoust, Schelingen, Zer- matt, Maderno Valley near Sondrio, Pfitsch in Tyrol, Magnet Cove in Arkansas.

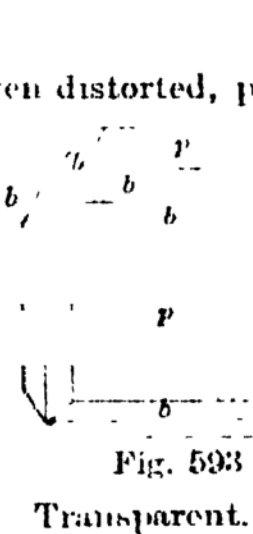


Fig. 593

681. Koppite $R_2Nb_2O_7$.

Cubic; ∞O∞. G. 4·45 to 4·56. Brown. Transparent. niobic acid 69·46, oxide of cerium 6·7, oxide of lanthan Schelingen on the Kaiserstuhl in Baden.

682. Annerodite $2R_2Nb_2O_7+5H_2O$.

Light prismatic. H 6. G 3·57. Metallic to greasy. Streak black, brown, greenish grey. Translucent in spl brittle. C.c.: 48 niobic acid, with zirconia, thoria, ceria, and uranium oxide. Amherst near Moss (Norway).

683. Dysanalyte, $6\dot{R}Ti+R\dot{N}b$.

Cubic, ∞O∞. Cl cubic. G. 4·13. Black. C.c.: titan 41·5, niobic acid 23·2, cerium oxide 5·7, lime 19·8; proto iron 5·8, soda 3·6. Vogt Isarg on the Kaiserstuhl.

684. Pyrochlore, $5\dot{R}Nb+4R(\dot{T}i\dot{T}h)_2+4NaF$.

Cubic (fig. 594). Cl octahedral; brittle; fracture conc H 5; G 4·2 to 4·4. Resinous, opaque. Red brown to black, ruby red and transparent rarely; streak pale brown. C.c.: niobic acid 53·2, titanic acid 10·5, thoria 7·6, iron oxide 7, lime 11·2, soda 2, fluorine 7·1. Black, Kaiser stuhl, Brevig, and Frederiksvarn. *Hatchettolite* from Chesterfield in Massachusetts, has tantalic acid 68·4, niobic acid 7·75, 11·7 lime 7·7 protoxide of manganese. *Dysanalyte* from Miask in the Urals, San Piero in Elba, and the Azores may be the same; at the last locality it is in orange-red octahedra, and is a niobate of zirconia.

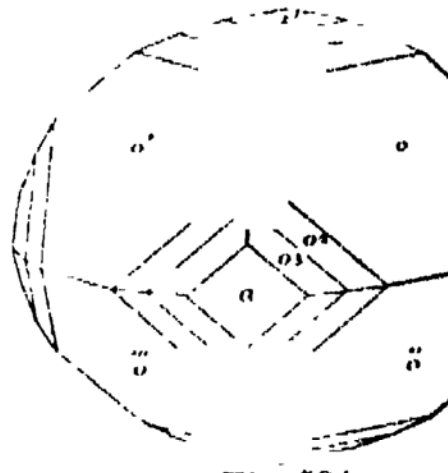


Fig. 594.

685. Bromstrandite, $(Ca,Fe)_3\dot{T}i_4\dot{U}\dot{N}b_2+\dot{H}$.

Massive. H = 5·5. G. = 4·17 to 4·25. Vitreous, black.

Translucent in splinters. C.c. niobic acid 49·8, titanic ·7, uranium oxide 23·7, protoxide of iron 3·3, lime 3·5, 9. Nohl (Sweden).

POLYCRASE, $4\dot{R}\ddot{T}i + R\ddot{N}b$.

prismatic (fig. 595). $\infty\breve{P}\infty$, ∞P P, $2\breve{P}\infty$ (56′). Fracture conchoidal. 6; G. = 5·1. Black; streak grey. B.B. decrepitates violently, mean- but does not fuse. Sol. in s. acid anic acid 26·6, niobic acid 20·4, yttria a 7·5, oxide of uranium 7·7, water tero (Norway), Slettäkra in Jonkop- den).

Fig. 595.

EUXENITE, $2R\ddot{T}i + R\ddot{N}b + H$

prismatic (fig. 596). ∞P (m) 140°,), $2\breve{P}\infty$ (d) 52°; P (p) 102° 58′, ° 6′. Fracture conchoidal. Opaque to vitreous. Black and brownish reak red brown. B.B. infusible. Not by acids. C.c.: niobic acid 32, cid 19·2, uranium oxide 19·3, yttria erium oxide 2·8, but variable

Fig. 596.

Tromo, Alvo, &c., in Norway; also and Cape Lindesnaes.

ESCHYNITE.

prismatic. ∞P (M) 128° 34′, $2\breve{P}\infty$ (o) 73° 16′, P ; $\infty P3$ 69° 23′; $P\infty$; $0P$. Crystals long prismati (fig l. traces; fracture imperfect conchoidal 5·5; G. = 4·9 to 5·1. Opaque, submetallic ous. Iron-black or brown, streak yellow vn. B.B. swells and becomes yellow or but is infusible. Not sol. in h. acid, in s. acid. C.c.: niobic and tantalic acids ane acid 22·6, thorium oxide 15·7, cerium e 18·5, lanthanum oxide and didymium 6. Miask, Hitterö.

POLYMIGNITE.

prismatic. P (p) polar 136° 28′ and 116° 22′; ∞P 109° 46′, $\breve{P}\infty$, $\infty\breve{P}\infty$ (fig. 598). Cl. a and brachydiagonal imper fect; fracture conchoidal. H. = 6·5, G. = 4·7 to 4·8. Opaque; semimetallic. Iron-black, streak dark brown. B.B. infusible. Sol. in h. acid. C.c.: titanic acid 46·3, zirconia 14·1, yttria 11·5, lime 1·1, iron peroxide 12·2, cerium oxide 5. Frederiksvärn.

Fig. 598 (sp. 689).

690. MENGITE, (Fe, Zr) Ti.

Right prisma (e) polar angle 151° 27′ and 101° 136° 20′; $\infty\breve{P}3$, $\infty P\infty$ (fig. 599). uneven. H. = 5 to 5·5; G. = Opaque; semimetallic. Iron- streak chestnut-brown. B.B. , but becomes magnetic. Sol. l. Miask, Groix island in Morbihan.

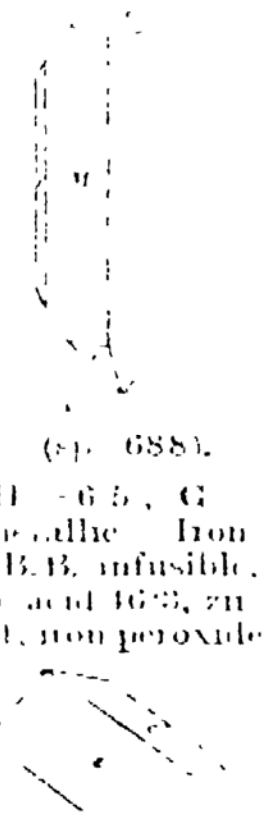


Fig. 599 (sp. 690).

TANTALITE, Fe (Ta, Nb).

prismatic. P (p) with polar edges 126° and 112° 30′, 91° 42′. $\infty\breve{P}\frac{2}{3}$ (r) 122° 53′; $\infty P\infty$ (s); (t); $\breve{P}\infty$ (m) 113° 48′; $3\breve{P}\infty$ (q) 54° $\frac{1}{2}\breve{P}\infty$ (n) 167° 36′; $\frac{2}{3}\breve{P}\frac{2}{3}$ (v); $2\breve{P}2$ (o). conchoidal or uneven. H. = 6 to = 6·1 to 8. Opaque; semimetallic, ine, or resinous. Iron-black; streak n- or coffee-brown. B.B. infusible; affected by acids. C.c.: 76 to 50 tan- d, 7·5 to 29 niobic acid, 9 to 16 s, and 1 to 6 manganese protoxide; some with 1 to 10 tin (*Cassiterotantalite*); also in union with iron (manganese) e. Kimito and Tammela in Finland, Broddbo and Finbo um, and Chanteloube near Limoges; always in granite.

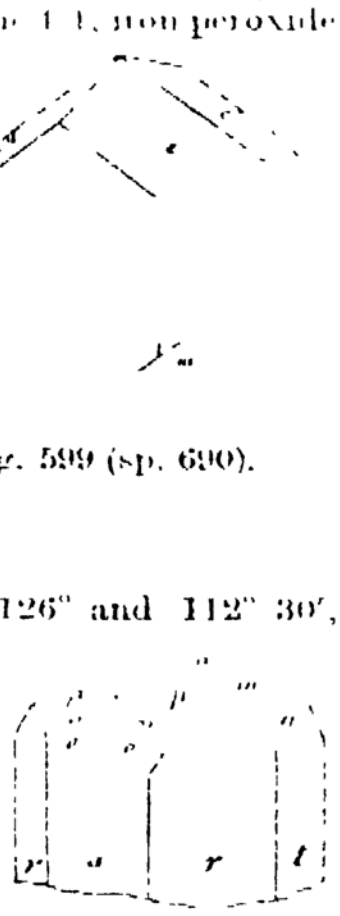


Fig. 600.

TAPIOLITE, $4\dot{F}e\ddot{T}a + F\dot{e}\ddot{N}b$.

nidal. P middle angle 84° 52′, summit 123° 1′. H. = 6; G. = 7·2 to 7·5. Black. Lustrous. C.c.: tantalic acid 73·9 n 11·2, protoxide of iron 15. Tammela in Finland.

693. COLUMBITE, $m\dot{F}e\ddot{N}b + a\dot{F}e\ddot{T}a$

Right prismatic. P (a) polar angles 104° 10′ and 151° angle 83° 8′; $0P$ (c), $\infty\breve{P}\infty$ (b_1), $\infty\breve{P}\infty$ (a_1); ∞P (a) 1 $\infty\breve{P}\infty$ (m) 101° 26′, $2\breve{P}$ (o), $3\breve{P}$ (n), $3\breve{P}\frac{3}{2}$ (π); $\frac{1}{2}\breve{P}\infty$ ($\breve{P}\infty$ (k) 145°; $2\breve{P}\infty$ (h_1) 112° 26′, $P\infty$ (x) 101° 12′, $2\breve{P}\infty$ (e) Hemitropes, face e; vertical axes forming an angle of 62° 4 on faces $2P2$ (a), and rarely b. Also granular and foliat brachydiagonal, perfect, also macrodiagonal. H. = 6; G. 6·4. Metallic, adamantine. Iron-black to brownish stre

Fig. 601.

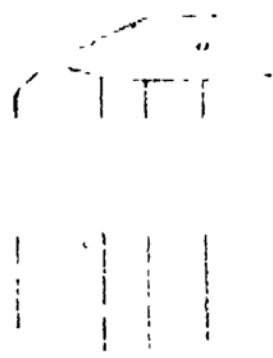


Fig. 604.

or reddish brown. B.B. infusible, not affected by acids isomorphic mixtures of niobic and tantalic acid with prot iron or manganese. Pure columbite would give 78·8 nio pure tantalite 86 tantalic acid. The niobic acid generally and the crystals are better formed the more this is t Rabenstein, Bodenmais, Chanteloube, Finland, Ilmen Evigtok in Greenland, Haddam and Middletown in Conn Acworth in New Hampshire, Pike's Peak in Colorado.

691. YTTROCOLUMBITE (Y, Ca, Fe, U)(Ta, W, Nb).

In two varieties. *a. Black.* Riche prismatic, in sh matic or tabular crystals. $\infty\breve{P}\infty$, ∞P (a) 121° 48′ 0P 103° 26′, $P\infty$ 0P 131° 26′, a : a 149° 42′ (fig. 601), also in grains and lamella Cl. brachydiagonal, indistinct, fracture conchoidal or uneven. Opaque, or in thin splinters translucent. Velvet black to me tallic lustre, and greenish grey streak. H. = 5·5, G. = 5·4 to 5·7. *b. Yellow.* Amorphous, yellowish brown, or yellow, often striped or spotted; remnants of vitreo us; streak white. G. = 5·46 to 5·88. Both varieties B.B. infusible, but become brown or yellow. Not affected by acids. C.c.: 57 to 60 tantalic acid, 1 to 8 tungstic acid, 0 to 2 acid, 20 to 38 yttria, 0·5 to 6 lime, 0·5 to 6 uranium p and 0·5 to 3·5 iron peroxide. Ytterby, and near Falun.

695. FERGUSONITE, (Y, La, Ce)(Nb, Ta)

Pyramidal and hemihedric. P (o) 128° 28′. Usual form (o), P, $\frac{1}{2}\breve{P}$ (a_2), $0P$ (c; fig. 605). s : s 100° 54′, s : o 115° 16′, o : o 169° 17′. Cl. traces along P, fracture imperfect conchoidal, brittle. H. = 5·5 to 6, G. = 5·8 to 5·9. Translucent in thin splinters, semimetallic. Brownish black; streak pale brown. B.B. infusible. C.c.: chiefly niobic acid and yttria, with erbia, also a little cerium protoxide, tin oxide, uranium oxide, and iron protoxide. Cape Farewell in Greenland, Ytterby, Riesengebirge, Rockport in Massachusetts. *Tyrite*, from Helle near Arendal, is similar.

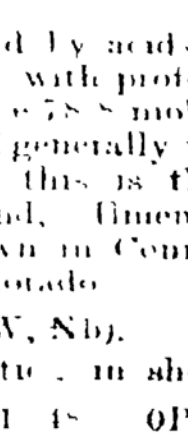


Fig. 605.

696. ALLANITE.

Massive, with granular fracture and traces of crystals. H. = , G. = 3·82. Velvet black; streak black. Lustre metallic. C.c.: tantalic acid 62·4, tin 6·6, 1·9, protoxide of iron 8·1, yttria 5·2. B.B. infusible tube decrepitates and yields water. Karafvet near Falun

697. SAMARSKITE (*Uranotantalite*), $(R_2R, R'_2)_3(Nb_2Ta)_3$.

Right prismatic. ∞P 122° 46′, $\breve{P}2$ 95°, $P\infty$ 94°, P, $\infty\breve{P}\infty$, $3\breve{P}_3$, also in grains. Fracture conchoidal; brittle 5·56; G. = 5·6 to 5·76. Opaque, strong semimetallic. black, streak dark reddish brown. B.B. fuses on the e black glass. In the closed tube decrepitates, yields wate desces, and becomes brown. Sol. in h. acid to a greens

·2 niobic acid 18·6 tantalic acid, 12 iron protoxide, 14 to
ium oxide, 6 thorina oxide 4 zirconia, and 16 yttria with
d magnesia Mitch., Mitchell county in North Carolina.
roilmenite of Hermann.

NIOBITE, R,Nb
ve H ·01 Black, brown. Splintery.
Opaque ·ff·eous Niobic acid ·0·4, uranium oxide 14·4,
ron oxide ·s, yttria 14·4, lime 4·7, water 4·6. Nohl
·ede Sweden

Yellowish brown Resinous lustre Trace
5 G 4·2 to 4·9 C.c.: niobic acid 31·3,
nium oxide 15·2 lime 8·9, water 4·5. Nohl

ANTIMONIATES

·e M ·ite, $Cu_2Sb_2O_7$.
·ite P 110 50 Scratches glass G 4·7. Honey yellow
·ish red B.B. fuses to a black h slag Sol. in acids
·s antimonic acid, 37·3 antimony oxide, and 21·4 lime, but
·s manganese and iron protoxide. St Marcel in Piedmont.
·ite, from Tyrol, may be an impure variety.

·ITE, $Pb_2Sb_2O_7$ + H
·m and massive H 4, G 3·9 to 4·8 Translucent;
·to earthy Colourless, yellow, brown, and grey. B.B.
·on charcoal. C.c oxide of lead 41 to 67, antimonious
·47, water 6 to 12. Lostwithiel, Horhausen, Nertschinsk.

·NOBLITE, $PbSb_2O_6 + PbCl_2$.
·prismatic, ∞P 122° 51′ Crystals tabular. Cl macro-
H. 3; G. 7. Yellowish or greyish brown. Resinous
·antine, translucent C·c lead 52·2, antimony 30·8
·chlorine 9. Constantine Algeria.

·IXOLITE
·e Yellowish to greyish green Opaque, fracture un
·ttle. H. 3·5 to 4; G 3·6 C·c oxide of copper
·de of silver 1·2, antimonic acid 12, carbonic acid 21
·l Cash in the province of Lerida. *Thrombolite* from Rez
·ungary, may be a hydrated variety

·LITE, $AlO(C_{12}O_9)$ + 18H
·dal; P 93° 5′ oP, Pæ and ∞P∞. Cl P, fractu
·l, brittle. H 2 to 2·5, G 1·5 to
·an-parent, doubly refractive, vitr
·oney yellow or reddish, streak white.
tube yields water B.B. chars with
Burns white and acts like alumina
·acid or potash C·c. alumina 14·4,
·id 40·3, water 45·3. In lignite at
·n Thuringia and Laschitz in Bohemia Walchow in
·ed·ous in coal at Miloyka in Tula

·XALITE, $2FeC_4 + 3H$
·y crystals, also botryoidal or compact; fracture uneven;
H 2, G 2·2. Opaque, resinous to dull Straw-yellow
·black, then red Sol. to yellow solution in acid. C·c
·protoxide, 42·1 oxalic acid, 1·8 water In lignite at
·k near Bilin Duisburg, and Gross Almerode in Hesse.

·NEWITE, CaC_4H
·prismatic, C 72° 11′ ∞P 100° 36′ Cl basal, perfect,
·H 2·5 to 2·8, G. 1·838 Transparent to opaque,
·Colourless C·c 49·31 oxalic acid, 38·36 lime, 12·33
·Hausm.

III. MINERAL RESINS

·of these are only vegetable resins slightly red Naphtha
·the other ·ellowish H ·· to 2 or 2·5. Most are amor-
·low ·ow·ful ·· G. 0·6 to 1·6. Mostly
·, colourless ·· ·ellowish brown, yellow, or red, with pale
Sol. in ·ol ·oled ether, ·d oils Me ·· readily, and
·n flame ·· ·moke

·APHTHA, $C_{10}H_8$ (?)
Colourless, yellow, ·· brown Transparent or trans-lu-
·0·7 to 0·9 Volatile ·· ·n the atmosphere with an
·bituminous odour C·c ·· 85 to 88 carbon, and 12 to 16
·. Varieties are
·ta. Very fluid, transparent, and light yellow. Tegern
·Bavaria, Amiano near Parma, Sulas in the Pyrenees,
·Baku on the Caspian Sea, Chera, Persia, and North
·sed for burning, and in preparing varnishes.
·m. - Darker yellow or blackish ·own, less fluid or
·Ormskirk, in Lancashire; Coalbrookdale, Pitchford, and
Madeley in Shropshire: St Catherine's Well, south of Edinb
Mainland of Orkney; and many other parts of Europe.

708. ELATERITE (*Elastic Bitumen, Mineral Caoutchouc*), C
Compact; reniform or fungoid; elastic and flexible like c
choue, very soft G. 0·8 to 1·23. Resinous. Blackish, red
or yellowish brown. Strong bituminous odour. C.c.: 84
carbon, 12 to 14 hydrogen, and a little oxygen. Derby
Montrelais near Nantes, and Woodbury in Connecticut.

709. ASPHALTUM, BITUMEN.
Compact and disseminated; fracture conchoidal, some
vesicular; sectile H 2, G. 1·1 to 1·2. Opaque, resi
and pitch-black; strong bituminous odour, especially when ru
Takes fire easily, and burns with a bright flame and thick sm
Sol. in ether, except a small remainder, which is dissolved
of turpentine C·c: 76 to 88 carbon, 2 to 10 oxygen, 6
hydrogen, and 1 to 3 nitrogen. Limmer near Hanover, Seys
the Rhone, Val Travers in Neufchatel, Lobsann in Alsace, i
Harz, Dead Sea, Persia, and Trinidad; Cornwall, Haughmond
(Shropshire), East and West Lothians, Elie and Burntisland (

710. ALBERTITE
Massive Velvet-black. Adamantine lustre; brittle.
carbon 86, hydrogen 9, nitrogen 2·9, oxygen 2. Hoy, Ork
Strathpeffer, Ross; Hillsborough, New Brunswick.

711. PIAUZITE.
Massive, imperfect conchoidal, sectile. H. = 1·5; G. =
Dimly translucent on very thin edges; resinous. Blackish br
streak yellowish brown Fuses at 600° Fahr., and burns wi
aromatic odour, lively flame, and dense smoke. Sol. in ethe
caustic potash. Priuze near Rudolfswerth in Carniola.

712. IXOLYTE
Massive, conchoidal fracture. H. = 7; G. = 1·008. Resi
Hyacinth red; streak ochre yellow. Rubbed between the fi
it emits an aromatic odour; becomes soft at 119°, but is
viscid at 212°. Oberhart near Gloggnitz in Austria.

713. AMBER (*Succinite*), $C_{10}H_8O$.
Round irregular lumps, grains or drops. Fracture perfect
choidal, slightly brittle H. = 2 to 2·5; G. = 1 to 1·1. Transp
to translucent or almost opaque, resinous. Honey-yellow, hyac
red, brown, yellowish white; also streaked or spotted. V
rubbe ·ble odour, and becomes negatively ele
It melts at 550°, emitting water, an empyreumatic oil, and suc
acid; it burns with a bright flame and pleasant odour, leav
carbonaceous remainder, only a small part is soluble in alc
C·c: 79 carbon, 10·5 hydrogen, and 10·5 oxygen. Derived f
from an extinct coniferous tree (*Pinites succinifer*), and f
in the Tertiary and diluvial formations of many countries, espe
northern Germany and shores of the Baltic, Sicily, Spain,
northern Italy, rarely in Britain (on the shores of Fife, Nor
Suffolk, and Essex, and at Kensington, near London). Use
ornamental purposes, and by preparing succinic acid and
nishes. *Krantzite*, from Nienburg, is essentially the same.

714. RETINITE (*Retinasphalt*).
Roundish or irregular lumps, fracture uneven or concho
very easily frangible H. = 1·5 to 2; G. = 1·05 to 1·15. T
lucent or opaque resinous or glistening Yellow or brown.
at a low heat, and burns with an aromatic or bituminous o
C·c in general carbon, hydrogen, and oxygen, in very
certain amount Bovey, Halle, Cape Sable, and Osnab
Fuscotinite from Aussig in Bohemia is similar.

715. WALCHOWITE, C_3H_2O.
Rounded pieces, with a conchoidal fracture. H. = 1·5
G. 1·035 to 1·069. Translucent, resinous. Yellow with b
stripes, and a yellowish white streak. It fuses at 482°, and b
readily. Soluble partially (7·5 per cent.) in ether; in s. acid f
a dark-brown solution. C.c. 80·4 carbon, 10·7 hydrogen,
8·9 oxygen Walchow in Moravia.

716. COPALINE (*Fossil Copal, Highgate Resin*), $C_{40}H_{64}O$.
Irregular fragments H. = 1·5; G. = 1·046. Translucent, resi
burns with light yellow flame and much smoke; alcohol diss
little of it, becomes black in sulphuric acid. C.c.: 85·54 ca
11·63 hydrogen, 2·76 oxygen. Highgate near London. A si
resin from Setting Stones mine in Northumberland, found i
drops or crusts on calc-spar, is infusible at 500° Fahr.; G. = 1·
1·51, it contains 85·13 carbon, 10·85 hydrogen, and 3·26 ash

717. BUCHOLZITE, $C_{40}H_{62}O_8$.
Amorphous; conchoidal fracture. Dark brown, inclinin
green, yellow streak. Resinous; unpleasant odour, and b
taste Fuses below 212°, and continues soft afterwards at ord
temperatures; easily soluble in alcohol. C.c.: 72·40 carbon,
hydrogen, 18·31 oxygen. San Juan de Berengela in Peru.

718. GUAYAQUILLITE, $C_{20}H_{26}O_3$.
Amorphous; yielding easily to the knife, and very friable.

2. Pale yellow. Slightly resinous. Fluid at 212°, viscid old; slightly soluble in water, and largely in alcohol, forming w fluid with a bitter taste. C.c.: 77·01 carbon, 8·18 hydro- nd 14·80 oxygen. Guayaquil in South America.

utter, from the Irish peat mosses, is similar: it melts at s easily soluble in alcohol, and contains 73·70 carbon, 12·50 en, and 13·72 oxygen.

HARTINE, $C_{20}H_{20}+H$.

nd masses or thin layers. Brittle, but easily cut with a G. = 1·6. Resinous. Reddish brown by reflected and deep transmitted light; streak light brown. Becomes black on re. C.c.: 86·43 carbon, 8·01 hydrogen, 5·56 oxygen. In in coal seam at Middleton near Leeds, and at Newcastle

OZOCERITE (*Native Paraffin*), CH.

rphous, sometimes fibrous. Very soft, pliable, and easily ed with the fingers. G. 0·94 to 0·97. Glimmering or ng; semitranslucent. Yellowish brown or hyacinth red by itted, dark leek-green by reflected light. Strong paraffin matic odour; fuses easily to a clear oily fluid, at higher ature burns with a clear flame, seldom leaving any ashes, soluble in oil of turpentine, with great difficulty in alcohol r. C.c.: 85·7 carbon, and 14·3 hydrogen. Brora (Sutherland Edinburgh: Slanik and Zietrisch in Moldavia; near g in Austria, and Baku: also at Urpeth coal mine near tle-on-Tyne. *Pyropissite* may be a variety.

HATCHETTINE (*Mineral Tallow*).

y, like spermaceti; or subgranular like bee's wax, soft and . G. = 0·6. Translucent; weak pearly. Yellowish white, llow, or greenish yellow. Greasy motionless, readily soluble r. C.c.: 85·91 carbon, 14·62 hydrogen, or similar to ozocerite yne (fusible at 115°), Merthyr Tydvil; Schaumburg.

FICHTELITE, C_4H_8.

talline (oblique prismatic) lamellæ, which swim in water, k in alcohol. White and pearly. Fuses at 111°, but forms crystalline on cooling. Very easily soluble in ether and peal by alcohol. C.c.: 88·9 carbon and 11·1 hydrogen. In pine a peat-moss near Redwitz in Bavaria.

HARTITE, C_6H_6.

thic; but mostly like spermaceti or white wax, and lamellar but not flexible. H. = 1; G. = 1·016. Translucent, dull s. White. Melts at 165°, and burns with much smoke. oluble in ether, much less so in alcohol. C.c.: 87·8 carbon 2 hydrogen. Oberhart in Austria.

KÖNLITE, C_9H.

talline folia and grains. Soft. G. = 0·88. Translucent, s. White, without smell. Fuses at 120° to 137°. Sol. in ; precipitated by water in a white crystalline mass. C.c.: rbon, 7·7 hydrogen. Uznach near St Gall; Redwitz.

SCHEERERITE, CH_2.

que prismatic; tabular or acicular. Soft and rather brittle. to 1·2. Translucent; resinous or adamantine. White, to to yellow or green. Feels greasy, has no taste, and when smell, but when heated a weak aromatic odour. Insoluble r; readily sol. in alcohol, ether, and nitric acid. C.c.: on, 25 hydrogen. Uznach. *Branchite*, white, translucent, at 167°, is similar; Montevaso in Tuscany.

IDRIALITE, C_8H_8.

ive; fracture uneven or slaty; scratched by 1·5, d 1 to 1·6 (1·7 to 3·2). Opaque; resinous. Greyish or sh black; streak blackish brown, inclining to red. Feels . Burns with a thick smoky flame, giving out sulphurous nd leaving some reddish brown ashes. C.c.: 77 idrialine carbon and 5·3 hydrogen) and 18 cinnabar, with a little luminia, pyrite, and lime. The idrialine may be extracted n olive oil or oil of turpentine as a pearly shining mass. tly fusible. Idria.

727. TORBANITE.

Massive; fracture subconchoidal. Yellow, brown-grey, brown. H. = 1·5 to 2; G. = 1·28. C.c.: 60 to 65 carbon, 9 h 4 to 5 oxygen, 10 to 20 silicate of alumina. When distille redness yields a burning fluid holding paraffin in solution redness a large quantity of highly illuminating gas. S the microscope to consist of granules of a yellow bituminou with interstitial shaly matter. Torbanehill in Scotland in Bohemia, Kuralena and Murayevna in Russia.

728. DOPPLERITE.

Jelly, like elastic masses. Brownish black, streak brown lustre H. = 0·5, G. = 1·1. After drying H. = 2·5; G. = 1·2 ubble in alcohol and ether. An acid substance related t acid. From peat beds, Aussee (Styria) and Switzerland.

THE COALS.

729. ANTHRACITE (*Glance Coal*).

Massive and disseminated, rarely columnar. Fracture con brittle. H. = 2 to 2·5, G. = 1·4 to 1·7. Opaque, brilliant iron-black, streak unaltered. Perfect conductor of el Burns difficultly with a very weak or no flame, and does n in the closed tube yields a little moisture, but no empyr oil, deto[illegible] with nitre. C.c.: carbon above 90 per ce 1 to 3 oxygen, 1 to 4 hydrogen, and 0 to 3 nitrogen, a chiefly of silica, alumina, lime, and peroxide of iron. Co some part of all coal-field, and especially in the United S in Rhode Island, Massachusetts, and above all in Penn Used chiefly for manufacturing metals.

730. COMMON COAL (*Black Coal, Steam or Manufacturing Coal*).

Compact, slaty, or coarsely fibrous, often dividing int bedded, columnar, or cubical fragments. Fracture conchoi even, or fibrous, rather brittle or scaly. H. = 2 to 2·5, G 1·2. Vitreous, resinous, or silky in the fibrous variety brown, pitch-black, or velvet black. Burns easily, emitti and smoke with a bituminous odour, heated in the clo yields much oil. C.c.: 74 to 90 carbon with 6·0 to 8 or 1 3 to 6 hydrogen, 0 to 1 to 2 nitrogen, 0·1 to 3 sulphur, a earthy matter or ash, in 100 parts.

Slate Coal or *Splint* has a thick slaty structure, and r fracture. *Cherry Coal* is the name applied to the brittle la trous variety common in the Lancashire coal-fields. *Caking* more bituminous variety which undergoes combustion when caking or agglutinating during combustion. *Cannel Coal* ha ous, glimmering lustre, and a flat conchoidal fracture, bu irregular cubical fragments, but is more solid and takes polish than other varieties. The bars with a bright fl yields much gas. Abundant in many fields, as in Englan land, and Ireland, in Bohemia and France, in Germa southern Russia, British America, and the United State numerous fields, especially in the valley of the Missi spe found in China, Japan, Hindostan, Australia, Borneo, and the Indian islands.

731. LIGNITE (*Jet, Brown Coal*).

Distinctly vegetable in organization, the external form, and v the internal woody structure, being preserved. The te pact woody, or earthy. Fracture conchoidal, woody, or soft and often friable. C.c.: 50 to 75 carbon. Lignite sometim ous, mostly glimmering or dull. Brown, black, or bl Burns easily with an empyreumatic odour, and a solution o deep brown. C.c.: 47 to 75 carbon, 5·5 to 7·5 hydrogen, oxygen (with nitrogen, and [illegible]). Very pitchy conchoidal fracture, and is [illegible]. Brown coal o Bovey-Tracy in Devonshire, also in Germany, Hungary, Italy, and Greece. [illegible] or Ireland seem a Coal as fuel, but much inferior to common coal. The coals of Yorkshire, Antrim, Brora, Mull, and Skye are in ate variety.

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ERAL WATERS. No absolute line of demarcation can be drawn between ordinary and mineral waters. There is usually in the latter an excess of mineral constituents or of temperature, but some drinking waters contain more mineral constituents than other- that are called mineral waters, and many very pure waters, both cold and warm, have been regarded for ages as sacred springs.

As to the origin of mineral waters, there is much in accordance with the elder Pliny said, that waters are such as the soil through which they flow. Thus in limestone and chalk districts there is an excess of lime is usually present; and the waters of a particular district have much resemblance to each other—as in the Eifel, in Auvergne, and in the Pyrenees. But this is only a partial explanation, for waters are by no means necessarily uniform throughout a particular geological formation. We do not know with certainty the depth from which various mineral waters proceed, nor the various distances from the surface at which they take up their different mineral constituents.

The source of the temperature of thermal waters remains a point of much uncertainty. Among the assigned causes are the internal heat of the globe, or the development of heat by chemical or electrical agencies in the strata through which they arise.

The occasional intermittence is doubtless often dependent on the periodical generation of steam, as in the case of the Geysers. A few geological facts are certain, which throw light on the origin of mineral waters. Such springs are most abundant in volcanic districts, where many salts of iron and much carbonic acid are present. They occur most frequently at meetings of stratified with unstratified rocks, in valleys, and at points where there has been dislocation of strata.

The diffusion of mineral waters is very extended. Pliny was quite correct in observing that they are to be found on the line heights and arising from the bottom of the sea. They are found at the snow in the Himalayas and close to the sea at Baiæ and Ischia. They are to be found in all quarters of the globe, but more particularly in volcanic regions, as in the Eifel and Auvergne, in the south of Naples, and parts of Greece, in Iceland, New Zealand, and Japan. But there are few countries in which they are not to be found, except in very flat ones, such as the deltas of rivers, for instance, in the north of France, where they are very few, and in Holland, from which they are absent. France, Germany, Italy, and Spain, as well as Asia Minor, and the Caucasus, are all rich in mineral waters. The British Isles have a fair though not very large portion of them. There are a few in Sweden and Norway. They are abundant in the United States, less so in Canada. They are found in the Azores and in the West India Islands. Of their occurrence in the interior of Africa or of Australia we know little, and the same is true of South America. But they are met with in Algiers, in Egypt, and in the Holy Land. The vast Indian peninsula has, for its size a comparatively small supply.

As the effects of mineral waters on the bodily health have been found to be different from those of common waters, an explanation of this has been naturally looked for. It has been imagined that there is something in the nature of mineral waters, that their heat is not ordinary heat, that their condition is a peculiar one. Some French modern writers even say that there is a certain life in them, that their constitution is analogous to that of the serum of the blood. But we must put these speculations, and be guided as far as possible by ascertained facts, respecting the action on the system of waters of heat and cold, and of the mineral constituents present.

Mineral waters, when analysed, are found to contain a great many substances, although some of them occur only in very minute quantities: soda, magnesia, lime, potash, alumina, iron, boron, iodine, bromine, silica, lithium, caesium, rubidium, fluorine, barium, copper, manganese, strontium, silica, phosphorus, besides organic matters, and various organic deposits known under the name of glairin or baregin. Of gases, there have been found carbonic acid, hydrosulphuric acid, nitrogen, carburetted hydrogen, oxygen, and ammonia. Of all these by far the most important in a therapeutic point of view are soda, magnesia, and iron, carbonic acid, sulphur and its hydrosulphuric acid. These substances, detected separately by chemists, are in their analyses combined by them in various salts, if not with absolute certainty, under

close approximation to it. Those combinations are
merous, and some waters contain ten to twenty of
but there are always some predominating ones,
mark their character, while many of them, such as
, rubidium, or fluorine, occur in mere traces, and
be assumed to be of any real importance. Mineral
therefore to dive themselves into weaker or stronger
of salt and gases in water of higher or lower
ature. For medical purposes they are used either
ly or internally, for bathing or for drinking. As
antity of salt present commonly bears but a very
proportion to that of the fluid containing them,
becomes a very influential agent in mineral water
nt, about which it is therefore necessary to say
ing.

he action of hot and cold baths the reader is referred
ticle Baths. But it may be observed here that,
ng to the most generally received opinion, the cuta
rface does not absorb any portion of the salts in a
water bath, although it may absorb a little gas
aline water, for instance, at most acting as a slight
nt on the skin), and that neither salts nor gases
y action on the system, except as stimulants of the
th partial action on the respiratory organs.

ems to be ascertained that drinking considerable
of cold water reduces the temperature of the body,
hes the frequency of the pulse, and increases the
pressure temporarily. Water when introduced
e stomach, especially if it be empty, is quickly
d; but, although much of the water passes into the
here is no proof that it ever produces in them, as is
es supposed, a state of fluidity or wateriness.
ntically, the imbibition of large quantities of water
a sort of general washing out of the organs. This
s a temporary increase of certain excretions,
ted diuresis, and a quantitative increase of urea,
ride of sodium, and of phosphoric and sulphuric
the urine. Both the sensible and the insensible
tions are augmented. A draught of cold water
tedly stimulates the peristaltic action of the
es. On the whole water slightly warmer than best
by the stomach, and is more easily absorbed by it
ld water, and warm waters are more useful than
s when there is much gastric irritability.

addition to the therapeutic action of mineral waters,
re certain very important subsidiary considerations
must not be overlooked. An individual who goes
ome to drink them finds himself in a different
, with possibly a considerable change in altitude,
s necessarily altered, and his usual home drinks are
p. There is change in the hours of going to bed and
. He is relieved from the routine of usual duties,
rown into new and probably cheerful society. He
more exercise than when at home, and is more in the
ir, and this probably at the best season of the year.
portant for the matter of season and climate been
that it is an established axiom that waters can be
the greatest advantage during the summer months
fine weather and during the periods most convenient
xation from business. Summer is therefore the bath
but of late years provision has been made in many
with the aid of specially constructed rooms and
s, for carrying on cures satisfactorily during the
season, e.g., at Aix-la-Chapelle, Wiesbaden, Baden
Baden in Switzerland, Bex, Vichy, and Bath. The
y bath season extends from the 15th of May to the
30th September. The season for baths situated
siderable elevations commences a month later and
ates some ten days earlier. Mineral waters may be
ed at home, but patients seldom so use them; and
this necessarily limits the time of their use. It is co
to declare that the treatment should last for such or
a period. But the length of time for which any rem
to be used must depend on its effect, and on the nat
the particular case. It is found, however, that the
tinued use of mineral waters leads to certain disturb
of the system, which have been called crises, such as
lessness, colics, and diarrhœa, and to skin eruptions k
as *la poussée*. This cause, and also certain peculiarit
the female constitution, have led to the period of
weeks to a month being considered the usual perio
treatment. A certain after treatment is often prese
—such as persistence in a particular diet, visiting sp
or climates of a different and usually of a tonic cha
or continuing for a certain time to drink the wat
home. It may be added that the advantage of h
recourse to mineral waters is often felt more after
during treatment.

Since improved methods of bottling have been disco
and the advantage of an additional supply of carboni
has been appreciated, the export of waters from their s
has increased enormously, and most of the principal
can now be advantageously used at home. It m
added that many of the artificial imitations of the
excellent.

The history of the use of mineral waters can onl
be alluded to. They have been employed from the e
periods, and traces of Roman work have been fou
most of the European baths which are now in favou
almost all the thermal ones. Occasionally new s
are discovered in old countries, but the great majo
them have been long known. They have vari
popularity, and the modes of applying them hav
varied, but less so than has been the case with most
ordinary medicines. Warm waters, and those cont
small quantities of mineral constituents, appear to
remained more steadily in favour than any other
within the appropriate sphere of mineral waters, wh
limited to the treatment of chronic disease.

The attempt has been made to range mineral
according to their therapeutic action, according to
internal or external use, but most generally accord
their chemical constituents so far as they have bee
time to time understood, and a judicious classif
undoubtedly is a help towards their rational employ
But their constituents are so varied, and the grad
between different waters are so finely shaded off,
has been found impossible to propose any one c
scientific classification that is not open to num
objections. Thus a great many of the sulphur wat
practically earthy or saline ones. Yet because the
contain very minute amounts of such a gas as hydrosul
acid, an ingredient so palpable as always to
attention, it is considered necessary to class them
the head of sulphur. The general rule is to atte
class a water under the head of its predominant ele
but if the amount of that be extremely small, this le
such waters as those of Mont Dore being classif
alkaline or aerated, because they contain a very
soda and arsenic. The classification in the following
which is that usually adopted in Germany, has the
of comparative simplicity, and of freedom from theo
considerations which in this matter influence the
much more than the German writers. The more imp
constituents only are given. The amount of solid co
ents is the number of parts to one thousand parts
water, the temperature of thermal springs is added
waters are classified as indifferent, earthy, salt, sulphu
iron, alkaline, alkaline saline—with subvarieties o
waters and purging waters.

MINERAL WATERS

TABLE I.—*Typical Mineral Waters.*

	Indifferent. Gastein, 95°-118°.	*Earthy.* Leuk, 123°8.	*Salt.* Kissingen.	*Salt.* Sea-Water	*Sulphur.* Aix-la-Chapelle, 113°-140	*Iron.* Schwalbach	*Alkaline.* Vichy, 105°8	*Alkaline-Saline.* Carlsbad, 118°-138°	*Table Water.* Selters.
Solids.									
Carbonate of soda.....					·6449	·0206	4·883	1·92	1·2
,, potash.							·352		
,, magnesia.	·0017	·013	·017	15	·0506	·2122	·303	·18	
,, calcium ..	·0195	·012	1·06	2·38	·157	·2213	·434	1·28	
Sulphate of soda.....	·0208	·050			·2831	·0079	292	2·37	
,, potash	·0135	038			·1527	·0037		16	
,, magnesia...		308	5·58	2·96					16
,, calcium.		1·520	·389	·25					
Sulphide of sodium					0136				
Chloride of sodium . ..	·0428		5·52	25·21	2·616		·531	1·03	2·2
,, potash.....			286						
,, magnesia..			393	3·39					
Carbonate of iron..... ...	·0005	·023	0·277			0837		003	01
Silicic acid....	·0496	036				·0320			
Gases.									
Carbonic acid..... . ..			3·19			5·35	2·6	1·6	2·24
Hydrosulphuric acid..					trace				

addition to their solid constituents, gases are present in waters in considerable quantity. There is a little n and a good deal of nitrogen in some of them; the ity of hydrosulphuric acid, even in strong sulphuric s, is wonderfully small: but the volume of carbonic present is often very large,—for instance, in the case of geu, Schwalbach, and Selters. Carbonic acid is so ally diffused that it is practically a very important in the therapeutics of mineral waters. Springs that in it are far the most agreeable to the taste, and quently most popular with patients. The immediate of the carbonic acid which they contain is that of ant stimulation to the stomach and system, although scarcely be said to approach, as some have thought, lighter forms of stimulation from alcoholic drinks. emely little appears to be known of its actual operation e system: a part of what is swallowed is returned by ation, and a part passes on t whether appreciable quantity reache e blood is doubtful. e is no question that carbonic acid increases diuresis. ically it is found to aid digestion, helping the functions e stomach, and in a slight degree the peristaltic action e intestines. The increased flow of urine may be d by its favouring the absorption of water by the ach. In some baths carbonic acid i bundant that utions have to be taken to prevent its tendency to mulate on account of its heavy specific gravity. Car acid gas, used as a bath, prove stimulating to the and to the general system: but its employment has nswered the expectations formed of it.

ifferent Waters scarcely vary in chemical qualities from ordi drinking water; but they are usually of high temperature therapeutic action, which is mainly exercised through baths, en explained on the theory of peculiarities of their electric or al condition, about which we know nothing definite, and on résence in some of them of a large quantity of nitrogen. It so been ascribed to the various organic substances in some of such as glairin, which when collected is sometimes useful as plasm. These waters are not often much drunk, but any ncy they may have in dyspepsia and perhaps in neuralgic oeas must be attributed to the favourable action of hot water digestion. The waters of this class, especially the hotter in the form of baths, are extremely useful in resolving the of inflammation, in thickenings of the joints, and in chronic matism and gout. They also are often effective, especially the ones, in neuralgia and in some hysterical affections. They metimes prescribed in urinary affections, in which case they bly assist by dilution. The effects of many of these waters are by the baths often being situated at considerable elevations n out-of-the-way spots, when the Germans called them *bader*. They are very widely diffused, being found in all rs of the globe, especially in volcanic districts. There are in New Zealand; in America the hottest are in the West and lifornia.

TABLE II. *Indifferent Waters*

	Height in feet	Temperature Fahr.
Evian, Lake of Geneva	1,100	
Lodenwerder, Baden	1,450	
Buxton, England	980	
Schlangenbad, Nassau		
Seidlitz, Spain		
Wildbad, Wurtemberg	1,320	
Pfeffers, Switzerland	1,116	
Rapitz, do		
Pantescos, S. Tyrol	2,110	50-90
Teplitz, Bohemia	648	101-120
Gastein, Austria		

Earthy Waters. The latter chiefly from ... containing an appreciable quantity of salts, ... or carbonate ... of magnesia, etc. ... majority of them are of high temperature ... effects as the indifferent waters, but are ... in neuralgic affection while they are more ... the chronic scaly eruptions. These waters ... consider these waters useful in urinary ... present day it is only the colder ones that ... for the expulsion of gravel ... urinary ... ment of affections of the bladder ... genera ... also of late years been tried ... on scrofula, and to be useful ... phthisis. This has been attributed ... them, although ... system unaltered. Many ... enjoy the elevated ... but ... the best of them,

TABLE III. *Saline Waters*

	Height in feet	Temperature Fahr.	
Leuk	4,400	93-123	Dyspepsia, diabetes
Ischl	1,480	117-122	Gout
Ischl	1,480	93-123	Do
Baden	1,400	85-104	Do
Baden		108-122	Do
Baden		108-122	Do
Carlsbad	1,400	129	Do
Bourbon l'Archambault	1,800	64-123	Do

and the following ... mineral waters in various Europ... countries that ... chief peculiarities of elevation of temperature ... The curative effects, necessarily attached to ... attributed to them.

MINERAL WATERS

Waters are so called from containing a predominant amount
de of sodium They also generally contain chlorides of
and of lime and occasionally small amounts of lithium,
and iodine They further often contain a little iron, which
portant a bitter on the great majority of the drinking wells
ge supply of carbonic acid. There are cold and hot salt
Sometimes they are used for drinking, sometimes for
and in the case of them is often resorted to.
great quantity of *common* salt contained daily by many is
about 300 grains The maximum quantity
to be present in any well may be 525 grains but commonly not
that amount is taken. The increase to the usual
therefore probably not much more than one third.
be presumed that the action of a solution of salt on an
different from that of the same amount of salt
food Salt introduced into the stomach excites the
gastric juice, and favours the peristaltic action and
in considerable quantity is distinctly aperient We
how it is useful in dyspepsia in atony of the stomach and
, and sometimes in chronic intestinal catarrh Salt when
by the stomach appears again in the urine, of which in
amount both of fluid and of solid constituents, especially
It seems therefore to be pretty certain that considerable
of salt taken into the circulation increases the excretion
ous products through the urine, and on the whole
the transformation of tissue Salt is thus useful in
stimulating the system, and also in anæmia, especially
is also present In some German stations, at Soden
salt waters are considered to be useful in chronic
or granular pharyngitis

salt waters, as nearly even 1 cent, contain more than 3
of chloride of sodium, some of the strongest perhaps from
per cent Their primary action is as a stimulant to the
which action it is probable that the other chlorides,
that of calcium, and still more the carbonic acid often
to operate In this way, and when aided by various pro-
what may be termed water poultice and packing, they
useful in removing exudation in chronic metritis and
mours of the uterus, and generally in scrofula and rachitis,
nally in some chronic skin affections

such accord high praise to some of their thermal salt
paralysis, and some German ones are used in a similar
nal affections The salt water is sometimes too strong
must be diluted for bathing In other cases concen-
trations of salt are added to make them sufficiently strong
ters are widely diffused, but on the whole Germany is
them, especially in such as are locally charged with
e Kreuznach spring may be considered as typical of the
wells and sea water of bathing water The art of salt-
l pulverization of the water are employed in German
medical agents

ring are found in many quarters of the world but the
nated groups for drinking purposes occur in Germany,
toga in America, where very remarkable wells indeed
found France and England have no spring of this
The stronger wells, used chiefly for bathing occur where

TABLE IV *Salt Springs*

Locality		
near Frankfort		Dyspepsia, anæmia, scrofula special for throat and phthisis
burg, do		Dyspepsia, slighter hepatic affections, chlorosis (salt In all essentials the same
near Bonn		Better known for its iron has a good salt drinking spring
North Germany		A salt well without carbonic acid used in scrofula and in some bathing more important
		Used in dyspepsia and recent the bathing is most important
		Still saltier water, uses similar
		Do.; special for treatment of paralysis
Montfort Vorarlberg	do.	Scrofula anæmia, loss of power, sexual disorders
Savoy (France)	do.	Vet only in use, Universal canal used for observ
North Italy	do.	Rheumatism special treatment with the bath closed
do	do.	Chief use baths, mud of bath used for poultice
de Monbuy, near Lerida, Spain	Lerida	Rheumatism, chronic exudations
Guipuzcoa, Spain	Salinas	Rheumatism and cutaneous affections

to vary from 11 to 18 per cent of chloride of sodium the water
rake, perhaps varying from 0·5 to 1·0

there are salt bearing strata, as in Germany, Galicia, Italy, Switzerland, France, and England. Very powerful waters of this class are those of St Catherines in Canada

The presence of minute portions of *iodine* or *bromine* in salt waters is by no means infrequent, and they appear in considerable quantity in some few It is, however, extremely doubtful whether any known spring contains a sufficient quantity of iodine, still more of bromine, to act specially on the system, even if that action were not necessarily superseded by the presence of the large quantity of other salts with which they are associated Some of the best known springs of the kind are Challes, Wildegg, Castrocaro, Hall, Adelheid's Quelle, Kreuzbrunnen, Kreuznach, Woodhall Spa.

Iron or Chalybeate Waters - Iron usually exists in waters in the state of protoxide or bi-carbonate, less frequently as sulphate or crenate, and very rarely at all as chloride. The quantity present is usually extremely small It may be said to vary from ·12 to ·03 in the 1000 part of water Some wells considered distinct chalybeates contain less than ·03. Many wells, especially in Germany, have a rich supply of carbonic acid, which is unfortunately wanting in French and English stations

It has long been the prevalent idea that want of iron in the blood is the main cause of chlorosis and of other anæmic conditions, and that these conditions are best relieved by a supply of that metal. Since the detection of it in hæmoglobuline this view has been still more popular. It is pretty certain that the blood contains 37 to 42 grains and the whole system 70 to 74 grains of iron; and it has been calculated that in normal conditions of the system somewhat more than one grain of iron is taken daily in articles of food, and that the same amount is passed in the fæces; for although the stomach take the iron up it is excreted by the alimentary canal mainly it being doubtful whether any is excreted in the urine. It is possible by drinking several glasses to take in more than a gram of carbonate of iron in the day, equivalent to half that amount of metallic iron It has further been enormously reckoned from practice that 10 to 15 grains of metallic iron suffice to supply the deficiency in the system in a case of chlorosis It is thought probable that a portion of the iron taken up in water is in certain pathological state not excreted, but returned in the system, and goes towards making up the want of that metal But, whether this or any other explanation be satisfactory, there is no question as to the excellent effects often produced by drinking chalybeate waters (especially when they are carbonated), and by bathing in those which are rich in carbonic acid after they have been artificially heated. As regards the drinking cure we must not, however, forget that carbonate and chloride of sodium, and also the sulphate, are often present and must be credited a share in the cure Thus chloride of sodium is a power

TABLE V *Strongest Salt Waters.*

	Chloride of Sodium in 1000 parts of Water	Therapeutic	
Rheinfelden, Aargau, Switzerland	541	Scrofula effects of inflammation, chronic exudations, some chronic exanthemas, rheumatism, uterine infiltrations.	
Salzungen North Germany	256	Do.	do.
Ischel Austria (1149 ft.)	256	Do.	do.
Hall Tyrol (1709 ft.)	255	Do.	do.
Reichenhall near Salzburg (1800 ft.)	221	Do.	do.
Bex Rhone Valley (1100 ft.)	156	Do.	do
Castrocaro, Tuscany		Do.	do
Droitwich near Worcester	2336	Do.	do.
Sea Water	301		
Rehme, Westphalia (92° F.)		(Do; special use in locomotor ataxia.	
Nauheim Wetterau (80–16		Do.	do.

TABLE VI *Iron Waters*

	Height in Feet	Carb. of Iron.	Therapeutic Use.
Rippoldsau Black Forest	1,886	12	For anæmic conditions; laxative.
Homburg near Frankfort		10	Do. do. do.
Elster Saxony	1,165	·08	Do. do. do.
Liebenstein North Germany	911	·08	
Schwalbach Nassau	900	·08	Do.; much of a ladies' bath.
Bocklet, near Kissingen	600	08	Do
Griesbach, Black Forest	1,614	·07	Do.; laxative; a ladies bath.
Schwalbach, Bohemia	1,293	·07	Do. do. do.
Pyrmont Germany		·07	Do.
Spa, Belgium	1,000	·06	Do.
Peterthal Black Forest	1,333	01	Do.; laxative.
St Moritz, Engadine, Switzerland	5,464		Do.; sought for its air.
Forges les Eaux, France			Do
La Malou, Herault, France (temp 88°)			Do.
Recoaro South Italy	1,463	·04	Do.
Harrogate Wells, England		·06	Do.; deficient in carbonic acid.
Murphy Spring, Harrogate (chloride)	...	·15	

juvant in the strong Stahl Quelle of Homburg and in the
n Well at Saratoga. A whole category of female complaints is
l successfully with these waters. Indeed anæmia from any
, as after fever or through loss of blood, and enlargements of
leen, are benefited by them. The stimulating action of the
s supply of carbonic acid in steel baths is a very important
nt; no one now believes in direct absorption of iron from the
. Iron waters are scarcely ever thermal. They are extremely
ou in all countries, frequently along with sulphuretted
gen in bogs, and near coal measures. But such springs and
rbonated wells generally are weak, and not now held in much
.

ay be added that some of the strongest known iron wells are
ted or *aluminated*. They are styptic and astringent, and can
e used diluted. They are sometimes useful as an application
rs and sores. Such springs have often been brought into notice,
ver retain their popularity. They are known in the Lake of
, in Wales, in Scotland, as well as in Elba, Aetna, and of late
he Bedford Alum and Oak Orchard Springs, U.S., have been
t into notice, the latter containing 19 grains of free sulphuric
the pint. All such springs have been considered useful in
a, anæmia, and chronic diarrhœa.

hur Springs.—Waters having the odour of hydrosulphuric
owever slightly, are usually called sulphur ones. The
mell sometimes to the presence of the free acid, sometimes
phides of sodium, calcium, or magnesium, and sometimes
Hydrosulphuric acid is absorbed more freely by cold
ter, and is therefore most abundant in cold springs. The
les decompose and give off the gas. Most of these
ear coal or shale measures, or in rocks containing lignite, or in
and in places generally where organic matter is present in
or strata. Many of them contain so little mineral impreg
that they might as well be classed among indifferent
hy waters. One group contains a considerable amount of
e of sodium, another of sulphate of lime, while a third has
ineral impregnation but contains sulphides.
osulphuric acid is a strong poison, and its action on the
has been pretty well ascertained. It has been assumed that
in mineral waters acts similarly, though in a modified
but there is next to nothing absolutely known of the
of the small quantities of the gas that are present in mineral
and which certainly have no toxic effect. It has been
d that this gas has some special action on the portal system
on the liver. On the connexion of metallic poisoning
e liver has been founded the idea that sulphur waters are
n metallic intoxication. Drinking large quantities of these
especially of such as contain sulphate or chloride of
or magnesia, combined with hot baths and exercise, may
break up albuminates, but there is no proof of the action
sulphur.

imilar reasons, and primarily to counteract mercurial poison
waters have been considered useful in syphilis. But it
well to remember that at most baths mercury is used along
em. No doubt they are frequently, like other warm waters,
n bringing out old eruptions, acting in this way as a test
ilitic poison, and in indicating the treatment that may be
required. Sulphur waters, both hot and cold, are used in g
rheumatism, in dyspepsia, in hepatic and cutaneous affection
of late years inhalation of them has been popular in phth
in laryngeal affections. They have long been popular rem
cutaneous affections. While so much doubt has been cast
action of the sulphur of these waters, it may be admitted t
sulphides are probably decomposed in the stomach and hy
phuric acid generated. That gas is probably a slight str
to the intestine. What hydrosulphuric acid reaches the l
eliminated by the lungs. There seems to be no doubt that
absorbed in small quantities by the skin.

It is in sulphur waters chiefly that glairin and baregin
This peculiar organic substance has been found both in Americ
in European springs. Cold sulphur springs are very widely d
throughout the world. Thermal ones are not so common
haps the largest though not the strongest group of the latte
be found in the Pyrenees. We may remark again how ver
hydrosulphuric acid there is in many of the most favourite s
-springs, including the very popular White Sulphur ones of V
There seems to be something peculiarly unsatisfactory
analyses of sulphur waters, and there has been difficulty in com
ing the following imperfect tables.

Some of the most powerful cold wells are those of Challes (
very peculiar water), Enk, and Harrogate. Enghien has a ver
amount of chloride of sodium in its springs. Cold sulphur
are on the whole more used in liver and indigestion than
ones. The general effects of warm sulphur waters differ so
at the various baths as to make it difficult to mention an
special to particular localities. Schinznach has a reputat
skin complaints, Cauterets, Eaux Bonnes, and Challes in lar
affections, the two Vixes, Luchon, and Archena in syphilis.

Alkaline Waters are such as contain carbonate (chiefly bic
ate) of soda along with an excess of carbonic acid. Of the ac
those carbonates it is known that when taken into the s
they are neutralized by the gastric juice, and converted into c
of sodium. On their introduction into the stomach they p
an increased flow of gastric juice. If given during or imme
after meals in any quantity they impede digestion. They s
increase peristaltic action, but only feebly unless as a cold b
salts. They act slightly as diuretics. Of the connexion b
the biliary system and alkalies, which undoubtedly exists, no
is known with certainty. The alkalization of the blood by t
assumed by many but not proved. It is very doubtful w
they reduce the quantity of fibrine in the blood, and thus r

TABLE IX. *Alkaline Waters*

Locality	Temp Fahr	Therapeutic Use
Lubatschowitz, Moravia	84	Springs rich both Soda and chl so
Tomnastein, Hung. Ver.	25	Light antacid to stomach
Ems, Nassau	80 114	20	Special in female plaints and membrane
Ischia, Italy	up to 170	20	Specially rheu and female com
Royat, Auvergne	80 95	15	Do and som affections
Mont Dore, do.	90 100 114		Asthma chron colds
Bourbon l'Arch. do.	80 104 122		Scrofula rachitis neous affection

TABLE X. *Alkaline Waters*

Locality	Height in Feet	Therapeutic Use
Vals, South France		Affect stomach gout ri liary calculi, over comp
Ems, Bohemia		
Vichy, France (105° F.)		
Neuenahr, Rhineland (72° 97° F.)		Irritates pe
St. Malon, France (97° F.)		
Vidago, Portugal		Portugese Vichy

TABLE VII. *Cold Sulphur Springs.*

Locality	Hydrosulphuric Acid	Sulphide of Sodium
Schaumburg-Lippe		
Prg. Lippe-Detmold	2·1	
el, Switzerland (3600 ft.)	15·1	
do. (3593 ft.)	11	
, Savoy (900 ft.)		
n, near Paris		
Isère, France (1500 ft.)		
ate, England		
effer, Scotland		
varna, Clare, Ireland		

TABLE VIII. *Warm Sulphur Springs.*

Locality.	Height in Feet	Temp Fahr	Sulphide of Sodium	Hydrosulphuric Acid absorbed in Water
Chapelle, Germany	551	151 110		
near Vienna	..	95 113		
ach, Switzerland	1,060	80 92		
Rhone Valley	1,350	92 113		
s Bad, Banat	500	110		
Balns, Savoy	765	108		
Pyrenees	2,000	135		
do.	4,100	113		
les-Balns, Pyrenees	810	81 117		
ts, do	3,254	71 134		
nnes, do.	2,400	90		
, Murcia, Spain	..	120		

TABLE XI. *Warm Saline Springs.*

Locality	Height in Feet	Therapeutic Use
Marienbad, Bohemia	1,460	Nervous and intestinal female complaints
Franzensbad, do.	1,012	Do, especially in obesit
Tarasp, Lower Engadine	1,294	Do, specially calculi, ba
Carlsbad, Bohemia (124° 164° F.)	4,000	Powerful action on abd
	1,200	Gout, liver affections, bili renal calculi, diabetes

state of the system, or whether they have any direct tend
combine with fat and carry off a portion of superfluous
tissue. Their ex of carbonic acid, through its action on
nach, favour the operation of alkaline waters. They have
assed as follow simple alkalines, where carbonate of
the urine waters, waters containing in addition some
of sodium chl waters containing sulphates of soda or of
a Alk where may be used to be used in gout, lithi
ction of the liver catarrh, and obstructions of the gal
ds; pepsi chronic catarrh of the stomach, and diarrhœa,
ty, and in diabetes. Some of the waters of the second class
chronic bronchial catarrhs and incipient plethoras,
ritic sulphated waters of the third class are
ly in catarrh of the stomach and in affections of the
n of the country one of importance Carlsbad is the
ne real cold water of Lara contains twice as much car
of soda. The cold ones are chiefly used internally, the
ones both internally and externally. The latter, besides
s warm water, heat ly irritate the skin when the car
nic is dominant, and the carbonate of soda has some slight
effect on the cutaneous surface like soap. These waters
known in England. They are most abundant in countries of
volcanic

Nearly all of all time water may be said to have a cubic
in *acidulous* springs or carbonated waters, in which the
of these very small, that of carbonic acid large. These
ters are readily drunk at meals. They have of late years
widely exported as to be within the reach almost of every
heir practical importance regarding digestion is in reality
greater than one could expect from their scanty mineraliza
They are drunk by the country people, and also largely ex
and imitated. They are very abundant on the Continent,
though some of the best-known ones enumerated below are
and French, they are common in Italy and elsewhere
gen Roisdorf, Land-kro, Apollinaris, Selter Bruckenau,
el, all German, St Galmier Pougues, Chatelguyon, French
nated with Class III is that of the strongly *sulphated* water
in Germany a bitter or purging water, which has of late
ly come into use as purgative agent. They are almost
in France and in America, and there are no very good ones
and. The chief supply is from Bohemia and Hungary. The
n waters of Ofen are the best known and some of them are
than the Hunyadi, of which an analysis has been given in
They are easily imitated. Some of the best known are
ullner, Sedlitz, Friedrichshall, Birmenstorf, Kreuznach
other class of water demands a few words of notice. The
have much faith in the presence of minute quantities of
in some of these springs and trace arsenical effects in those
ns them and some French authors have established a class
rsenical waters. Bourbonne-les-Bains in Auvergne is the strongest of
ters said to contain $\frac{1}{20}$th of a grain of arsenite of soda
ce of water. Baden Baden, according to Bunsen's latest
, has a right to be considered an arsenical water. It is,
extremely doubtful whether the small amount of ar-
of soda which have been detected, accompanied as the ar
ound in so large amount of other salts, have any actual opera
the system. The following are among the most noted
Bourbonne Mont Dore, Royat, Salins, Bagneres, Plom-
Ems, Baden Baden

has been discovered in the waters of Baden-
and in some other place least of the amount of that sub
in the springs. Indeed a new bath has been established at
the expense of Dr Blanc in consequence of the discovery of
some containing some lithium. Not very much
is known of lithium in ordinary medicine, and it may
be stated at once that its effects even in the strongest
waters are those of Baden Baden, Assmannshausen,
Bertrich Spa and Saratoga (U S.)

number of springs in the
public attention has
the specific virtues is very
one hundred. Of this number
of these not more than six St
Creston, Charlottesville, and
ray. The first three belong
sulphate and the last two are
waters. The Sweet
remarkable for the very large
ts of sodium
sodium chloride which it
the principle being more than
times the quantity of
in the large baths of Kreuz
Prussia. The Virginia
Sweet Springs likewise
the noted sulphur waters
Europe in their excessive per
of alkaline and
The latter 1·72 cubic inches of the gas in the pint
mineral springs in the United States are very unequally dis-
d, by far the larger number of those which are in high
reputation occurring along the Appalachian chain of mountains,
and more especially on or near this chain where it passes thro
States of Virginia, West Virginia, and New York. The De
and Silurian formations which overlie the Eozoic rocks alo
course of the Appalachian chain have been greatly fissur
faulting of the strata being in some places of enormous ma
by the series of upheavals which gave rise to the many
mountain ridges of the Appalachians. In many places the
ocean directly along the lines of fault. The various cla
mineral waters are likewise very unequally represented, the
springs, and those containing Glauber and Epsom salts, bein
inferior to their European representatives. On the other ha
very numerous and abundant springs of Saratoga compa
favourably with the Selters and similar saline waters, and
the many American chalybeate springs the subclass repr
by the Rockbridge Alum is unequalled in regard to the ve
percentage of alumina and sulphuric acid which it co
Besides its greater amount of mineral constituents (135 gra
pint), the Ballston spring surpasses the similar saline w
Homburg, Kissingen Wiesbaden, and Selters in its percen
carbonic acid (33 cubic inches). It is also remarkable for t
large proportion of carbonate of lithia, amounting to 0·701
The al springs
the Mississippi a
Virginia alon
the middle a New England States Lebanon is the
Subjoined is a list of thirty A
the design being to represent as many of the mos
possible while at the same time enumerating the be
sentative of
tic divisions a
the German method of classificatio

	Apenta Apollinaris, Lahn	Scrofulous ulcers and
nia, ozena, chronic
and dysentery, se
and tertiary syphilis
	Ahn, Ems, Co Va (Sweet	Chronic and subacute
tism, gout, neuralgi
ritic and calculous
Chronic rheumatism
diseases of liver, ne
contractions of join
	Bo a (Hot	
	Fr Rol Ems, Obe
al (Lahn)	
	Montes W Va (Hot	Dartrous diseases
functional diseases
chronic mercurial
poisoning
	ter Mon Co W
ony, Mo	Calculus, gravel, ca
stone or bladder, dy
Gravel, dyspepsia
diaphoretic).
Neuralgia (restorative
Purgative, diuretic.
	ers Wau	Diabetes mellitus, g
flammation of bladde
albuminuria (diuretic
Aperient and alterati
Do do.
	Bedfo	Dartrous skin disea
cases of the bladde
der, dyspepsia
Do., scrofula and sy
	Chalyb	Anæmia, gravel,
(strongly diuretic).
		Rheumatism, gout,
neuralgia.
		Rheumatism, gout.
		Dyspepsia, jaundice,
nal plethora.
		Do. do
		Ulcers, diseases of t
passive hæmorrhage
diarrhœa (has 10 grai
sulphuric acid in th
		Chlorosis and anæm
rally; tonic
		Do. do.
		Scrofula, chronic dia
		Anæmia, chlorosis,
diarrhœa, dropsy.
	dford Co Mich	
	ow Co, Ark (carbon-
ic)	
	Santa Clara Co, Cal.)	
	Ohio	
	ator Co Mich (simple)	Dyspepsia, neuralgia
and subacute rheum

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(J. M—E. L.)

MINERVA (*i.e.*, *menes vi*, endowed with mind) was the Roman goddess who presided over all handicrafts, inventions, arts, and sciences. She was probably an Etruscan deity, but her character was modified on Roman soil through her identification with the Greek Pallas Athena (see ATHENA). No legend of her birth is recorded; the Roman deities were abstractions, not distinct persons with an individual history. Her chief worship in Rome was in the temple built by Tarquin on the Capitol, where she was worshipped side by side with Jupiter and Juno. This foundation may be assigned to Etruscan influence. She had also an old temple on the Aventine, which was a regular meeting-place for dramatic poets and actors. The dedication day of the temple and birthday of the goddess was March 19, and this day was the great festival of Minerva, called *quinquatrus* because it fell on the fifth day after the Ides. The number five was sacred to the goddess. All the schools had holidays at this time, and the pupils on reassembling brought a fee (*minerval*) to the teachers. In every house also the *quinquatrus* was a holiday, for Minerva was patron of the women's weaving and spinning and the workmen's craft. At a later time the festival was extended over five days, and games were celebrated. This feature is evidently due to the Graecizing conception of Minerva as the goddess of war. To this same Graecizing tendency we must attribute the *lectisternium* to Minerva and Neptune conjointly after the battle of the Trasimene Lake. The 23d had always been the day of the *tubilustrium*, or purification of the trumpets, so that the ceremony came to be on the last day of Minerva's festival. Trumpets were used in many religious ceremonies; and it is very doubtful whether the *tubilustrium* was really connected with Minerva. There was another temple of Minerva on the Cælian Hill, and a festival called the Lesser *quinquatrus* was celebrated there on June 13–15, chiefly by the flute-players.

Minerva of the Cælian temple was called Capta, June 19 was the foundation day of this temple and the birthday of the goddess. The *palladium*, an archaic image of Pallas brought from Troy to Lavinium, and thence to Rome by the [illegible] of the Nautii, it was preserved in the temple of Vesta as a pledge of the safety of the city. There are some traces of an identification of Minerva with the Italian goddess Nerio, wife of Mars; it is probable that March 19 was originally a feast of Mars.

Besides Preller, *Röm. Myth.*, and Hartung, *Religion d. Römer*, see *Ephem. Epigraph.*, i. 258; Mommsen, *C. I. L.*, i. 388, 1 222.

MINGRELIA, a former principality of Transcaucasia, which became subject to Russia in 1804, and since 1867 has constituted three circles of the government of Kutais—Letchgum, Senakh, and Zugdidi. The country corresponds to the ancient Colchis; and Izgaur or Iskuriah on the Black Sea coast, which was the capital during the period of Mingrelian independence under the Dadian dynasty, is to be identified with the ancient Dioscurias, a colony of Miletus. The Mingrelians (still almost exclusively confined to the Mingrelian territory, and numbering 197,000) are closely akin to the Georgians. See CAUCASUS, vol. v. p. 257, and GEORGIA.

MINIATURE is a term which by common usage has come to be applied to two different branches of painting. Derived from the Latin word *minium*, the red pi used in the primitive decoration of MSS., in the first it is the technical word employed to describe a paint a MS.; and, from the fact of such pictures being ex on a reduced scale, it has its secondary and modern cation of a small, or miniature, portrait. In the latte it belongs to the general subject of painting. Here proposed to trace the development of the miniature in of the different schools of Europe.

The rise of the art of ILLUMINATION, in whic miniature plays so important a part, has been des under that heading, and something has been said i place about the earliest extant specimens of min painting. Unfortunately we cannot with any cer reach farther back than the 4th century for the ancient of them; and all remaining examples betwee period and the 7th century in Greek and Latin can be counted on the fingers. The two famous cod Virgil in the Vatican Library stand pre-eminent most ancient Latin MSS. decorated with paintings. miniatures in the first of them, the *Codex Ro* are large and roughly yet boldly executed paintings, have no pretension to beauty, and are simply il tions; but they are as old as the 4th century, a of the highest value in enabling us to appreciat debased style to which classical art had descende which no doubt was more largely employed than we think. The second MS., the *Schedæ Vaticanæ*, whic also be assigned to the 4th century, is far more and retains a good deal of the grace of classic ar the same kind, but of rather later date, are the frag of the *Iliad* in the Ambrosian Library at Mila miniatures of which are generally of excellent Next comes the Dioscorides of the Imperial Libr Vienna, with its semiclassical portrait miniatures ex at the beginning of the 6th century. Of a rathe period are the paintings which illustrate the Gree of Genesis in the same library. A far finer and olde of the same book of the Pentateuch once existed Cottonian Library, but was almost totally destroy fire. The few fragments of the miniatures whic filled this volume, and which were of the 5th centu sufficient to show what excellent work could be done capital of the eastern empire, from whence the MSS probably came. The late interesting discovery of a trated MS. of the Gospels in Greek, of the latter the 6th century, at Rossano in southern Italy, adds a number to our scanty list of early volumes of this which is closed by the Latin Pentateuch in the libr the earl of Ashburnham. This last MS., however, older than the 7th century. It was executed in and is adorned with many large miniatures, not artistic merit, but of great interest for the hist painting and of costume.

Coeval with the MSS. which have just been enum are the beautiful mosaics and wall paintings whi seen at Rome, Ravenna, and in other parts of Italy, as standards of comparison and carrying on the his art where MSS. fail us. The strong and ever inc Byzantine element which appears in these works p us to find the predominance of the same influence w again pick up the broken thread of the history of mi painting. We may then, at this point, turn for a m to the east of Europe and state briefly what rem Greek art in MSS. Of Greek miniatures there a many fine examples extant, but, excepting those have been noticed above, there are few which are than the 11th century. At this period the mi appears in the set form which it retained for the ne or three hundred years; and the connexion betw

and that of the mosaics is too evident for us to be at to explain the course of development. The figure ing is delicate, but rather exaggerated in length, the s are brilliant and the whole effect is heightened by ine background of gold. In some few instances, er, the Greek artist breaks away from conventionalism, perfectly when portraying the divine features of the n or the rapt aspect which deeply stirs his feelings, he with the noble dignity with which he invests Miniatures also caught the fancy of these ; and there still remain MSS., such ilter and saints' lives adorned throughout with le little drawings of great symmetry and beauty ornamentation which was employed in Greek MSS. period of which we are speaking, either as frames natures or as borders or head pieces, is designed tly after Eastern types, and has more than an ntal likeness to the patterns which are seen in the and prayer carpets of Persia. After the 13th y decadence sets in, and we need not follow the of Byzantine art in MSS. further than to notice that diately from it sprang such national styles as those , Bulgaria, and modern Greece.

nwhile, in the West, under the fostering care of magne, arose a great school of decoration in MSS., at the close of the 8th and beginning of the 9th y were multiplied and enriched with all the splendour colours and gilding could give to them. But the thus ornamented were almost always copies of the l, or Bibles, or church service books, which afforded scope for invention. Hence among the miniatures of eriod we have an endless repetition of portraits of angelists, drawn, for the most part, in a lifeless way Byzantine traditions, and degenerating, as time passes, sitive ugliness. The few miniatures of other descrip such as Biblical illustrations, show no great merit, bald barbaric splendour was generally preferred to effect. But an exception must be made in regard style of drawing found in the MS. known, on t of its present resting place, as the Utrecht Psalter. olume is filled from beginning to end with delicately pen illustrations, designed and executed with a which, compared with the mechanical and clumsy g of other Continental MSS. of the period, is astonish- And these drawings are of particular interest for us, y are of the style which was adopted in England and gives to Anglo-Saxon art its distinctive aspect ted about the year 800 or early in the 9th century, robably in the north of France, the volume was soon ht to England, where, however, MSS. of the same it may be assumed, had long before been intro- The light "fluttering" outlines of the drapery and detail of the drawings seem to suggest that the ginal were derived directly from Roman life, and partly copied from sculpture, but those models have undergone many modifications before passing he type of the drawings of the Psalter. That the was copied from an older one there can be scarcely a ; and it is not impossible that the original archetype date back two centuries earlier. May not MSS. St Augustine and his companions brought from Rome contained drawings of the same kind? The style of ng was, at all events, adopted and became nationalized gland; but it had there a rival in the Irish school of entation, introduced from the north of the island. arly civilization of Ireland placed her in the van of art opment in these islands. The wonderfully intricate eed designs which render Irish MSS. of the 7th 8th centuries such marvels of exact workmanship their origin, in all probability, from the metal work of earlier ages. But, apart from ornamentation, th miniatures of saints and evangelists are extraordina grotesque instances of purely mechanical drawing, cause us to wonder how the same eyes and hands assisted in the creation of such beautiful specimens ornament could tolerate such caricatures of the shape. The explanation is perhaps to be found in stitious regard for tradition. This style of art was by the monks to Iona and thence to Lindisfarne, wh founded the school which produced, in the 8th a centuries, the richly ornamented codices of Durham. then, Byzantine models were copied on the Contine tree drawing introduced from the south and the i ornamentation brought in from the north were pract England, but the tree drawing, with its accomp decoration copied from foliage, and gradually dev into beautiful borders harmoniously coloured, gain day, and lasted down to the time of the Norman Co The one great fault of this latter style of drawing the eye at the first glance. This is the inordinate of limb with which the human figures are endowed this blemish is forgotten when one comes to appreci many points of merit in the designs.

In Italy, after a long period of inactivity, tw different styles of decoration of MSS. sprang into ex The first of these was that of the Lombardic school, is distinguished by intricate patterns and bright col The large initial letters which are found in the M the 11th and 12th centuries, the best period style, are often a perfect maze of interlaced bands and forms, and are extremely handsome and effective. drawing however, seems to have been but little pr by the Lombardic artists, but such as there is app a broad scale and well executed. In the collect Monte Cassino are some of the best examples school. In the second style which developed in It Byzantine influence was at first most marked. among its early specimens of the 13th centu some which might pass for the work of Greek artists the genius of the Italians soon assimilated the element, and produced a national school which throughout the peninsula and afterwards exten influence to southern France and Spain. It is, h remarkable that in a country which produced su pictures and wall paintings at an early date there paratively little miniature painting in contemporar A curious and early instance of this kind of art in a MS. in the British Museum, written and mented with a series of miniatures at Winchester, 12th century, in which are two paintings wh purely Italian and of more than ordinary excellence

In the majority of the extant Italian miniatures 14th century the influence of the great artists Florentine school is manifest. The peculiar treatm flesh tints, painted in body colour over a founda olive green, and the peculiar vermilion and other which need be but once seen to be ever afterwards nized as belonging to this school, are constantly The figures are generally rather shortened and the carried in straight folds, very different characteristi the waving figures and flowing drapery of the Engl French artists of the same period. The ornamen which accompanied this style of miniature ge consists of heavy scrolls and foliated or feat pendants from the initial letters, with spots of g here and there in the border. There are also extan examples of a most beautiful kind of ornamentation appears to have originated in central Italy, and seems to partake of the qualities of both the st Italian art of which we have been speaking, co

awing of the Florentine school with a lighter colour
nich may have been suggested by the Lombardic.
native Spanish miniature art little can be said. In
sigothic MSS. of the early Middle Ages there is no
ent beyond roughly coloured initial letters and some
ic figure drawing. A little later, however, we get
indication of national peculiarities in the MSS. of
0th, 11th, and 12th centuries. Here there appear
ures, stiff and rude in their drawing, but exhibiting
mistakable Spanish predilection for sombre colours,
ky reds and yellows and even black entering largely
e compositions.
materials at our disposal of the 10th, 11th, and
enturies show the gradual development in France
estern Germany of a fine free hand drawing which
encouraged by the proportionately increasing size
oks. Both in outline and colour the fully de
d miniatures of the 12th century are on a grand
and initial letters formed of scrolls and interlacings
the same proportions. The figure drawing of this
s frequently of great excellence, the limbs being well
tioned; care is also bestowed upon the arrangement
drapery, which is made to follow the shape and, as
e, to cling to the body.
the great revulsion from the broad effects and bold
ur of the 12th century to the exact details and careful
of the 13th century is nowhere more striking than
iature painting in MSS. With the opening of the
eriod we enter on a new world of ideas. Large
generally disappear to give place to smaller ones;
e writing supersedes the large hand and miniatures
in circumscribed spaces in the interior of initial
. The combination of the miniature with the initial
it into close connexion with the ornamental border,
develops *pari passu* with the growth of the minia
and by degrees assumes the same national and
tive characteristics. Burnished gold was now also
used, tending to give the miniature a more decorative
ter than formerly. In England, northern France,
he Netherlands the style of miniature painting of
eriod was much the same in character; and it is
difficult to decide from which of these countries a
is derived. English work, however, may be often
guished by its lighter colouring, while deeper and
brilliant hues and a peculiar reddish or copper tinge
e gold marks French origin. The drawing of the
sh artists was scarcely so good, the outlines being
ntly heavy and the colours rather dull. Of the
sh or Cologne school examples are more scarce, but
generally show greater contrasts in the colours,
though brilliant, are not so pleasing. As the
y advanced, and particularly at its close, national
tions became more defined. English artists paid
attention to graceful drawing and depended less
colour. In some of their best productions they are
ed with slightly tinting the figures, finding room in
ckgrounds for display of brilliant colours and gilding.
ance the drawing, though exact, is hardly so graceful,
lour plays a more important part. From the 13th
middle of the 15th century great decorative effect
ained by the introduction of diapered or other highly
ented backgrounds. Of landscape, properly so called,
is but little, a conventional hill or tree being often
as sufficient indication. Borders begin in the 13th
y in the form of simple pendants from the initial
, terminating in simple buds or cusps. But once
d fairly in the 14th century, a rapid development in
rts of the decoration of MSS. takes place. There is
r freedom in the drawing; the borders begin to throw
anches and the bud expands into leaf. This is the best
riod of English miniature painting, many of the fine
of this century which are preserved in the public lib
bearing witness to the skill and delicate touch of
artists. In France the decoration of MSS. received a
impetus from the patronage of King John and Charl
of whose famous libraries many handsome volumes a
to be seen, and later in the century the duke of
carried on the same good work.
With regard to miniature art in Germany there
few examples to guide us that little can be said. M
them are rough in both drawing and colouring; a
the few remaining specimens of really good work f
influence is distinctly seen. In the west the art of
and Flanders, and in the south that of Italy, an
dominant. Perhaps the finest MS. of this southern
to be seen in England is a Psalter belongin
Lord Ashburnham, which was probably executed
14th century at Prague, and is full of miniatures
in drawing and colouring follow the Italian school.
When we enter the 15th century we find great el
in both the great English and French schools
England the graceful drawing of the previous centu
disappeared. At first however, some beautiful exam
purely native work were produced, and still remain to
our admiration. Probably the most perfect of these
are the Sherborne Missal belonging to the duke of
umberland, and a very beautiful volume, a Book of
in the library of Lord Ashburnham. The care be
upon the modelling of the features is particularly not
in English work of this period. In decoration the
of the 14th century had by this time grown to a solid
surrounding the page, but now another form of mos
ive ornament was also used, consisting of twisted t
like scrolls brightly coloured and gilt. As the e
advanced native English work died out, and Frenc
then Flemish influence stepped in.
In France immense activity was shown all throu
15th century in the illumination and illustration of
of all kinds, sacred and profane, and it is in the
of that country, and, a little later, in those of th
Countries, that we can most exactly watch the tra
from mediæval to modern painting. Early in the c
there were executed in France some of the most t
MSS. which have descended to us. In these the col
is most brilliant, the figure drawing fairly exact a
landscape begins to develope. The border has grown
the branching pendant to a framework of golden sp
of conventional and realistic leafage and flowers. T
the middle of the century the diaper disappears for
and the landscape is a recognized part of the mini
but perspective is still at fault, and the mystery
horizon is not solved until the century is well adv
And now Flemish art, which had long lain dormant,
into rivalry with it. French talent, under the stimulus
to it by the Van Eycks, and the struggle was carri
but unequally, through the rest of the century.
art gradually deteriorates, the miniatures become fl
hard; nor are these defects compensated for
mere coarse practice of heightening the colours b
fusely touching them with gold. The Flemish arti
the other hand, went on improving in depth and s
of colouring, and brought miniature painting to its
tion. The borders also which they introduced gave
for the study of natural objects. Flowers, insects,
and jewels were painted in detached groups on a
framework of colour surrounding the page.
But if, at the 15th century drew to its close, the Fl
had outstripped their French rivals they had now
powerful antagonists to contend with. The Italian
been advancing with rapid strides towards the glo

naissance. Early in the century there arose a taste r models. As for their writing and afterwards printing, they went back to the 11th and 12th s for their standards, so they adopted again the ng designs of the Lombardic school for their orna- nd produced beautiful borders of twining patterns by colour, or they took natural objects for their and painted borders of delicate flowers made still il out with clustering stars of gold. Later, they n the ancient classical designs inspiration for the d border of arabesques, medallions, griffins, human ntique objects, &c., which they brought to ach n early in the next century. Their miniatures he rank of exquisitely finished pictures, and were by some of the best artists working under the e of such great houses as those of Sforza and

rther, having advanced to the threshold of the of modern painting, we leave these two great f miniaturists in possession of the west of Europe. ninge had the wider field; they were wanderers from home; and their works are scattered through many lands, from England in the north to Spain in the south. But Italian art had greater inherent strength, and will always hold the first rank. To instance a few of the more famous MSS. of this closing period of miniature painting: the Breviary of Isabella the Catholic, in the British Museum, is a masterpiece of Flemish art produced in Spain; the Grimani Breviary at Venice is another fine example of the same school. Some beautiful Italian miniatures (executed for Leo X. and others) were in the collection lately sold by the duke of Hamilton. The earl of Ashburnham possesses a most delicately illuminated Book of Hours written for Lorenzo dei Medici by the famous scribe Sinibaldo in 1485, as well as a MS. to which Perugino and his contemporaries contributed paintings. And in one MS., a Book of Hours belonging to Mr Malcolm of Poltalloch, are gathered some of the best miniatures of both schools, viz., a series of exquisite paintings by Milanese artists supplemented by later ones of the finest Flemish type. (E. M. T.)

MINIMS. See FRANCIS (ST) OF PAOLA, vol. ix. p. 695.

MINING

nt of mining consists of those processes by which eful minerals are obtained from the earth's crust. inition is wider than what is popularly known as for it includes not only underground excavations open workings, at the same time it excludes under workings which are simply used for passages, such y tunnels and sewers, and galleries for military . We must remark also that the word "mine," or alent in other languages, varies in signification in countries on account of legal enactments or which define it. Thus, in France and Belgium, ngs for mineral are classified by the law of 1810, g to the nature of the substance wrought, into *minières*, *et carrières*. In the United Kingdom, on rary, it is the nature of the excavation which he question for certain legislative purposes, and mines is restricted to workings which are carried nground by artificial light. The consequence i at is merely an underground stone quarry in become a true mine in England, whilst the open for iron ore, such as exist in Northampton ould be true mines under the French law. It is , therefore, in an article on mining, to go beyond ch legal definition of a mine and include the of working minerals in excavations open to day- well as in those which are purely subterranean. ore as it is customary for the miner to cleanse a greater or less extent before selling it to the will treat under the head of mining, those which are commonly known as the dressing or preparation of ores; and, finally, a few remarks recent important legislation affecting mines in the Kingdom, accidents in mines, and the production useful minerals in various parts of the globe.

ubject therefore will be dealt with as follows:

manner in which the useful minerals occur in the rust, viz., tabular deposits and masses; faults or ons.

ospecting, or search for mineral.

oring with rod and core, or diamond drill.

eaking ground; tools employed. Blasting by vari hods: machine drills. Driving levels and sinking

inciples of employment of mining labour.

ans of securing excavations by timber or masonry.

7. Exploitation, or the working away of strata or veins.

8. Carriage or transport of minerals through underground roads.

9. Winding, or raising in the shafts, with the machinery and apparatus required.

10. Drainage of mines, adit levels, pumps, pumping engines.

11. Ventilation and lighting of mines.

12. Means of descending into and ascending from mines.

13. Dressing or mechanical preparation of minerals.

14. Recent legislation affecting mines in the United Kingdom.

15. Accidents in mines.

16. Useful minerals produced in various parts of the globe.

1. *Manner in which the Useful Minerals Occur.*—The repositories of the useful minerals may be classified according to their shape as (A) tabular deposits, and (B) masses.

A. *Tabular Deposits.*—These are deposits which have a more or less flattened or sheet-like form. They may be divided, according to their origin, into (1) beds, or strata, and (2) mineral veins or lodes.

(1) *Beds.* Geology teaches us that a large proportion of the rocks met with at the surface of the earth consist of substances arranged in distinct layers, owing to the fact that these rocks have been formed at the bottom of seas, lakes, or rivers by the gradual deposition of sediment, by precipitation from solutions, and by the growth or accumulation of animal and vegetable organisms. If any one of these layers consists of a useful mineral, or contains enough to make it valuable, we say that we have a deposit in the form of a bed, stratum, or seam. Of course the most important of all bedded or stratified deposits is coal, but, in addition, we have beds of anthracite, lignite, iron ore, especially in the Oolitic rocks, cupriferous shale, lead-bearing sandstone, silver bearing sandstone, diamond-, gold-, and tin bearing gravels, to say nothing of sulphur, rock salt, clays, various kinds of stone, such as limestone and gypsum, oil shale, alum shale, and slate.

The characteristic feature of a bed is that it is a member of a series of stratified rocks; the layer above it is called the *roof* of the deposit, and the one below it is the *floor*. Its *thickness* is the distance from the roof to the floor at right angles to the planes of stratification; its *dip* is the

Strike and dip

tion downwards measured from the horizontal: its
s the direction of a horizontal line drawn in the
plane.

thickness of beds that are worked varies within
ide limits. Whilst the thickness of certain workable
f coal is only 1 foot, and that of the Mansfield
erous shale only 10 to 20 inches, we find on the
hand one of the beds of lead-bearing sandstone at
rnich no less than 85 feet thick, and beds of slate
ceeding that thickness. It must not be supposed,
er, that the thickness of a bed necessarily remains
n. Occasionally this is the case over a very large
but frequently the thickness varies, and the bed may
le away gradually, or in
in size, or become divided
wo owing to the appearance
parting of valueless rock.
shows beds of shale, lime-
iron ore, and sandstone
one of these beds may be
le enough to be worked.

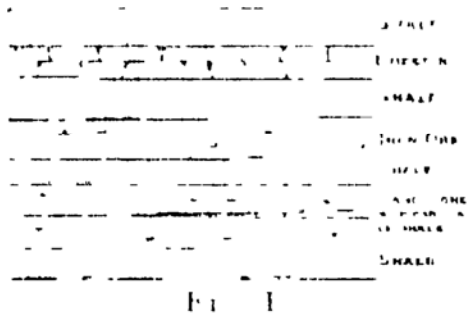


Fig. 1

Mineral Veins or Lodes. - Veins or lodes are tabular
et-like deposits of mineral which have been formed
the rocks by which they are surrounded, they differ,
ore, by their subsequent origin from beds, which, as
ated, are of contemporaneous origin with the enclo-
cks (although of course cases occur in which the
t is lying unconformably upon very much older
or is covered unconformably by very much younger
). It is necessary to explain that the term "vein"
s definition is used in a more restricted sense than is
mes customary among miners, who speak of *veins*
l, clay-ironstone, and slate, which geologically are
eds. They see a band of valuable mineral or rock,
areless of its origin, call it metaphorically a vein or
On the other hand, the definition is broader than
which prevails among some geologists, who would
the term vein to deposits occupying spaces formed
ures.

erm "lode" was defined in 1877 by Mr Justice Field in the
ted Eureka *v.* Richmond case as follows:- "We are of opinion,
re, that the term, as used in the Acts of Congress, is applie
any zone or belt of mineralized rock lying within bound
early separating it from the neighbouring rocks." This
etation seems suitable for the peculiar mining tenure of the
States, where the discoverer of a vein or lode can obtain
g claim of 500 yards in length along the lode. It protects
spector, whose object is to obtain a secure title, the mode of
f the deposit being a matter of small importance to him so long
worth working. In many cases also it would be impossible
le upon the mode of origin until workings had progressed
rably, and even then there would be room for disputes.

doubt a very large number of mineral veins are
the contents of fissures; others are bands of rock
gnated with ore adjacent to fissures or planes of
tion; others, again, have been formed by the more
s complete replacement of the constituents of the
l rock by particles of ore.

ns may occur in igneous or in sedimentary rocks,
the latter they frequently cut across the planes of
cation.

a bed, a vein has its dip and strike; but, as the dip of veins
rally great, the inclination is usually measured from the
, and is then spoken of as the *underlie* or *hade*. The
g planes of a vein are called the *walls* or *cheeks*, and they
uently smooth and striated, showing that one side must have
ainst the other. The upper wall is known as the *hanging*
he lower one as the *foot wall*. The width of a vein is
d at right angles to the walls.

pical example of a fissure vein is shown in fig. 2, repre-
a lead lode in slate at Wheal Mary Ann mine[1] in Cornwall.

It is evident that a fissure in the surrounding slate has h
filled up by the successive deposition of bands of mineral
sides.

A large proportion of the contents of a lode may co
fragments of the walls that have fallen into the original fiss
these are often tightly cemented
together by minerals that have
been introduced subsequently. The
horizontal section of part of the
Comstock lode[2] (Plate IV.) shows
much "country" rock enclosed
within the walls.

Where a lode consists of rock
impregnated with ore, the mineral-
ized part may fade away gradually
into the surrounding rock (*country*)
without there being any distinct
wall, as shown in fig. 3, which is an illustration taken f
Great Flat Lode[3] near Redruth in Cornwall.

Fig. 2.

The celebrated Ruby Hill deposit in the Eureka district,
is a mineralized zone of dolo-
mitic limestone varying in
width from a few inches to
450 feet, and having a mean
width of 250 feet. It con-
tains numerous irregular ore
bodies, which consist mainly
of highly ferruginous car-
bonate of lead, rich in silver
and gold. This mineralized
limestone band, long called
a lode by miners, has been determined by the decision ge
tioned to be a lode in the eyes of the law.

Fig. 3.

Veins often continue for a great distance along their strik
Van lode in Montgomeryshire is known for a length of
whilst the Great Quartz Vein in California has been tra
distance of no less than 80 miles. Veins are of less unifo
productiveness than beds, and are rarely worth working thro
Rich portions alternate with poor or worthless portions.
parts have received various names according to the for
assumed. Fig. 4 represents a
longitudinal section along
strike (*course*) of a lode, and
the stippled parts are ore
bodies. B, B, B are *branches*, A
is a large bunch or *course of*
ore, when an ore body forms
a sort of continuous column
we have a *shoot*, and ore
bodies which on being ex-
cavated leave chimney like
openings are called *pipes* (fig. 4, C). In the United St
Spanish word *bonanza*, literally meaning "fair weather"
sperity," is frequently used for a rich body of ore.

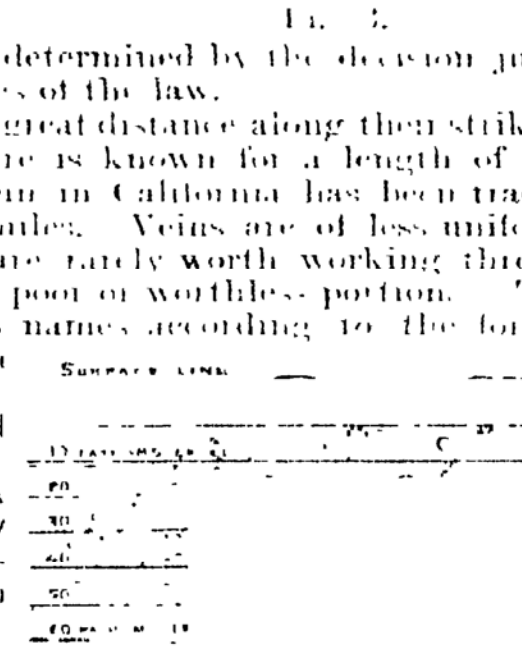


Fig. 4

The richness of veins is dependent in many cases upon th
of the adjacent rock (*country*), upon the underlie, and u
strike, variations in any one of these three elements bei
sufficient to cause a decided change of productiveness.

Various theories have been formed concerning the o
mineral veins. Some geologists suppose that the miner
constituting the veins have been dissolved out of the adjace
and re-deposited in the vein cavity; others, on the contrary
that the ores have been brought up from great depths by
springs. In all probability both theories are correct, so
having been formed by the former process and some by th
and, furthermore other lodes appear to owe their origin to a
substitution of valuable minerals in the place of some of
stituents of a worthless rock. One of the most import
tributions to the science of ore deposits of late years h
the discovery by Professor F. Sandberger of small quan
silver, lead, copper, nickel, cobalt, bismuth, arsenic, an
and tin in silicates, such as olivine, augite, hornblende, an
which are constituents of igneous rocks. He therefore
these rocks as the sources from which lodes have deriv
riches.

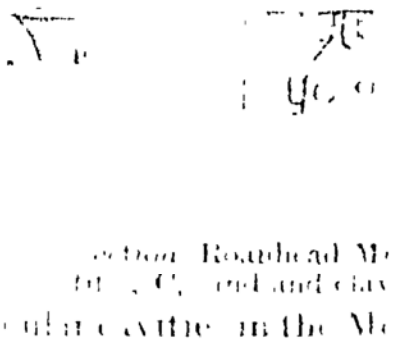
B. *Masses.* These are deposits of mineral, o
irregular shapes, which cannot be distinctly recogn
beds or veins. Such, for instance, are the red ha

[1] J. Le Neve Foster, "Remarks on the Lode at Wheal Mary Ann, Illot," *Trans. Roy. Geol. Soc. Cornwall*, vol. ix. p. 158.

[2] James D. Hague, in *United States Geological Exploration of the Fortieth Parallel*, vol. iii., "Mining Industry," Washington Atlas, plate 11.

[3] J. Le Neve Foster, "On the Great Flat Lode, south ruth and Camborne, and on some other Tin Deposits fo the Alteration of Granite," *Quart. Journ. Geol. Soc.*, vol. x 614.

eposits of the Ulverston district (fig. 5[1]) and the brown æmatite deposit- (*chaux*) of the Forest of Dean, which



section Roadhead Mine. A, Mountain Limestone; B, C, red and clay; D, gravel. Scale 1 inch = 60 feet.

ular cavities in the Mountain Limestone. Th- ...ve... ...been formed by the percolation of water having ...ved ... iron ore obtained from overlying Trias ...ne rock. ... other examples of ma... ...ex... ...re the calamine deposit ... Altenberg" (fig. 6), Sardinia, ...nd Lombardy, the iron ore ...deposits in Missouri, such ... Iron Mountain and Pilot ...Knob, the large upright ...necks or "pipes" of dia... ...bearing rock in South ...Africa, and the granite decomposed ... where worked for ...china clay in Cornwall.

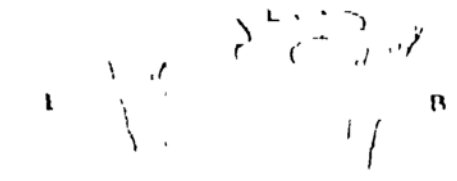


Fig. 5.—Section ... Mine, Cornwall. ... dolomite; ... clay.

Under the head also are inclu... by most authors the ...called "stockwork," or "reticulated masses," name... ...applied to masses of sedimentary or igneous rock which ...are penetrated by so many little mineral veins as to make ...the whole worth excavating.

It must be understood that we cannot expect nature to make ...distinct lines of demarcation between the different kinds of ...deposits. Though we may be able to see clearly that a vein of ...ore is contemporaneous with the enclosing rock—and that a vein ...later than the bed of shale and sandstone was formed subsequently, ...as frequently occurs where the crown of the vein is uncertain— ...for example we have the lead-bearing sandstone of Mechernich and ...the silver-bearing sandstone of Utah. The origin of each of ...these deposits is certain, but common difficulties ... the ... Fissure veins were deposited with the rock ... were introduced ...subsequently by solutions percolating through the beds. In ...one of the well-known beds of Cleveland iron stone Dr Sorby ...decides that the iron was "derived partly from ... mineral ...position and partly from subsequent chemical replacement of ...originally deposited carbonate of lime." Limestone, which ...may be considered contemporaneous with the coal, is often ...found replaced by iron ore, and ... ...in place ... and ... the shape of ... ... This ...has happened even with a coal seam.[2]

All kinds of deposits are subject not only to ... ...which depend upon their mode of formation but also to ...later disturbances known as faults, heaves or throws.

We will take the case of a bed (fig. 7). AB is ... by ... and ... at B, whilst the continuation is found at a lower level ...(D). ... bed ... evidently once continuous, but ... took ... ... the line XY, followed by a dislocation. ... ...

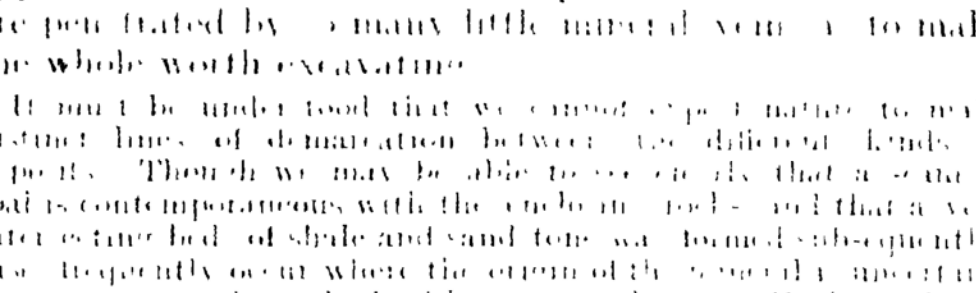


Fig. ...

...portion of ... on the ... wall side of a fault appears to ...have slid down ... ...

variety of gypsum, called *briscale* by the miners, and considered by them as affording important indications concerning the bed itself.[1]

Other signs of mineral deposits are given by springs and by certain plants dependent upon the deposit or its associated minerals for part of their nourishment. The appearance of the so-called lode lights may be explained by the production of phosphoretted hydrogen from the action of organic matter and water upon phosphates, which are so common in the upper parts of mineral veins, and one hears also of differences in the appearance of the vegetation along the line of the deposit, of places where snow will not lie in winter, and of vapours hanging over the ground. Though some writers refuse to put any value upon these indications, they should not be entirely overlooked, because the outcrop of a lode, of different nature and texture to the surrounding rocks, and which is generally a channel for water, may readily cause the phenomena just mentioned. Where the surface is cultivated and the natural primes are tapped by adit levels or other mine workings, these appearances cannot be looked for to any great extent. With one special mineral, magnetic iron, the position of the deposit may be traced out with some degree of accuracy with a dipping needle, this being used in Sweden.

After having acquired an idea of the position of a vein or seam by some of the surface indications just mentioned, it is necessary, before attacking it by shafts or levels, to obtain more certain data concerning it. In the case of mineral veins, trenches are dug at right angles to the supposed strike; and, when the upper part of the deposit has been cut in several places, its general course and dip can be determined sufficiently for the purpose of arranging the future workings. These trenches are called "costeaning pits"; in some cases, instead of a trench, a pit is sunk a short distance and a little tunnel driven out.

Where the mineral to be wrought occurs as a bed or mass, the process of boring is resorted to, and indeed this method is also applied in the case of veins, especially in the United States. Boring is a work of such importance that it deserves to be treated under a separate heading.

3. *Boring with Rods and Ropes. Diamond Drill.* The object of boring is to reach a deposit by a small hole and ascertain its nature, its depth from the surface, thickness, dip, and strike. Bore-holes are also used for obtaining water, brine, and petroleum, which either rise to the surface or have to be pumped up from a certain depth, and finally for tapping water in old workings or for effecting ventilation. The methods of boring may be classified as follows: (1) boring with the rod; (2) boring with the rope; (3) boring with the diamond drill.

In the first method tools for cutting and removing the rock are fixed to rods, which are lengthened as the hole increases in depth, and which are worked by hand or by machinery at the surface. Where the ground is soft, such as sand or clay, tools like augers can be employed; but in harder ground it becomes necessary to have recourse to percussion; various forms of chisel are used, the simplest being made of the shape shown in fig. 11.[2] The rods generally consist of bars of square iron, from 1 inch to 2 inches on the side. The length of each rod depends upon the height of the tower, derrick, or shears erected above the bore-hole, which should be an exact multiple of the individual parts. These are made in lengths of 15 to 30 or rarely 40 feet, and with a suitable tower it is possible to detach or attach two or three lengths at a time, instead of having to make or unmake every joint. The mode of connexion usually preferred is by a screw joint as shown in fig. 12; care is taken to have all the joints exactly alike, so that any two bars can be screwed together. In order to

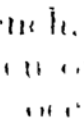


Fig. 11.—Chisels. Fig. 12.

diminish the weight of the rods, which becomes considerable in deep holes, wood has sometimes been employed. The rods are connected by male and female screws attached to the rods by sockets of sheet iron, or by a similar arrangement. At the surface a head is screwed to the uppermost rod by which the rods can be lifted, and are turned by means of cross bars called tillers.

When the depth is small the rods are lifted by hand and allowed to drop, being turned slightly at each lift so that the cutting chisel may strike a new place each time. For greater depths a lever has to be employed, the rod being suspended at one end whilst the other end can be pressed down by men using hands or feet. The spring pole is another arrangement, in which the elasticity of a long pole is made use of for lifting the rods at each stroke. The length of the stroke can be augmented the deeper the bore hole is deepened by means of a screw and swivel at the top of the rod.

With deep holes, and especially those of large diameter, machinery has to be employed for working the rods, which may be direct acting and stand immediately above the hole, but a commoner arrangement is to employ a jumper working a beam. Occasionally also the beam is actuated by connecting rod worked by a crank.

The actual boring machinery has now been described, but mere boring appears to be a very simple matter, consisting in lifting the rod a little and allowing it to drop, the rod being slightly twisted round after each stroke. Nevertheless the process of sinking down a bore hole is not so simple as it seems, for there are various indispensable accessory operations which take up much time. In the first place the debris have to be removed, and in order to effect this the rods must be drawn up, the swivel head unscrewed and a cap screwed on. A length of rods is now drawn up by a hand or steam windlass and disconnected. It is well to have as many cups as there are lengths to be drawn up, and then each can be suspended in the tower. Sometimes a *grab* which catches the rod at the bulging point is used instead of a cap. The next operation consists in lowering by means of a rope the *sludger* or *shell pump*, which is a hollow cylinder with a clack or shell valve (fig. 13). It is worked up and down a little till it is filled, and it is then drawn up and emptied at the surface. The operation is repeated, if necessary, and the boring is resumed with the rod.

Occasionally a bore hole has to be widened slightly with a tool called a *reamer*. Soft beds may have to be bored through with a *auger*, and under the rock are hard and firm, the hole has to be lined with a tube generally of boiler iron. Accidents may occur, causing no inconsiderable amount of trouble, such as the breaking of rods or chisel and numerous implements have been devised for seizing the broken or the fragments of tool which prevent further progress with the work.

In boring at considerable depth, the weight of the rod becomes so great that much vibration ensues when the mass is suddenly arrested by the chisel striking against the bottom of the hole. Various devices have been contrived for overcoming the difficulty and for reducing a tool which will act independently of the rod. One of the best known arrangements is the free falling tool invented by Kind, fig. 14. The head of the actual boring rod is held by a catch or grapple; when the boring rod descends, the resistance of the water in the hole slightly stops the clack (B), the jaws D open, the head is disengaged, and the boring part falls and strikes the bottom without any injurious vibrations being communicated to the heavier rod. When the rod descends further the head is caught again by the clack. Special tools also are used for cutting an annular groove at the bottom of a bore hole and breaking off the core, which is then brought up with certain precautions, so as to show the nature and dip of the beds traversed.

In order to obviate the great loss of time which ensues from connecting and disconnecting long lengths of rod, recourse may be had to boring with the rope. In this method, known as the Chinese method, the chisel is worked by a rope in the same manner as the sludger already described. Mather and Platt of Manchester have long used wire ropes, in many parts of England and various other countries, a system of boring by means of a flat hempen rope.[3]

The most important modification of late years

[1] Lorenzo Parodi, *Sull' Estrazione dello Solfo in Sicilia*, 1873, pp. 7 and 24.

[2] Serlo, *Leitfaden zur Bergbaukunde*, Berlin, 1878, p. 59.

[3] J. Callon, *Lectures on Mining*, vol. i., Atlas, plate ix.

rocess of making bore-holes is the introduction of the iamond drill. The working part of the drill consists of he so called crown which is a short piece of tube made of ast steel, at one end of which a number of black diamonds re fastened into small cavities (fig. 15).

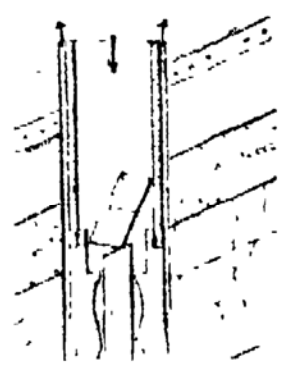


Fig. 15.—Diamond Drill.

The crown is screwed on to wrought-iron pipes, which constitute the boring od. Machinery at the surface causes he rod to rotate, and the result is the utting of an annular groove at the ottom of the hole, leaving a core, which, breaking off from time to time, s caught by a little shoulder, and rought up to the surface with the rod. n places where it is not necessary to make any verification of the rocks tra-ersed, the crown is arranged with iamonds in the centre also. The débris, in either case, are washed away by a stream of water, which is forced down the tube and flows up the sides of the hole. With this system a bore hole can be deepened continuously at a speed altogether unattainable by the other methods, which require stoppages for cleaning out. It has the further advantage of making it possible to drill holes in any direction, and prospecting diamond drills are constantly used with much success in iron, tin, and metal mines, especially in the United States.

Fig. 16[1] shows the Little Champion Rock-Drill, which is largely employed in the Lake Superior district for prospecting. It can be used above or below ground. Two inclined cylinders drive a horizontal crank shaft which works beveled gear, causing the drill to revolve. At the same time a counter shaft is slowly set in motion, and the effects the advance of the drill by gearing driving the feed screw, a there are three kinds of gearing, the speed can be varied at pleasure. The feed screw and its connections are carried by a swivel head, and this can be turned so as to drill holes at an angle. The drum shown above the cylinders is used for hoisting out the drill rods by a rope. The rods are lap welded iron tubes 1 inch in diameter, fitted with a bayonet joint.

Another light portable prospecting drill for underground work is

Fig. 16.—Little Champion Rock-Drill.

Fig. 17.

represented in fig. [illegible] is made in diameter to a depth of [illegible] inch in diameter. It has a [illegible] diameter with 3[illegible] revolutions. The drill [illegible] turning the swivel head only [illegible]

The larger rock drill used by [illegible] Boring Company for putting down [illegible] consists of a 20 horse-power boiler, with two oscillating 6 inch cylinders and the necessary [illegible] for [illegible] the drill, all [illegible] for drilling holes 1¼ inches [illegible] The cores which it yields are [illegible] Rating cylinders 3½ inches in [illegible] can run up to a speed of 800 [illegible] to bore in any direction by [illegible] erred.

[illegible] American Diamond Rock [illegible] to a depth of 3000 feet [illegible]

[1] *Engineering and Mining Journal*, vol. [illegible], p. 119.

[2] *Ibid.*, vol. xxvii. p. 273.

mounted upon a carriage, so that the whole machine is readily moved from place to place. The feed is effected by gearing or by hydraulic pressure; a 2⅝-inch crown is employed, leaving a 2-inch core. Each separate drill rod is 10 feet long. The total weight of the machine is about 4 tons.

4. *Breaking Ground—Tools Employed—Blasting by Various Methods—Machine Drills—Driving Levels and Sinking Shafts.*—The kind of ground in which mining excavations have to be carried on varies within the widest limits, from loose quicksands to rocks which are so hard that the best steel tools will scarcely touch them.

Loose ground can be removed with the shovel; but in the special case of peat sharp spades are employed, which cut through the fibres and furnish lumps or sods of convenient form for drying and subsequent use as fuel. What is called *firm, soft*, or easy ground, such as clay, shale, decomposed clay slate, and chalk, requires the use of the pick and the shovel. The pick is a tool of very variable form, according to the material operated on. Thus there are the navvy's pick, the single-pointed pick with a striking head at the other end called the poll pick (fig. 18), and numerous varieties of the double pointed pick (fig. 19), the special tool of the collier, but also largely used in metal mining. When the ground, though harder, is nevertheless "jointy," or traversed by many natural fissures, the wedge comes into play. The Cornish tool known as a *gad* is a pointed wedge (fig. 20). The so called "pick and gad" work consists in breaking away the easy ground with the point of the pick, wedging off pieces with the gad driven in by a sledge or the poll of the pick, or prizing them off with the pick after they have been loosened by the gad. The Saxon gad is held on a little handle, and is struck with a hammer. It is used for wedging off pieces of jointy ground, and in former days even hard rocks were excavated by its aid. The process consisted in chipping out a series of parallel grooves and then chipping away the ridges left between the grooves. As a method of working this process is obsolete, but it is useful on a small scale for cutting recesses (*hitches*) for timber, for dressing the sides of levels or shafts before putting in dams, and for doing work in places where blasting might injure pumps or other machinery.

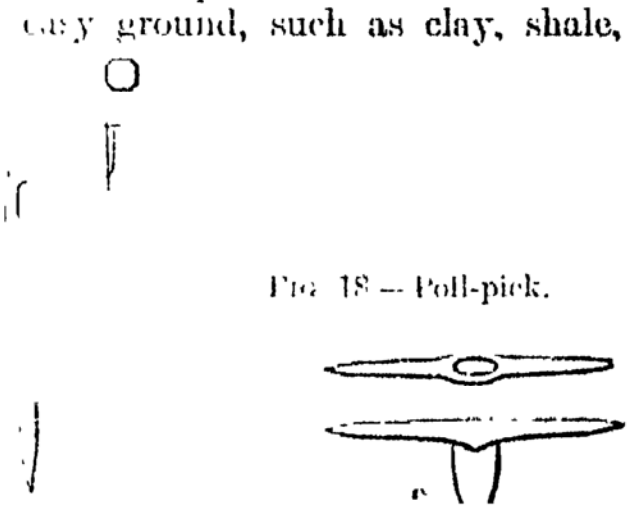


Fig. 18.—Poll-pick.

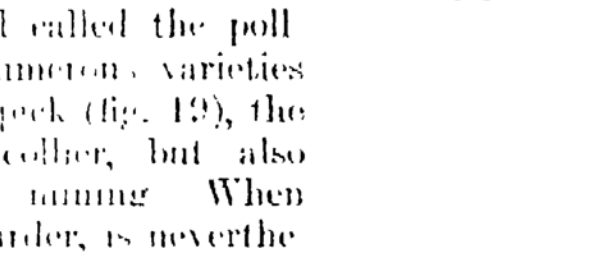


Fig. 19. Double-pointed Pick.

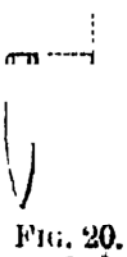


Fig. 20.—Gad.

We now come to hard ground; and in this class we have a large proportion of the rocks met with by the miner, such as slate of various kinds, hard grits and sandstone, limestone, the metamorphic schists, granite, and the contents of many mineral veins. Rocks of this kind are attacked by boring and blasting. The tools employed are the jumper, the borer or drill, the hammer, the sledge (*mallet*, Cornwall), the scraper and charger, the tamping bar or rammer, in some places the pricker or needle, the claying bar, the crowbar, and finally the shovel for clearing away the broken rock.

Fig. 21.

The jumper (fig. 21) is merely a long bar of iron terminating in two chisel-like edges made of steel; generally there is a swelling in the middle, and sometimes the jumper tapers all the way from the middle to the edge or bit. The jumper is most commonly used when it is necessary to bore holes downwards, and is

largely employed in quarries; occasionally it is used in boring holes horizontally, as for instance in the salt mines of Cheshire. The jumper is held in the desired direction, lifted up, and thrust down; it is turned a little after each stroke.

However, the miner's tool is generally the borer proper, or drill (fig. 22), which is a bar of round or octagonal steel, usually from $\frac{7}{8}$ inch to $1\frac{1}{4}$ inches in diameter, with one end forged into a chisel-shaped edge, the exact shape and degree of sharpness varying according to the hardness of the rock. The hole is bored by striking the drill with a hammer or sledge and turning it after each blow. Boring is said to be single-handed if the miner holds the drill in one hand and strikes with the hammer in the other, whilst it is called double-handed when one man turns and another strikes. The hammers for single-handed boring usually vary in weight from 2 to 6 or 7 lb.

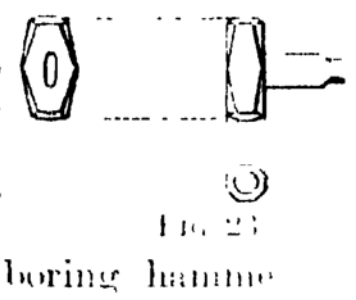


Fig. 22.

The double-handed boring hammer weighs from 6 to 10 lb or more. The hole is bored downwards, the miner pours in a little water and leaves the hole wet. From time to time he draws out the sludge with the scraper, a little disk at the end of a metal rod, and he takes a fresh borer when the tool he is using has become blunt. The depth bored varies with the rock and the nature of the excavation; but in driving levels in the ordinary way the depth is commonly from 18 inches to 3 feet.

Holes for blasting are sometimes bored by tools like carpenters' augers. One of the simplest, which is used in some French slate-mines, is very like a brace and bit, and the tool is kept pressed against the rock by means of a screw fixed in a frame resting on the ground.

The pricker, or needle, is a slender tapering rod of copper or bronze, with a ring at the large end. It is used for maintaining a hole in the *tamping* through which the charge can be fired. The use of needles made of iron is prohibited in many countries, on account of the danger of their striking sparks which might fire the charge. The tamping bar, or *stemmer*, is a rod of iron, copper, or bronze, or iron shod with copper, and it is used for ramming in dried clay, slate pounded up, or other fine material, upon the powder, and so creating a resistance sufficient to make the gases generated by the explosion the charge rend the rock in the manner required. The aying bar is used for lining wet holes with clay, and rendering them temporarily watertight.

Shovels vary much in different districts. In the south-west of England the long-handled shovel is preferred to the common one with a short handle, in Germany the ore or rubbish is frequently scraped into a tray with a sort of hoe.

In addition to these tools the miner requires an explosive, and a means of firing the charge at the bottom of the hole which will give him time to escape. Twenty years ago gunpowder was the only explosive in common use in mines, but at the present day its place has been taken to a very large extent by mixtures containing nitro-glycerin or gun-cotton. The powder used for blasting in mines usually contains less saltpetre than that which is employed for sporting or military purposes. The following is an analyses of mining powder by Captain Noble and Sir F. Abel[1]:

Saltpetre	61·66	Oxygen..	
Potassium sulphate	0·12	Ash	0·59
,, chloride	0·14	Water	1·61
Sulphur	15·06		
Carbon	17·93		100·00
Hydrogen	0·66		

[1] "On Fired Gunpowder," *Phil. Trans.*, 1880, p. 225.

Gunpowder compressed into cylinders of diamet suitable for bore-holes, and provided with a central h for the insertion of the fuse, has lately been brou forward with some success.

Nitro-glycerin or glyceryl nitrate is a light-yellow o liquid which is very sensitive to shocks; under the act of a fulminating cap it explodes with great violen Its chemical composition is expressed by the form $C_3H_5(NO_3)_3O_3$ or $(C_3H_5)3NO_3$: its specific gravity 1·6. It has been found so dangerous that its use itself has been given up, but on the other hand the m ture of nitro-glycerin and infusorial earth (*Kieselguhr*) cal dynamite or giant powder is now one of the common explosives met with. It has the advantage over powe that it is far more powerful, that it may be used in w holes or under water, that it is very effective even ground full of "vughs" or cavities, and that it requires hard tamping, which is always a source of danger. plasticity too enables it to fill the space at the bottom o bore hole, which is rarely a true cylinder, more complet than any solid cartridge can do. One di-advantage that it has to be thawed in cold weather, and there is a the fact that occasionally the whole of a charge of dy nite fails to go off, and unnoticed remnants have explod and caused serious and even fatal accidents when str with the pick or borer. The danger is enhanced when t remnants have been left in contact with water, which can a separation of the sensitive nitro-glycerin, so that eve blow upon the adjacent rock may lead to an accident any of the explosive oil has leaked into cracks. T strongest dynamite contains about 75 per cent. of nit glycerin, the rest being kieselguhr. A newer explosive blasting gelatin, it is made by mixing nitro-cotton w nitro-glycerin, until enough nitro-cotton has been dissolv to convert the nitro-glycerin into a jelly-like mass. T blasting gelatin in ordinary use contains no less than per cent. of nitro-glycerin, with 7 per cent. of nitro-cott and its strength is very great.

Gun-cotton *per se* is not much in favour in ordina mining, but mixed with some nitrate or mixture nitrates, such as the nitrates of barium and potassium, a known as cotton powder, tonite, and potentite, it employed extensively. Though not quite so powerful dynamite, nitrated gun-cotton possesses the importa advantage of not requiring to be thawed in cold weath As in the case of dynamite, accidents have been caused remnants of charges, and with both explosives it is nec sary to examine carefully the bottoms of all holes af blasting, and to destroy any possible remnants by firing a detonator in any bottom or "socket" which cannot w certainty be pronounced free from danger.

The commonest method of firing a charge is by me of the *safety fuse*, a cord containing a core of gunpow introduced during the process of manufacture, it may rendered waterproof by tar or gutta percha.

In blasting in the ordinary way the charge of gunpowder is no other loose or in bags or paper bag and it is pressed dow the bottom of the hole with a wooden stick, whilst a piece of also inserted extending from the charge well beyond the h If the powder is loose the miner carefully wipes down the sid the hole with a wet *scraper* or wooden rod with the hair-l at one end, or with a wisp of hay twisted round the scraper, order to remove any loose grains adhering to the fuse or the s of the hole, and then presses in a wad of hay or paper. A h fine tamping often the dust from boring a dry hole is now thro in and rammed down with the wooden charge-rod, and the s process is repeated, and when harder tamping is required the m bar is brought into operation, until the hole is completely filled

As the safety fuse burns slowly, at the rate of about 2 or 3 a minute, the miner can secure ample time for retreat by takin sufficient length. It is usual to ignite the fuse by a candle- fixed under it by a piece of clay, and it takes a little time for candle to burn through the fuse.

The old plan of firing a charge, which is still in use in m

places, consists in inserting the needle into the charge and then
amping up the hole [illegible] to draw out the needle a little
s the tamping pro[illegible] prevent too much force being r
quired for practical w[illegible] The small hole left in this way
erves for the introduction w, rush, or series of small quills, filled
with fine powder, wh[illegible] the fuse reaches from the charge to
he outside [illegible] which [illegible]tes a stream of sparks down
he needle [illegible] The straw or quill is
ighted [illegible] low match made [illegible] dipping
on [illegible]ed saltpetre or sodium a piece of paper or a
nother [illegible] of candle touch paper also is used.
Dyn[illegible] gelatin, gun cotton, and cotton powder are
[illegible] on of a fulminating cap. A long copper cap
of necessary [illegible] forced into the cartridge by
top [illegible] inserted into a
of the
hole
[illegible] not taken up with
[illegible] sometimes the cot[illegible] red
charge of powder al[illegible]
cartridges for exp[illegible]
ired with the ca[illegible]

[illegible]amp. Among the [illegible]s may be men[illegible]
[illegible]nical pairs of dry wood which will [illegible]
[illegible]ften wetted, wedges worked by [illegible]
[illegible]ydraulic pressure, cartridges com[illegible] [illegible]
[illegible]mmer composed almost entirely [illegible] [illegible]
[illegible] pressures, and lastly cartridges of [illegible] lime which
[illegible]ood when water is brought into it.

For the purpose of firing several h[illegible]-multaneously,
[illegible] Bickford, Smith, & Co., the original inventors and
[illegible]akers of the safety fuse, have brought out a new fuse
[illegible]e," fig. 26, the action of which
[illegible]ill be easily understood
[illegible]om the figure. An ordi
[illegible]ary fuse is fixed into a
[illegible]etal case called the igniter,
[illegible]om which a number of
[illegible]staneous fuses convey fire to as many separate holes
[illegible]t is found in practice that this plan answers very well.

Charges may be readily fired singly or simultaneously
[illegible]ith the aid of electricity, either of high tension obtained
[illegible]om a frictional, magneto-electric, or dynamo-
[illegible]achine, or of low tension from a galvanic battery.
[illegible] referred.

[illegible] [illegible] [illegible] [illegible]
[illegible] [illegible] wooden [illegible] ramming a pipe [illegible] E,

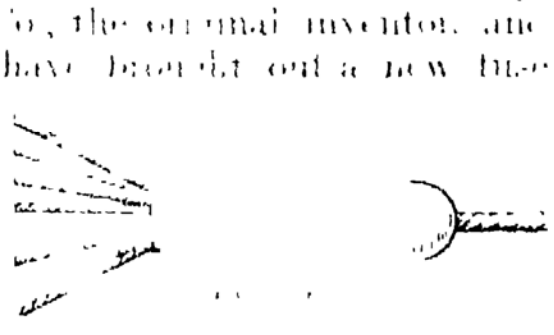


Fig. 26.

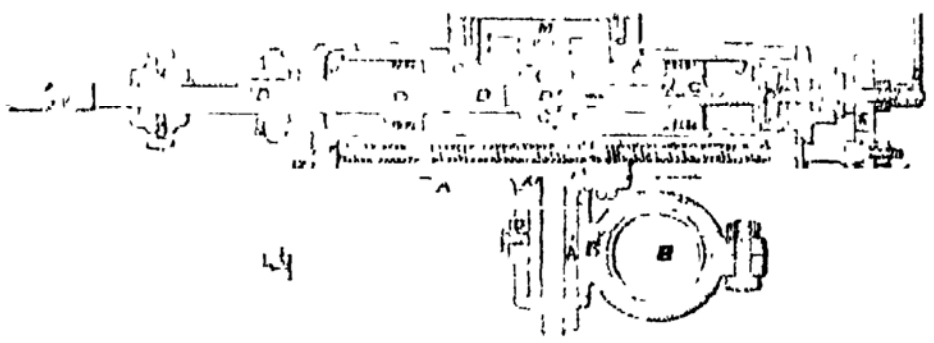
[illegible] [illegible] composition C at the bottom. Two
[illegible] D are fixed in gutta percha E, E reach down to
[illegible]ne, where they are about ¼ inch apart. A copper
[illegible] fixed on to the small end of the wooden rod
[illegible] D D are long enough to reach beyond the bore
[illegible] of the wires are taped here, and one wire of the
[illegible] hole [illegible] ther with a wire of the next hole and so
[illegible], and [illegible] second wire of the first and last hole are
[illegible] to the two cores of a single cable, or to two separate
[illegible]ables [illegible] place of safety to which the men can
[illegible]retire. [illegible] wires are connected by binding screws
[illegible] to a [illegible] and a powder. A few turns
[illegible] the handle [illegible] and by pressing a knob or by
[illegible]ome other [illegible] the [illegible] pleted and the discharge
[illegible]ffected. The electricity [illegible] rough the fuse wires making
[illegible]park at each hole [illegible] [illegible] the gunpowder composition
[illegible]The flame flashes through [illegible] and ignites the fulminating
[illegible]ercury I, the detonation [illegible] the explosion of the
[illegible]ammate, bursting [illegible] [illegible] the cap.

One great advanta[illegible] [illegible] before firing is that the miner
[illegible]an retire to a perfectly [illegible]afe place before attempting to
[illegible]xplode the charge. This is important in sinking shafts,
[illegible]here the means of escape are less easy than in levels.
A second advantage is that there is no danger of a "hang
fire," an occasional source of accidents with the ordinar
safety fuse.

One of the greatest improvements in the art of minin
during the last few years has been the introduction
machinery for boring holes for blasting; most of th
machines imitate percussive boring by hand, but a fe
rotary machines are also in use. A percussive drill
perforator consists of a cylinder with a piston to whic
the drill is fastened. Compressed air is made to a
alternately on each side of the piston, and in this manne
the drill receives its reciprocating motion. Variou
arrangements have been adopted for securing the automat
rotation of the drill. In some cases also the advanc
forward of the machine, as the hole is deepened, is als
effected automatically, but in many of the best drills th
work is left to the man in charge. It is impossible withi
the limits of this article to describe the various drills no
in use, or even to make a complete enumeration of them.

The following, in alphabetical order, are the names of some
the best known drills: Barrow, Beaumont, Burleigh, Champion
Cornish, Cranston, Darlington, Desideratum, Doering, Dubo
and Francois-Dumesnil, Eclipse, Excelsior, Ferroux, Frohlich, Inger
oll Leyner, Mackie, Osterkampf, Rand, Roanhead, Sandycroft
Schram. An account of two of the simplest, the Barrow and th
Darlington drills, will be sufficient to give a general idea of th
construction of the machines.

"The Barrow drill (fig. 27) consists essentially of a gun-meta



cylinder C about 2 feet in length and 4 inches in diameter, i
which works a cast-steel piston-rod D, fitted with two pistons
about 12 inches apart, and midway between which is the tappet,
box, G. In a valve box on the top of the cylinder is placed th
oscillating slide valve H (shown separately), hinged at M, whic
is worked by the reciprocation of the tappet G' coming in co
tact with the lever edges, which for this purpose are formed wit
two lugs at each end, as shown. It has ports corresponding
with openings in the slide valve face for admitting the fres
charge of compressed air from the inlet pipe I (fig. 28) to th

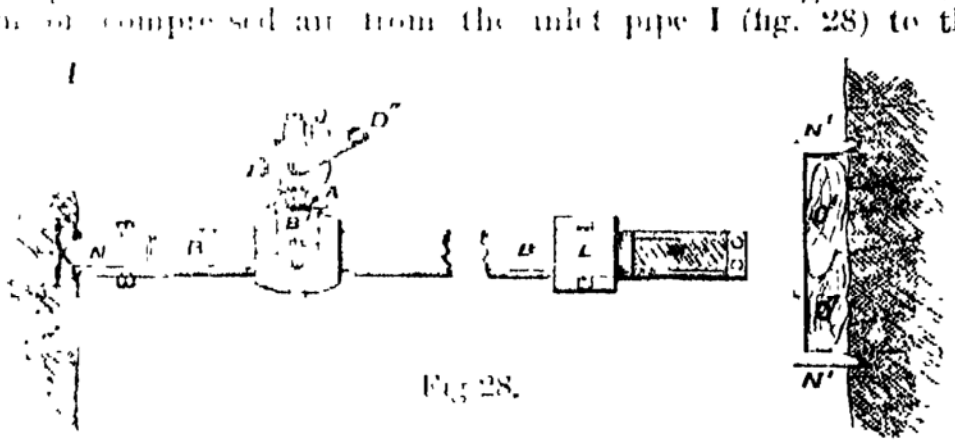


Fig. 28.

ports a at each end of the cylinder, and for letting the spent
exhaust air or steam escape by the exhaust pipe J. This simpl
arrangement constitutes the whole valve gear of the machine.

"The borer is inserted into a hole formed in the fore end of th
piston rod, and is fixed therein by means of a screw. Its rotatio
is effected by hand by means of the handle D", turning a spind
D', which is fitted by means of the cotter *d*, made fast in th
piston D, and fitting in a slot in the spindle D', that the latt
can slide in the piston D, but when turned by the handle caus
the piston to turn with it. The spindle D' has a pinion E gearin
into the pinion F, on the adjusting and feeding screw C', so th
when the piston D is turned by means of the handle D" th
cylinder C is simultaneously pushed along the bed-plate A. The
pinions can be easily disconnected by loosening the nut *f*, and th
the piston and the adjusting screw can be turned independently
one another when required.

"The borers used are respectively 1¾ inches, 1⅝ inches, and 1 inc
in diameter, the length of the stroke 4 inches, and the maximu
number of blows about three hundred per minute. The air

lown about 400 fathoms from surface, at a pressure of 50 to
ne square inch, in wrought iron pipes 2 inches in diameter in
and 1¼ inches in the level, and admitted through a flexible
the inlet I on the left hand side of the cylinder. The cost
es is rather under 7d. a foot, or about 3s. 3d. per fathom
compressed at the surface by a 14 inch compressor, worked
nch horizontal engine, capable, however, of working two

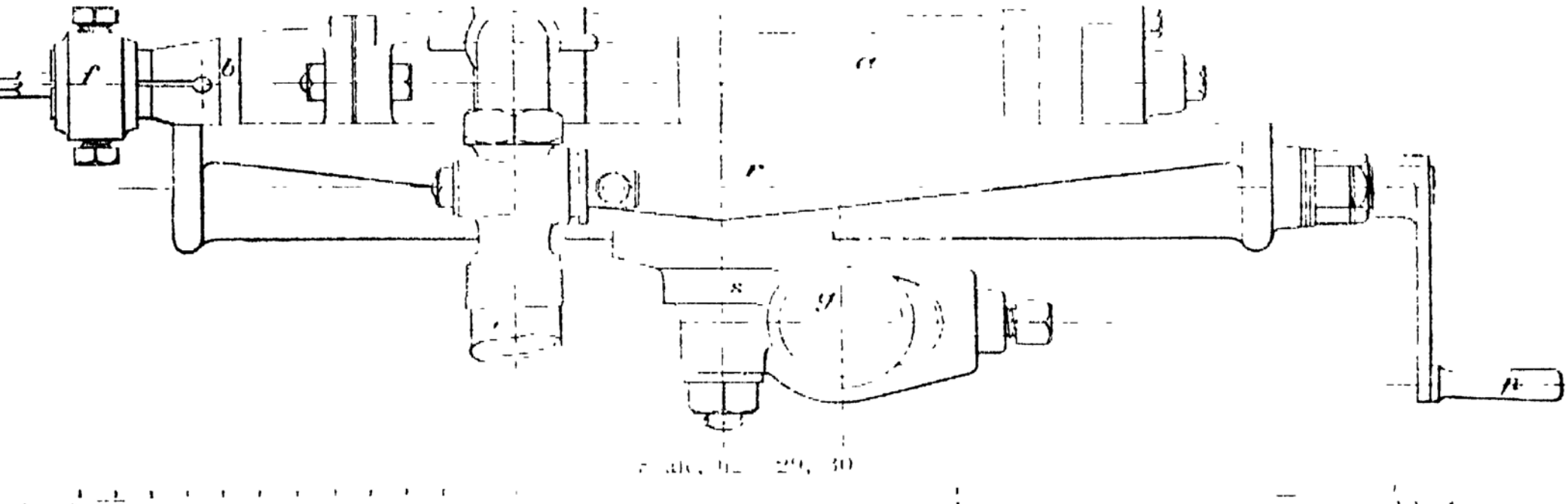


Fig. 29.—Side Elevation of Darlington's Rock Drill.—Scale ½.

laced in position either horizontally or vertically as may
convenient, but is generally placed across the level, against
s of which it is secured by means of the clamp L, and

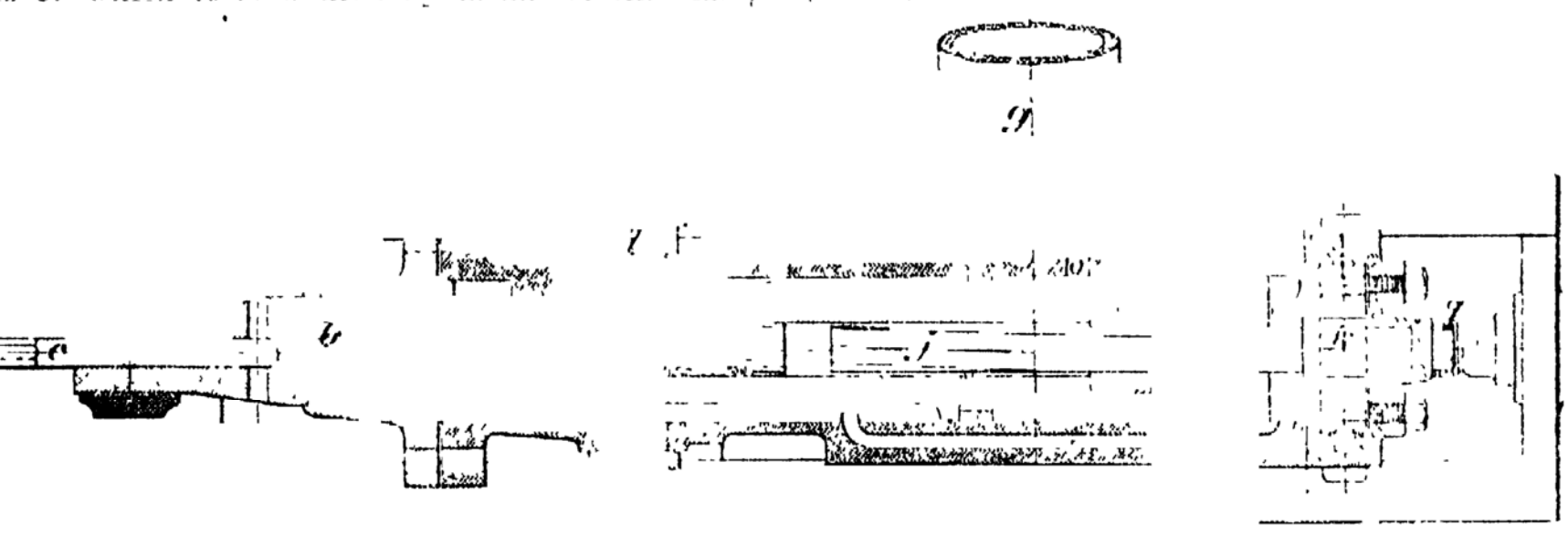


Fig. 30.—Horizontal Section of Darlington's Rock Drill.—Scale ½.

adjusting screw M, and clasps N and N'. If necessary, a wooden
wedges O, O' are driven in between the laws and the wall to make
it still firmer. The weight of the bar is about 120 lb."[1]

mpressing plant of greater size has now been erected at
h mine, to which the above description refers. At Snail
ine in Shropshire they have two air compressors of 18 inches

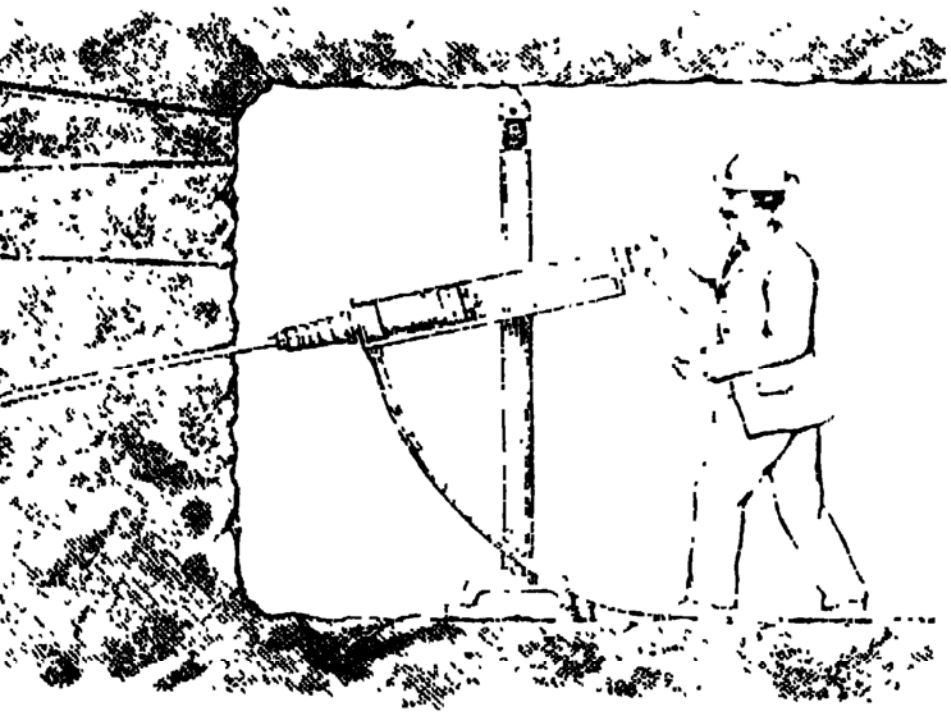


Fig. 31.

er and 5 feet stroke; the air-main is at first 9 inches in dia-
then 6 inches, whilst 2-inch gas pipe is used in the levels
ck-drill which has done, and is doing, excellent work is that
of Mr John Darlington. Its construction will be understood by
referring to figs. 29, 30 and 31, *a* is the cylinder, *b* the piston rod
c the lever, *d*, *d* the two openings for admission of compressed air
either of which may be used according to the position of the drill
e the inlet box with a top piece, *f* drill bonnet, *g* stretcher bar
h piston, *i* rifled bar for turning piston and drill, *k* ratchet wheel
attached to rifled bar, *l* rifled bush fixed in the piston head, *m* wood
for lessening weight of piston rod and blocking piece, *n* portway for
allowing the compressed air to pass to the top of the piston and give
the blow, *o* bush, *p* portway. The action of the drill is as follows:
The compressed air is admitted at *d* to the underside of the piston
and when the upper side of the piston communicates with the outer
atmosphere through the portway *n* the piston is forced backward and uncovers the
exhaust port *o*, and the air rushes through and presses against
the upper side of the piston, which has a greater area than the lower
side, the difference being equal to the area of the piston rod. The
piston is driven upward, and the drill strikes a blow
At the same time the exhaust port *o* and then the compressed air passes on to the annular area on the underside of the piston
producing the return stroke. The number of blows per minute
hole is limited to eight hundred. The rotation of the drill is
effected by the rifled bar. On the down stroke of the piston the
bar with its ratchet wheel is free to turn under a couple of pawls
and consequently the piston moves straight whilst the bar and
ratchet wheel turn. When the up stroke is made the ratchet
wheel is held by the pawls and the piston is forced to make part of
a revolution. As the hole is deepened the cylinder is advanced
forwards by turning the handle *p*, this working an endless screw

[1] *Proc. Mining Institute of Cornwall*, vol. i., 1877, p. 12.

assing through a nut attached to the cylinder; *r* is the cradle rrying the feed screw and supporting the cylinder. It is centred the clamp *s*. As the clamp can be fixed in any position on the ar, and as the cradle can be turned on the clamp, it is evident hat holes can be bored in any direction.

In driving a level with the Darlington drill it is usual to fix the retcher bar horizontally across the level so as to command the pper part of the face, holes can then be bored with the cradle bove the bar or below it. The bar is then lifted low enough to ore the bottom holes. It is found that all the necessary holes can e bored from two positions of the bar. The bar therefore has imply to be fixed twice; the alterations in position for boring holes various directions are managed by shifting the clamp on the bar nd turning the cradle on the clamp. Fig. 31 shows the stretcher ar fixed in a vertical position which is sometimes convenient.

In order to wash out the loose from holes that are looking ownwards a jet of water, supplied from a hose attached to a half nch gas pipe leading from a cistern at a higher level, is made t play into the holes during the process of boring.

For sinking shafts Mr Darlington has the drill fixed in a cylin rical case with a large external thread which works in a nut or amp. The drill is fed forwards by turning a hand wheel attached o the case.

Rotating machine drills are also used in mines as well those with percussive action. Stapff pointed out some ears ago that, if a rock may be chipped off by power com unicated by a blow, it may also be chipped off by a similar mount of power communicated by pressure. Brandt's otatory boring machine consists of a hollow borer which as a steel crown with cutting edge screwed on. The ool is kept tight against the rock by the pressure of a olumn of water, and is at the same time made to rotate y two little water pressure engines, whilst a stream of water passing down through the borer washes away the débris and keeps the cutting edge cool. In principle, herefore, the drill resembles the original diamond boring machine of De la Roche Tolay and Perret, save that the rown is made of steel and not of diamonds. During the ast few years it has been tried with success in railway unnels and in mines. Darlmuck's drill acts also by otation, but the borer is fed forwards and pressed against he rock by a differential screw arrangement. The machine an be worked by hand, or by a little water pressure or ompressed air engine or an electro motor. In working ertain minerals occurring in seams the undercutting may e performed by machines similar to those used in coal ines (see vol. vi. p. 68).

We now come to the application of the tools and machine drills to the purpose of breaking ground for driving levels nd sinking shafts.

A level or drift is a more or less horizontal passage or unnel, whilst a shaft is a pit either vertical or inclined. n driving a level by hand labour in hard ground, the first bject the miner has to do is to blast

et a preliminary opening in the "end" or "forebreast". The position of this cut is determined by the joint, which ' miner find carefully so as to obtain the greatest dvantage from these natural planes of division. This- which, owing to joints, it was

dvisable to begin with a hole No. 1, and then bore and blast 2, 3, and 4 one after the other. The miner as a rule does not plan the position of any hole until the previous

Österreichische Zeits. für Berg- und Hüttenwesen, 1881.

one has done its work; in fact he regulates the position and depth of each hole by the particular circumstances of the case. Though a vein and its walls may be hard, there is occasionally a soft layer of clay (DD, DD, fig. 33) along one wall (*dig*, Cornwall: *gouge*, United States). The miner then works this away with the pick, and, having excavated a groove as deep as possible, he can now blast down the lode by side holes and so push the level forward.

In sinking a shaft a similar method of proceeding is observed. A little pit (*sink*) is blasted out in the most convenient part, and the excavation is widened to the full size by a succession of blasts, each hole being planned ording to circumstances. This series of operations is repeated, and the shaft is thus gradually deepened.

Where boring machinery is employed, less attention, and sometimes no attention, is paid to natural joints, because when once the drill is in its place it is very little trouble to bore a few more holes, and the work can then be carried on according to a system which is certain of effecting the desired result.

A common method of procedure for hard ground is shown in figs. 34 and 35. Four centre holes are bored about a foot apart at first, but converging till at a depth of 3 feet they are within 6 inches, or less, of each other. Other holes are then bored and them until the end is pierced by twenty or thirty holes in all. The four centre holes are then charged and fired simultaneously, either by electricity or by Bickford's instantaneous fuse, and the result is the removal of a large core of rock. The holes round the opening are then charged and fired, generally in volleys of several holes at a time, and the level is thus carried forward for a distance of 3 feet. If the ground is more favourable fewer holes are required, and they may be bored deeper,- in fact as much as 6 feet in some instances. Occasionally the four centre holes are directed so that they meet at the apex of an acute pyramid, and then, after all have been charged with blasting gelatin, only one of them receives a primer and cap; the shock of the explosion of one charge fires the other three adjacent charges simultaneously. The preliminary opening is not necessarily made in the centre of a level, and sometimes it is blasted out in the bottom or one side.

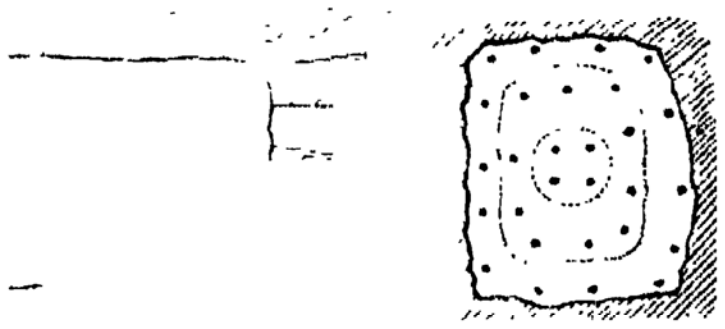
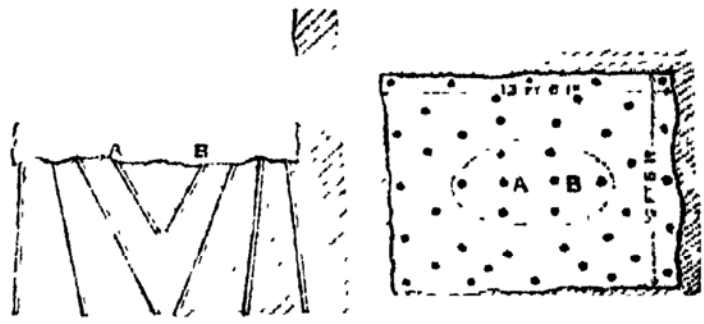


Fig. 35.

In sinking shafts by boring machinery operations are conducted much in the same way as in driving levels, except of course that the holes are directed downwards. Figs. 36 and 37 are a section and plan of a shaft which has been sunk by the Foredale mining company in the Isle of Man. About forty feet from the bottom of the shaft the holes



A B

d F Fig. 37

blasted with ordinary fuse. They serve simply to smash up and weaken the core, then the six holes nearest the centre, which are 8 feet deep, are blasted all together with Bickford's instantaneous fuse and the result is the removal of a large core leaving a deep *sink*. The remaining holes are fired in volleys of a time in the ordinary way. In this manner the shaft, which is in hard granite, is being deepened at the rate of 3½ or 4 fathoms a month. Tonite is the explosive used.

Sundry machines have been invented and used for driving levels without blasting. Some cut up the face into small chips which can

easily be removed, but they have not made their way at present into ordinary mining. The Bosseyeuse of MM. Dubois and François acts on a different principle. It is a strong machine worked by compressed air. It first of all drills holes 4 inches in diameter by percussion; a striking head is then substituted for the drill, and wedges, on the principle of the plug and feathers, are inserted into the holes; and powerful blows with the striking head wedge off the rock in lumps. This machine is being used with success in Belgium for driving levels and crosscuts in fiery mines.

Some comparative experiments between hand labour, a percussive drill, and a rotatory drill have lately been made in one of the Freiberg mines,[1] and the results are of much interest and importance. The actual figures are as follows, the cost including, in the case of the machines, interest, depreciation, and cost of repairs, and cost of steam power, supposing water-power not available:

	By hand	By Schram's Drill	By Brandt's Drill
Distance driven per week (in metres) ...			
Cost in marks per metre driven... ...			
Wages realized by the miners, in marks, per hour's shift			

The advantages of machine work are very great both as regards rate and cost of driving, and were fully attained by the use of Brandt's rotatory drill did its work cheaper and faster than Schram's machine; but nothing is said in the communication about the relative cost of a machine driven by compressed air for ventilating which is used in advanced headings in which these drills are employed.

Brandt's machine was worked with water at a pressure of 8·5 atmospheres, of which 5·6 atmospheres were obtained by the pressure pumps provided with an accumulator and 2·9 atmospheres by natural fall, owing to the working level being 297 metres below the pumps. The water was conveyed to the machine in pipes of 1½ inches diameter inside. The diameter of the hole bored was 2⅜ inches, and they could be bored to a depth of 1·5 inches per minute. The stretcher bar on which the machine is mounted is hollow, and has a piston which can be forced out by hydraulic pressure so as to fix the bar firmly. A similar bar is sometimes used with percussive drills.[2]

As a method of breaking ground the action of fire-setting requires to be mentioned. Before blasting was known it was largely employed, but its use is now confined to a few places on the Continent where the rocks are exceedingly hard and where wood is abundant and cheap. Piles of wood are heaped up against the face of the working and set on fire. On returning to the work a day or two or three days afterwards, when the rock has cooled a little, it is found that the ground has split and flaked off, and that much has been loosened which can be removed easily.

We finally come to water as an agent for [illegible]. Streams of water were formerly used in South Wales for [illegible] beds of clay ironstone at the outcrop. The water washed away the clay and shale and left the clean nodules of ore. The china clay of Cornwall is also worked by water. A stream of water is turned on to the soft mass, and the workmen loosen the ground with a pick; the water carries off the [illegible] rock in suspension to regular settling pits. Water under pressure has rendered vast services to the miner in working auriferous alluvia. The system is described and figured at p. 74 of vol. [illegible], so it is unnecessary here to enter into details. In the case of salt-mines recourse may be had to the solvent action of water directed by suitable nets, for making excavations.

5. *Principles of Employment of Mineral Labour.* As a large proportion of the expenditure in mining is for actual manual labour, it is very important that means should be taken to prevent any waste in this department. Three principles are in vogue: payment by time, by work done either measured or weighed, and by the value of the ore extracted.

The overseers, called captains in many metal mines, are naturally paid by the month, and where strict supervision can be exercised, such as is possible at the surface, on the dressing floors for instance, the same principle may be adopted; but when men are working underground, and often in small gangs of only two or three persons at some distance apart, piecework of some kind is more economical and satisfactory in every way.

In driving levels and sinking shafts it is usual for the men to work at a certain price per running yard or [illegible]. The agents have to see that the excavation, whether driving or level, is maintained of the full dimensions agreed upon and preserved in the proper direction. At the end of a certain time, generally a month, the work is measured by the agent. From the gross amount obtained by measuring the price by the number of fathoms driven or [illegible] is necessary to deduct the cost of the materials supplied to the men by the mining company, such as explosives, candles, &c., and the remainder is divided among the persons who took the contract. When the useful mineral is being obtained the men may be paid at so much per cubic yard or fathom excavated, or at so much per ton of mineral extracted, the overseer of course having to see that in the latter case, that worthless rock is not sent to the surface. Payment by the number of inches bored is a method in use in some countries, where the men are not experienced or enterprising enough to undertake the work in any other way. A foreman points out to the men the position and direction in which the holes must be bored, measures them when completed, and subsequently charges and fires them.

The third method is that which is known as the "tribute" system. The miner working on tribute undertakes to extract and dress the ore in a certain portion of the mine which is assigned to him and called his *pitch*. He gives to the mining company all the ore he extracts at a certain fixed proportion of its value, after he has paid all the cost of getting it, hoisting it to the surface, and dressing it. Thus, supposing he takes a pitch at 5s. in the £, and produces marketable copper ore of the value of £250, his share will be 50 × 5s. = £12. 10., less the cost of the materials which he has been supplied with, and all expenses for [illegible] charges, sampling, &c.

6. *Means of Securing Excavation by Timber, Masonry, &c.* The following kind of timber are the most frequently employed for securing excavations under ground: oak, larch, pitch pine, pine, fir, and occasionally beech. To minimize the tendency to rot which timber is subject to by dry rot, which gradually reduces it to powder, and when the timber is often renewed the expense may be very considerable, various methods of preventing dry rot have been tried with more or less success, such as letting water trickle over the timber in the mine or treating it with preservatives beforehand. Brine, creosote, and solutions of chloride of zinc, sulphate of zinc, sulphate of copper, and sulphide of iron, increase the duration of timber. It was found by experiments carried out at Community Grube, Silesia, during a series of years that one of the best plans was to steep the timber for twenty four hours in a strong solution of sulphate of iron. The total cost was only 3d. per yard of prop, and the timber lasted eleven times as long as when the preservative treatment was omitted.

Timber is used in various forms, either whole and unsawn into levers, or squared up, or sawn in half, or into planks of various thickness.

Where the roof of the level is weak, props are used, but in some coal mines and clay ironstone mines the roof is supported by horizontal beams (*couples*) laid from prop to prop crosswise (fig. 58).

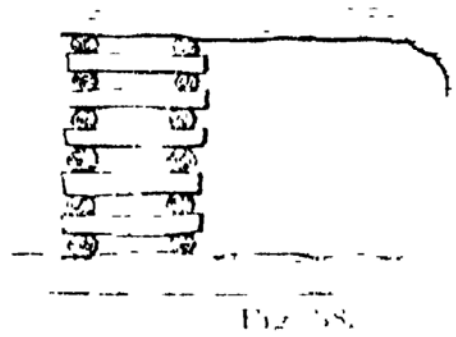


Fig. 58.

Though the excavation of a level is a very simple matter, the method of timbering it varies considerably, because the parts requiring support may either be the roof alone, or the roof and one or two sides, or the roof, sides, and bottom.

If the roof only is weak, as is the case with a soft lode between two hard walls, a *cap* with a few boards resting on it is sufficient to prevent falls. If one side is weak the cap

[1] *Jahrbuch fur das Berg- und Hüttenwesen im Königreiche Sachsen auf das Jahr* 1882, p. 18, and abstract in *Proc. Inst. Civ. Eng.*, vol. lxix., 1881–82, part iii. p. 51.

[2] *Annales des Mines*, ser. 8, ii., pl. 1, fig. 6, 1882.

oported by a side prop or *leg* (fig. 40), and very often by two gs. The forms of joint between the cap and leg are numerous

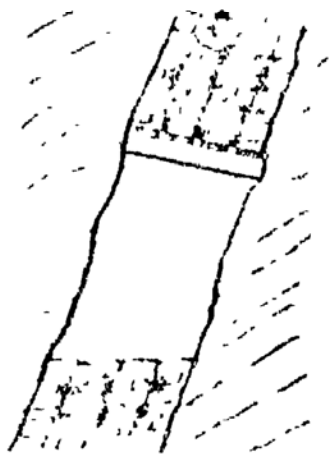


Fig. 39

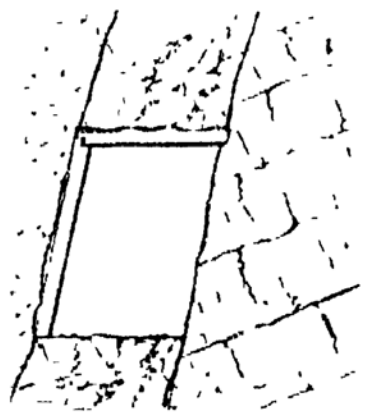


Fig. 40

g. 41), depending to a great extent upon the nature of the pres re, whether coming upon the top or sides. With round timber e top of the leg is metimes hollowed shown in fig. 42 but occasionally joint is flat and thick nail, or *spur*, put in (fig. 42 B)

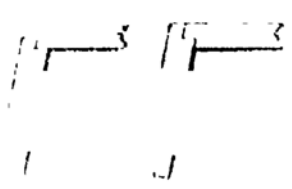


Fig. 41.

Fig. 42

prevent the effects of side pressure, or, better, a piece of thick nk is nailed under the cap (fig. 43). Where the floor of a level soft and weak, a le piece or *sill* be mes necessary, and, the sides or roof are ely to fall in, a ning of poles or anks is used (fig. 43) In some very heavy ound in the Com- ock lode a special stem of timbering is opted (fig. 44)

Fig. 43.

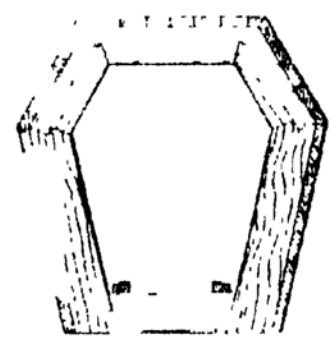


Fig. 44.

If the ground is loose, so that the roof or sides, or both, will run unless immediately supported, the method of working called *lagging* or *poling* is pursued. It consists in supporting the weak rts by boards or poles kept in advance of the last frame set up. e poles or boards *aths*) are driven ward by blows om a sledge, and ground is then orked away with pick, as soon as sufficient advance s been made a new ame is set up to pport the ends of poles or boards d the process is re ated in fig. 45 and

Fig. 45

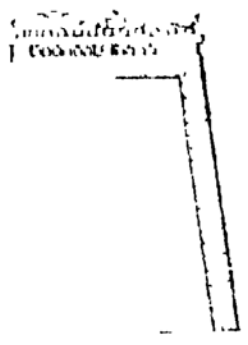


Fig. 46

In running ground it is necessary to have the lath-timbering ck together, and the working face also must be supported by e.g. lags in place by little struts resting against the frame- ces are removed and advanced one by one after the laths h ve been driven beyond them

To a consideration of the high price of timber, must sometimes ad ed the difficulty of obtaining it in many districts. One method is that of building walls of rubble masonry, into the form shown in fig. 47, and making it ample for the roof to rest on

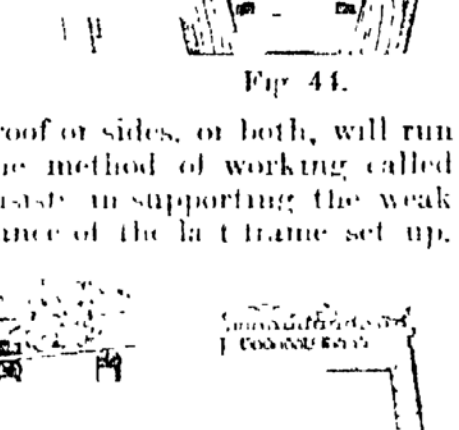


Fig. 47

pace at the sides filled with rubbish

Masonry has long been employed for supporting the sides of shafts in soft ground or where extensive. The materials necessary are stone or brick ers, or slag bricks, and the walls may be built up about 3 *walling*) or with the addition of mortar or hydraulic concrete. The bottom of a level is occasionally ed with concrete to carry off the flow of water, which otherwise might run into lower workings through cracks and crevices. ry walling is not uncommon, and it may be combined with the e of timber or iron) as shown in fig. 60 in which a level is maintained between two walls keeping back a mass of rubbish.

Figs. 48 and 49 show methods of securing a drift by arches when a lode has been removed.

The timbering required for shafts varies according to the nature of the ground and the size of the excavation. A mere lining of planks set on their edges (fig. 50) suffices for small shafts, corner pieces being nailed to keep the successive frames together. In some of the salt mines of Cheshire the shafts are lined with 4-inch planks united by mortice and tenon joints.

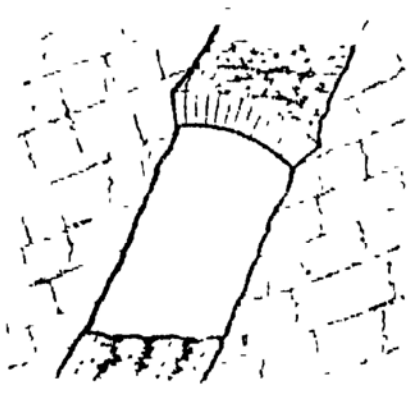


Fig. 48

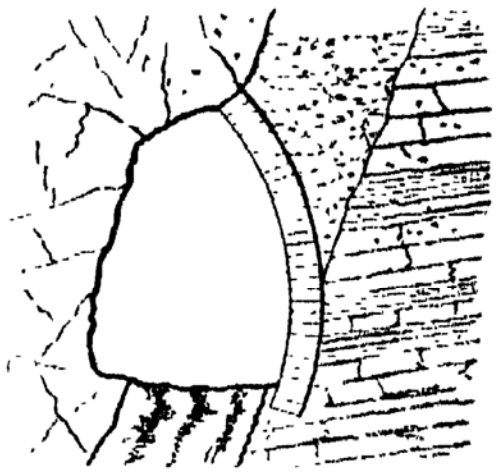


Fig. 49.

Fig. 50.

The usual method of securing shafts is by *sets* or *frames*. Each set consists of four pieces, two longer ones called *wall plates* and two shorter ones called *end-pieces*. They are joined by simply halving the timber as shown in

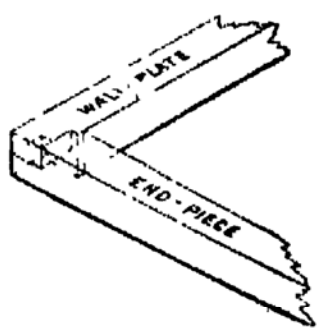


Fig. 51

Fig. 52.

fig. 51. A more complicated joint (fig. 52) is often preferred. The separate frames are kept apart by corner pieces (*studdles*, Cornwall; *jours*, Flintshire), and loose ground is prevented from falling in by boards or poles outside the frames.

As shafts are frequently used for the several purposes of pumping, hoisting, and affording means of ingress and egress by ladders, it becomes necessary in such cases to divide them into compartments. Pieces of timber parallel to the end-pieces (*buntons* or *dividings*) are bxed across the shaft, and serve to stay the wall-plates and carry the guides as well as to support planks (*casing boards*) which are nailed to them so as to form a continuous partition or boarding. The magnificent timbering of some of the shafts on the Comstock lode is described by Mr James D. Hague as follows:[1]—

"The timbering consists of framed sets or cribs of square timber, placed horizontally, 4 feet apart, and separated by uprights or posts introduced between them. Cross timbers for the partitions between the compartments form a part of every set. The whole is covered

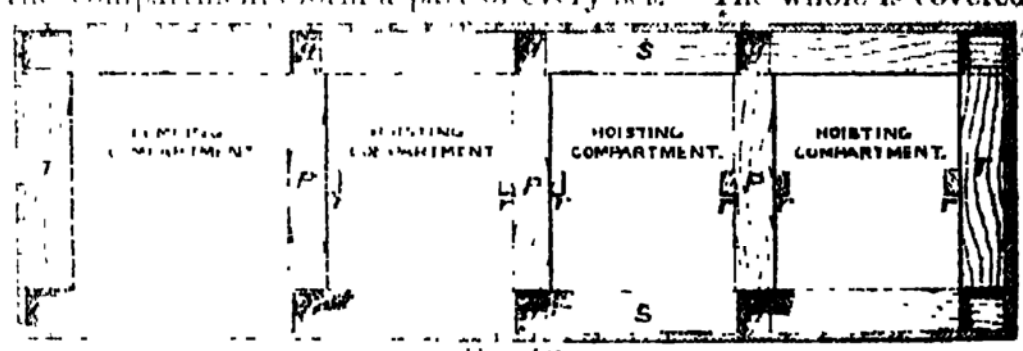


Fig. 53.

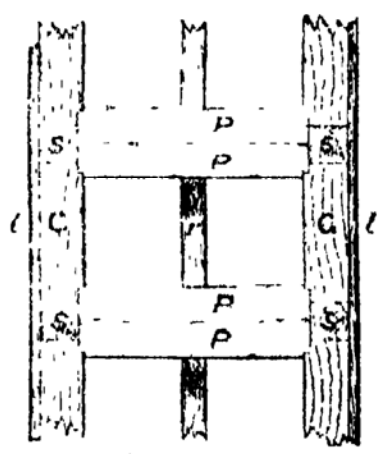


Fig. 54

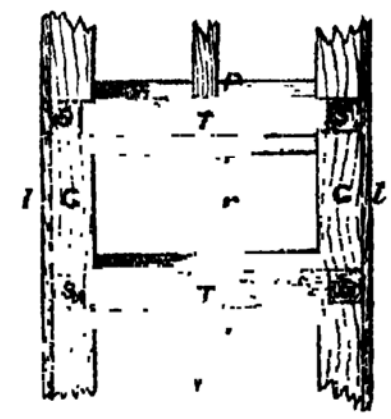


Fig. 55.

on the outside by a lagging of 3-inch plank placed vertically." Figs. 53, 54, and 55, copied from Mr Hague's plates, illustrate this method

[1] *United States Geological Exploration of the Fortieth Parallel*, vol. iii., "Mining Industry," p. 193.

of timbering. Fig. 53 is a plan of the shaft "S, S are the longitudinal or sill timbers, T, T the transverse end timbers, P partition-timbers, *r* guide rods between which the cage moves, *g* gains cut in the sill-timbers, to receive the ends of the posts. The sheathing or lagging is seen enclosing the whole frame." Fig. 54 is a transverse section through the partition P of fig. 53, "between the pumping compartment and the adjoining hoisting compartment, looking towards the latter. In this figure, G, G are the posts, S the sill-timbers, P the partition-timbers, the ends of which are framed with short tenons that are received in gains cut in the sill timbers and the ends of the posts; *r* guide-rod, *l* lagging or sheathing." Fig. 55 is an end view of the frame shown in fig. 53. "The single piece T forms the end, while the double pieces P forming the partitions are seen beyond." "The outer timbers of each set, that is, the two sides and ends of the main frame, are 11 inches square; the posts, ten in number, four at the corners and two at each end of the three partitions, are of the same size. The dividing timbers, forming the partitions, are 12 inches square."

When ground is loose or running, recourse must be had to a *spilling* process like that described for levels. Strong balks of timber are fixed at the surface or in solid ground, and then the first frame is hung from these *bearers*, and each successive frame from the one above it. Iron bars with cotters may be used for suspending the sets; but on the Comstock lode each bolt is made in two parts with a tightening screw in the middle, and the frames can thus be kept very firmly together. The laths are driven in advance, in the manner explained in the case of levels, and a new frame is put in as soon as the excavation has been sufficiently deepened within the protecting sheath of boards. In very unstable ground it may be necessary to put in the frames touching each other, so that the shaft becomes encased in a solid box of timber occasionally 14 inches thick.

Like levels, shafts may be lined with masonry or brickwork, and these have the advantage of being far more permanent than timber, and of requiring fewer repairs. This kind of shaft lining is especially desirable in the loose ground near the surface, because, if the working is discontinued temporarily, the shaft still remains secure and available for use at any future time; whereas if timber is put in it often decays, the top of the shaft collapses, and much expense is incurred in the process of reopening it. The section of the shafts that are walled is generally circular as affording the best resistance to pressure, but elliptical walling is also met with. Another shape is like a rectangle, save that the sides instead of being straight, form curves of large radius. The walling may be dry or with mortar, according to circumstances.

The masonry is put in either in one length or in successive portions in descending order, and this is the usual plan. The shaft is sunk a certain depth, with temporary timbering if necessary, and when firm ground has been reached a bed is cut out round the shaft, and on this is placed a curb or crib AB fig. 56[1] consisting of segments of timber which form a ring. This serves for a foundation for the brickwork, which is built up to the surface; the temporary timbering is removed, and the space filled up with earth or concrete. Sinking is then resumed below the curb, and for a certain distance of a smaller diameter, so as to leave a bracket, or ledge, to support the first curb. On arriving, after a certain depth of sinking, at another firm bed, a second curb CD is put in and a portion of brickwork built up. When the ledge of rock is reached, it is carefully removed in small sections and the brickwork brought up to the first curb. This process is repeated till the shaft is completed, or reaches rock in which no masonry is required. If, owing to the nature of the ground, it is impossible at first to find a firm seat for the curbs, it becomes necessary to hang them by iron bolts from a strong bearing frame at the surface.

Fig. 56.

When shafts pass through very watery strata, it is most desirable to stop all influx into the mine for the purpose of saving the heavy expense of pumping. The manner in which this is effected by a watertight lining, known as tubbing, is described in the article COAL, vol. vi. p. 62, where will also be found an account of Triger's plan of sinking shafts with compressed air, and the very successful method of boring shafts through water bearing ground invented by Messrs Kind & Chaudron.

7. Exploitation, or Working Away of Veins, Beds, and Masses.—We have described how shafts are sunk and levels driven, and we now come to the processes employed in removing the mineral.

[1] J. Callon, *Lectures on Mining*, vol. i., Atlas, plate xxvii.

The deposit must first of all be reached by a shaft where the contour of the country permits it, by a level. In the case of a vein an exploratory shaft is often sunk on the course of the lode for 20 or 30 fathoms, and if indications found in a level driven out from the shaft warrant further prosecution of the mine, a first main shaft is sunk to intersect the lode at a depth of 60 fathoms or more from the surface. Crosscuts are then driven out at intervals of 10, 15, or 20 fathoms to reach the lode, as shown in fig. 57, which represents a section at right angles to the line of strike. Sometimes the main shafts are carried down all the way along the dip of the deposit, though perpendicular shafts have the advantages of quicker and cheaper winding and cheaper pumping, to say nothing of the possibility of utilizing the cage for the descent and ascent of the miners. If an inclined shaft appears to be advisable, great care should be taken to sink it in a straight line. In either case levels are driven along the strike of the lode as shown in the longitudinal section fig. 58, in the hopes of meeting with valuable

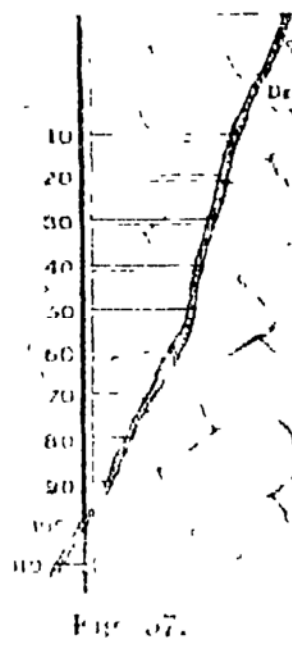
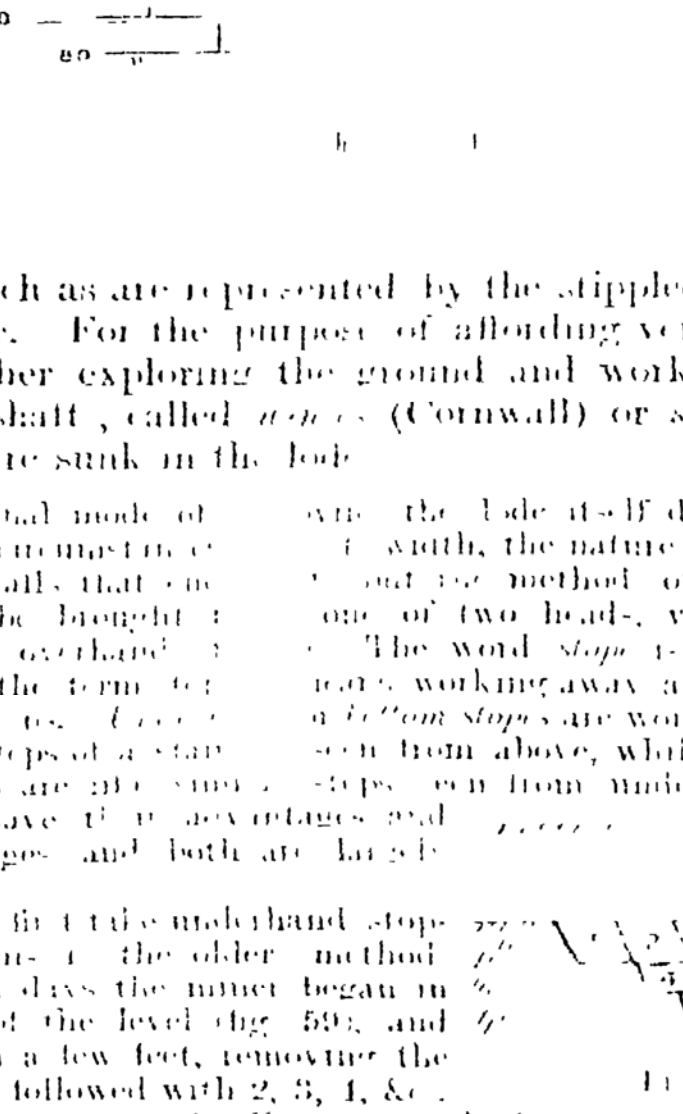


Fig. 57.



bodies such as are represented by the stippled portion of the figure. For the purpose of affording ventilation and still further exploring the ground and working it, intermediate shafts, called *winzes* (Cornwall) or *sumps* (South Wales), are sunk in the lode.

The actual mode of working the lode itself depends a good deal upon circumstances, such as the nature of the ore and the walls that can generally be brought under one of two heads, viz., the stoping or overhand system and the underhand system. The word *stope* is equivalent to working away any deposit, and *overhand stopes* are working from below, while *underhand stopes* are worked from above, whilst *back stopes* are also sometimes spoken of. Both methods have their advantages and disadvantages, and both are largely

We will first take the underhand stoping, as this is the older method. In the old days the miner began at the floor of the level (fig. 59), and sank down a few feet, removing the whole of the lode as he went. He would then proceed with 2, 3, 4, &c., until the excavation finally presented the appearance of fig. 60. Any valueless rock or mineral was deposited upon forms of timber (*stulls*), and the ore was drawn up into

mollass. One great disadvantage of the method is that the
l water have to be drawn up some distance by hand labour:
timber required
e stull of the
arge quantity of
les left in the
or it the ore are
The excavated
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l is used, and,
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ore picked after it is broken, with little loss of any valuable

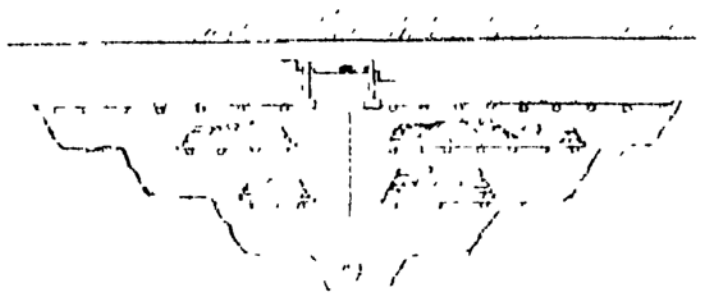


Fig. 60.

one common method of working by underhand stopes, and
nerally employed in Cornwall at the present day, consists in
ng an
ground and a lower
e been driven. An
e the two levels is
ade either to take
e upper level or to
e lower one. The
ed by means of com-
n at the two upper
the winze and the
removed as a
of rope, the working
The stopes are usually made long so that the ore may
roll into the winze and so that the rock-holes may do better
ion; but the long stopes are very apt to cause trouble
d fall. The large open chambers left by the removal of large
the workings are a source of danger, for there is always a risk
of rock and from places which cannot readily be examined
e; and as, kindly supplied to Captain Josiah Thomas,
the general arrangement of the working of the largest
ne in Cornwall. The lode after producing copper ores to
desirable depth changed its character and became tin-bearing
orking, for tin ores are mined almost entirely to the

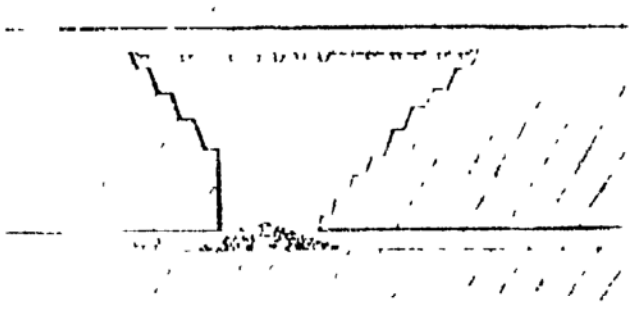


Fig. 61.

granite. The section fig. 62 shows that the main shaft of th
is at first vertical and then carried down on the dip of the l

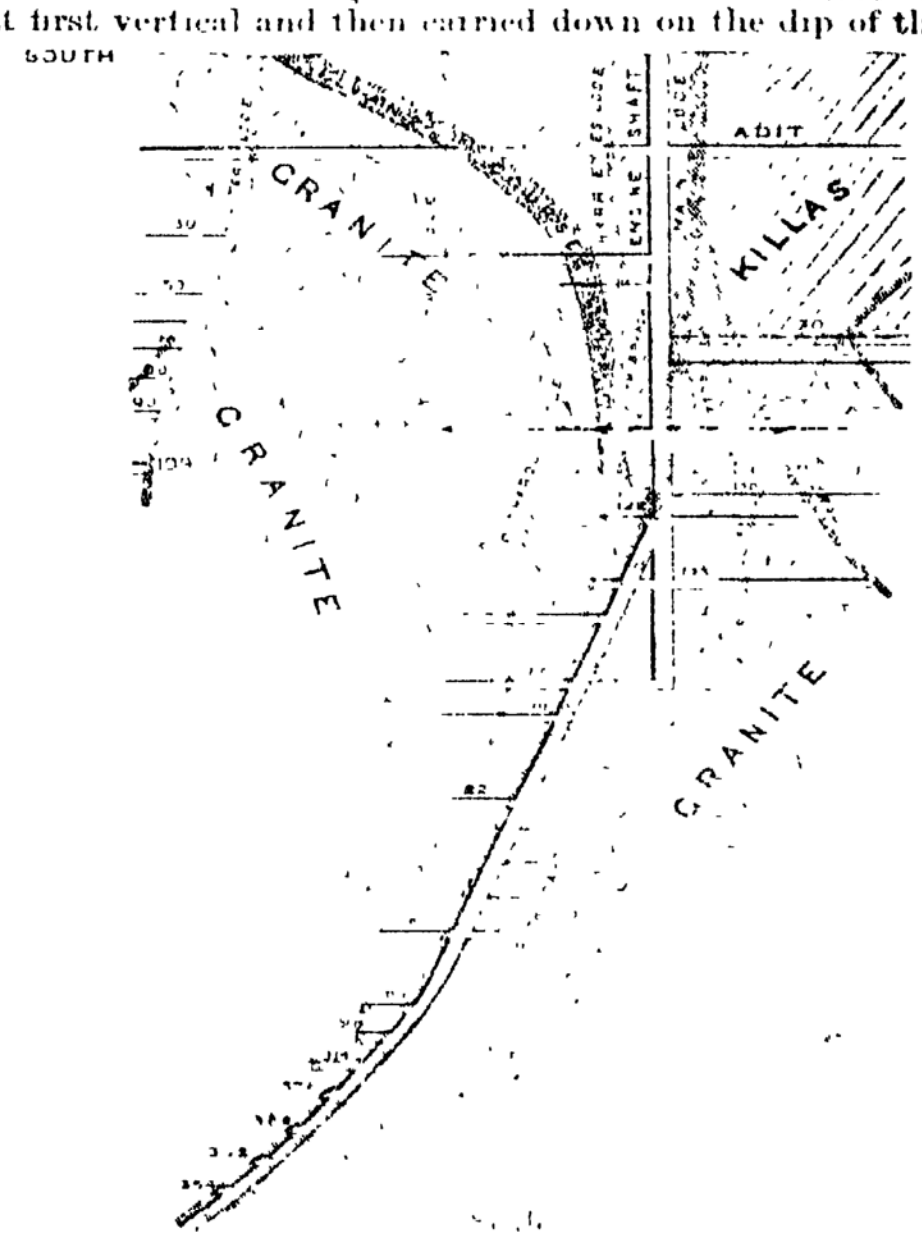


Fig. 62. Transverse Section, Dolcoath Mine, Cornwall.

The process of overhand stoping is precisely the reverse

Fig. 63. Longitudinal Section, Main Lode, Dolcoath Mine, Cornwall.

has been just described; the work is commenced from a rise
Report of Miners' Association of Cornwall for 1887, and R. J.
ville, Trans. Roy. Geol. Soc. Cornwall, vol. x. part v.

(fig. 64 A), or better from the two bottom ends of a winze (fig
As soon as the men have excavated a sufficient height of th
the level, they put in strong pieces of timber from wall to w

ese cross pieces (*stempels, stull-pieces*) with boards or poles, ow down the rubbish upon the platform (*stull, bunning*) med. In the midst of the rubbish chimney-like openings *asses*) are reserved, lined with boards or dry-walling, and

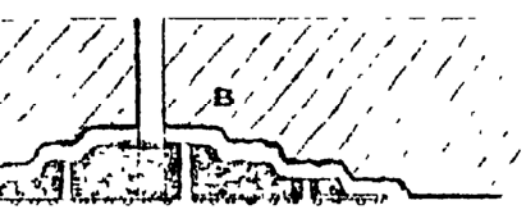


Fig. 64.

Fig. 65

t the bottom with shoots provided with doors. The ore n into these passes, which are tapped when necessary, the into the tram-waggon placed ready to receive it. 5 gives a transverse section showing the rubbish resting on l. This is what may be called the typical method of top n the lode affords rubbish enough for the men to stand on eep them close to the rock they are attacking. Very often ot the case, and the whole of the lode has to be won to the or treatment. If the walls are firm the lode sometimes way, a stull put in, and sufficient heap of broken ore is the stull to give the miner good standing-ground. The excess n over the ends of the stull, or the great heaps tipped by a hole in the ering and al- a quantity to n into the level. er method con- putting in y stages upon e men stand to r work, whilst vation is left as space (fig. 66).

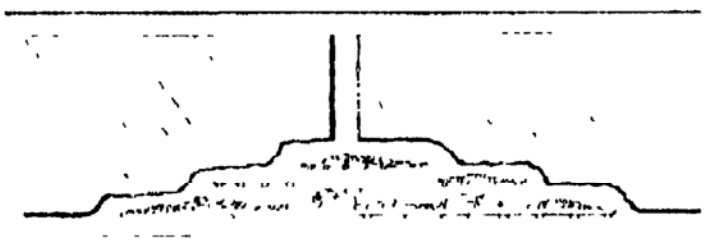


Fig. 66

ode of working is incompatible with weak ... It afford rubbish enough for ... up the ace, or if it is too narrow to do their work comfortably. e of the walls may be cut l blasted down (fig. 67), so men always stand upon a of rubbish while at work, re is no fear of a collapse mine. In certain special bbish is sent down from the o fill up the excavations. advantages of overhand are—that the miner is by gravity in his work. ore or rock has to be drawn and labour, and that less s required. On the other e miner is always menaced , but as he is close by he stantly test the solidity of the roof and side by sounding th his sledge; there is the further disadvantage that particles ay be lost in the but this loss is evented by laying oards or sheets of le the lode is being lown.

Fig. 67.

very wide lodes be worked, recourse had to special s. The great lode mous Van mine, in nerysh ire, is some- 0 feet in width, and ging wall is weak. e is stoped away t, and the cavities with rubbish, part h is derived from itself, whilst the portion is supplied from a special quarry at the surface explains the details of the case. A is the original cross-

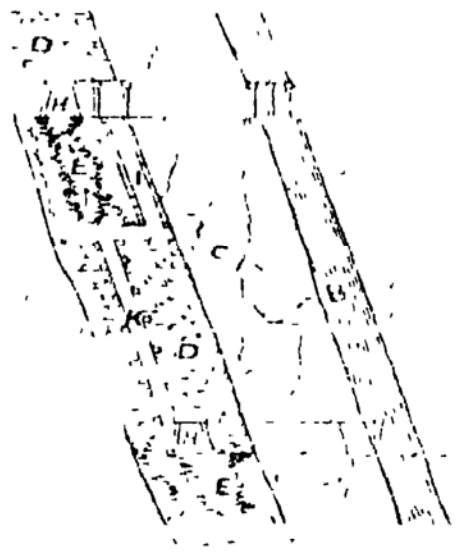


Fig. 68.

Neve Foster, "Notes on the Van Mine," *Trans. Roy. Geol. Soc. Cornx.* p. 41.

cut (not in the line of section) by which the lode was B is the *fluccan*, C the bastard lode, generally worthless, E lode, H permanent levels, and K *ore-passes* reserved amidst the (*deads*) D, I *passes* down which rubbish is shot, N crosscut ing the level H with P the permanent level in the *country*.

If the lode is not firm enough to allow of the stopes being for its full width, the crosscut method is adopted; the w in this case, instead of proceeding along the strike, are carrie the deposit from one wall to another.

The lode is removed in successive horizontal slices A, B, and for each slice a level L, fig. 69) is driven, either in th

Fig. 70

partly or entirely in the country from the level cros put out 6 or 8 feet wide, shown in the plan, fig. 70). F regularly timbered according to the nature of the ro when No. 1 is completed No. 2 is begun and the rubbi No. 2 thrown into the empty space of No. 1 to save quantity of insufficient deads are brought in from the ca from exploratory workings, worthless rock in the neighbo Sometimes the cross-cuts are not driven side by side but would be driven first, leaving 2, 3, and 4 as a solid pillar would be worked away, and finally 2 and 4 between the ro rubbish on each side. The greater part of the timber is covered when the next stope above is taken off, the prop m with the small end downwards, and can be driven levers. Mining 69) is carried in the dead ground for ventilation. The method of working is applicable not lode, but also to irregular masses.

In working away the different horizons of ore in lode of t Comstock lode, which are from 15 to 30 or even 40 or 50 f and which are enclosed in very un-

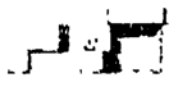


Fig. 71.

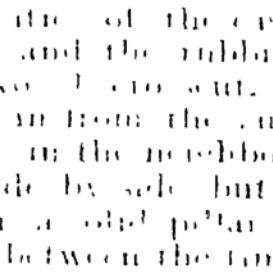


Fig. 72

timbering is composed of sets and 7). It consists of nine timbers together in certain definite sets, each of being composed of a square base placed horizontally, formed of four timbers, sills, and cross-pieces 4 to 6 feet long, framed together and mounted by four posts 6 to 8 feet high, at each corner and capped by a frame work, similar to that of the base. These cap-pieces, forming the top of any set, are at the same time the sill or base of the next set above; the posts in the one set are one above the other in the shaft, being generally placed in position directly over those below. The timbers are usually of 12 inch stuff, quite square, hewn or sawn. Each post has a tenon 9 inches long at the upper end and a tenon of 2 inches at the lower end, which latter is to mortises in the cap and sill respectively, a sill and cap have horn-tenons on each end and boulde receive the ends of the posts and the horizontal cross-pieces wall of the excavation, the latter is framed by a lagging of split or sawn planks. The whole width of the ore-body is stoped away at once, and its place supplied by waste rock, and finally the vacant space filled with waste rock derived from dead work in the mine or from special excavations under ground quarried on set purpose. In barren ground the stopes are overhand, starting from an intermediate drift or winze 7) will explain how the different frames are built up one a other.

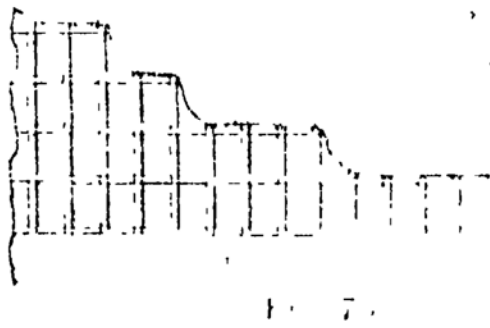


Fig. 73.

Another method of working a wide lode is to attack it

James D. Hague, *United States Geological Survey*, 1st ... the *Pacific*, vol. iii. "Mining Industry," p. 112.

parallel to the dip, working away each slice separately as if it were a lode of ordinary dimensions and filling up with rubbish (fig. 74).

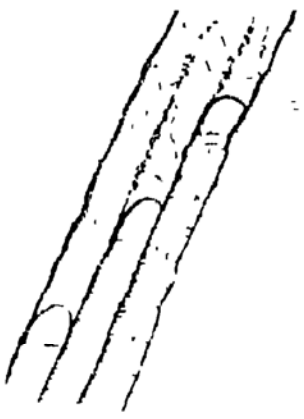


Fig. 74.

We now come to beds or seams. The mode of working the most important beds that occur in the earth's crust, viz., coal seams, has already been described in the article COAL (vol. vi. p. 61), and the details have therefore only to be given concerning the removal of the mineral by pillar working and long-wall working. Both these methods are applicable in the case of many other mineral beds. Such for instance are the beds of fireclay met by roadways which are wrought by both the methods just mentioned (see also in connexion with coal mining). Next in importance to coal in this section and a brief account of the workings in the Cleveland ore district will explain the manner in which more than one third of the iron ore raised in the British Isles is obtained by mining. It resembles the "board and pillar" system used for working coal in Durham.

The Cleveland ore occurs in the form of a bed from 6 to 16 feet thick in the Middle Lias, lying pretty level. A mainway (fig. 75) is driven about 12 feet wide for a considerable distance, and at right angles to it *boord* are driven 5 yards wide for a length of 30 yards and then at right angle a *stall* 7 or 8 feet wide and 20 yards long. By driving sets of this kind the bed is cut up into pillars or blocks 30 yards long by 20 yards wide. The pillars are subsequently removed in the following way. A *place*, or drift, 6 feet wide, is driven

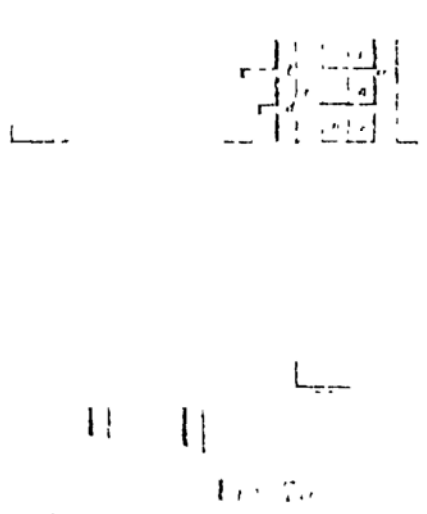


Fig. 75.

across the pillar 10 yards from the corner, and portions *slitts* about 5 yards wide are worked away in the order 1, 2, 3. After No. 1 slitt has been removed the timber put in to support the roof temporarily is withdrawn, and the roof is allowed to fall. No. 2 is then taken, and No. 3 in the same way. While these slitts are being taken out, another place *or* is being driven across the pillar 10 yards from the first, and the pillar removed entirely by a series of four slitts.

Fig. 76 represents in section and plan the chambers and pillars in the underground gypsum quarries which supply the well-known plaster of Paris to all the world.[1] The principal bed is from 50 to 60 feet in thickness; pillars are left 10 feet square at the base, and the *stalls* between them are 10 feet wide. The workings are slightly arched and are

Fig. 76.

carried up to the roof, for the purpose of better maintaining the security of the chambers, because heavy charges would have to be used if they "heaved in" and rent the entire strata. A small layer left for the floor prevents (see COAL, vol. vi. p. 64), and the underground roads to be kept in good repair.

Underground slate quarries afford examples of very various method of removing thick beds of mineral of comparatively little intrinsic value. At Angers in France, where the beds dip at a high angle, the underground workings are carried on like an open quarry

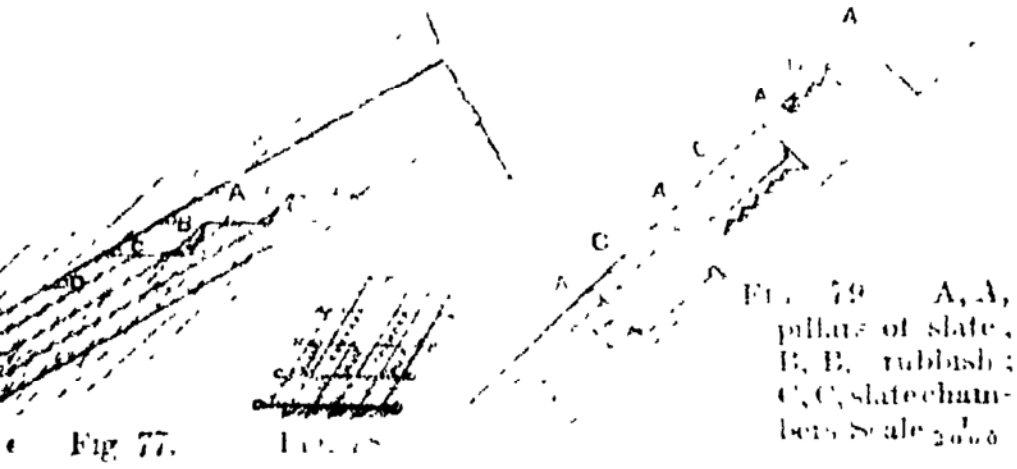


Fig. 77. Fig. 78. A, A, pillars of slate; B, B, rubbish; C, C, slate chambers. Scale 200 feet.

under a strong roof of slate, the floor is continually being worked away in steps, and an immense open chamber is left. In the Festiniog district in North Wales the principal bed, or *vein* as it is called, is more than 100 feet thick in places, and the method of working consists in making alternate pillars and chambers each 30 feet to 50 feet wide along the strike (cross-section and plan, figs. 77 and 78). The pillars follow lines of natural cross rending PP', which commonly make an angle of 25° to 35° with the direction of the dip. The excavations are arranged in regular lines, and form continuous chambers extending very often from the surface to the very lowest workings. A, B, C, D are the original working levels. The slate of the supporting pillars is entirely lost, as these cannot be removed with safety. This method of working requires a strong roof. In the Ardennes, on the contrary, the pillars are carried along indefinitely along the strike (fig. 79, cross-section). The slate in each longitudinal chamber is removed in slices parallel to the bedding, and the men stand upon the rubbish, which finally fills up the chambers completely.

Rock salt constitutes another important mineral which occurs in the form of stratified deposits. The principal source of the Cheshire salt is a bed 8 feet thick lying horizontally; but only the bottom part, 5 feet to 6 feet thick, is mined. Pillars 10 yards square are left prominent by about 25 yards apart, as shown in fig. 80, which represents part of Marston Hall rock salt mine.[2] The workings

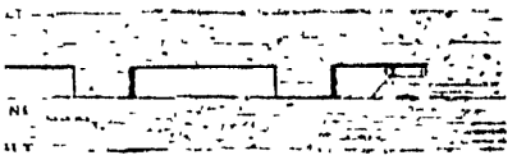


Fig. 81.

are advanced by making in the upper part an excavation 5 feet 9 inches high (called the *notong* or, fig. 81), and then the lower two-thirds of the part cut are removed by blasting slanting holes. Many of the old salt mines have collapsed from weakness of the roof or insufficiency of the pillars, and have become inundated; the brine is then extracted by pumping and evaporated for salt.

In some countries, especially when the beds of salt are impure or much mixed with clay or shale, the formation of brine is conducted regularly by making a network of drivages within a rectangular, elliptical, or circular area in thick beds of saliferous marl, and then introducing fresh water by pipes, so as to form underground ponds which gradually dissolve the roof and sides. The brine is drawn off and either pumped up or conveyed by adits to the surface.

A few words remain to be said about open workings. Some minerals are always obtained in this way; others are worked open before regular underground mining begins; and, thirdly, it often happens that underground and surface work are both carried on simultaneously on the same deposit. Among deposits worked open-cast are peat, numerous kinds of stone, iron ore, cupreous pyrites, lead ore, gold and tin-bearing alluvia, and diamantiferous rock.

Owing to its soft, spongy, and fibrous texture, and the fact of its often lying below the water level, peat has to be worked in a special manner. Trenches are dug about a foot deep with a sharp spade, and the sods cut out are of convenient size for drying and burning. When one layer has been removed in this way, another is taken off, and so on. If water is reached the working can still be pursued by using the long spade *cayond louchet*, France) with a handle of 16 or 20 feet. It cuts out a sod 3 or 4 feet long at each thrust.

When a deposit is more or less solid the workings are frequently arranged in steps, the height and breadth of each depending upon the firmness of the rock.

In many cases the first work consists in removing worthless rock at the surface (*découverte*), and where the underlying deposit is thick or very valuable it will pay to remove a very great thickness of overburden, on account of the advantages of working a deposit open. The chief advantages are entire removal of the deposit without loss in pillars, no expense for timbering or for packing with rubbish or for ventilating or lighting the workings, better ventilation, easier supervision, longer working hours, less danger.

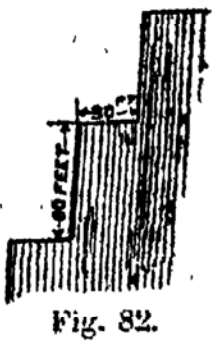


Fig. 82.

As an example of a large open working may be mentioned the great Penrhyn slate quarry near Bangor, employing about 3000 hands, and worked by a succession of terraces on an average 60 feet high by 30 feet wide (fig. 82). Reference has already been made to the thick lead-bearing sandstone of Mechernich, which is in part worked as an open quarry. Mokta-el-Hadid, near Bona in Algeria, and the Rio Tinto mines in Spain, afford instances of extensive combined open and underground workings for iron ore and cupriferous pyrites respectively.

Local laws regulating the size of the working areas, or claims,

[1] Callon, *Lectures on Mining*, vol. ii. plate xii.

[2] Joseph Dickinson, "Report on the Salt Districts," *Reports of the Inspectors of Mines for the year* 1881, p. 66.

owned by separate individuals or companies, considerably affect the methods of working. This is especially the case with the diamond deposits of South Africa. The diamantiferous rock at the celebrated Kimberley mine (formerly called Colesberg Kopje) occurs in the shape of an elliptical upright mass, the greatest length being about 330 yards and the greatest breadth about 200 yards. The superficial area is about 9 acres; the mass extends downwards within almost perpendicular walls of shale, and is worked in places to a depth of about 400 feet. The claims are only 31 feet square, and are more than four hundred in number, and these have in some instances been subdivided into portions as small as the sixteenth of a claim, but, as at the present time one company may own very many claims, the number of individual holdings is less numerous than formerly when the limit was two claims. The working is carried on vertically downwards, and, as the claims are not all worked at the same rate, those that progress most rapidly are surrounded by perpendicular walls of neighbouring claims. The shale, or *reef*, enclosing the deposit is constantly falling into the huge open pit, and has to be cut away to a slope, the expense of this work being borne by the claim holders generally by the mining board. The diamantiferous rock is extracted by numerous rails with rope traction.

We have already referred to the method of working gold-bearing alluvia by the hydraulic process, which has rendered notorious in the United States (GOLD, vol. x. p. 716). At the same time we must not be blind to the evils of this method of working, which at last necessitated legislative interference. Some idea of the extent of the mischievous results of hydraulic mining will be gathered from the statement that one working alone, the Gold Run Ditch and Mining Company, for the last eight years has been discharging 4000 to 5000 cubic yards of sand, gravel, and boulders daily, for a period of five months each year, into a tributary of the Sacramento. As a natural consequence deposits are formed lower down the river, obstructing the navigable channels, rendering overflows more frequent and destructive, and causing valuable land to be destroyed by deposits of sand. The superior court of Sacramento county, California, has recently decided that the hydraulic mining companies must build dams to impound the coarse and heavy debris, or take other efficacious means to prevent them being washed down the rivers.

8. *Carriage or Transport of Minerals along the Underground Roads.*—After the mineral has been broken down in a deposit it is necessary to pick out any barren rock and then convey to the surface all that is of value.

The simplest and oldest method of transport along underground roads is carriage on the back, and this method may still be seen at the present day even in countries where the art of mining is generally highly advanced. Thus, for instance, in the little slate mines near Cochem on the Moselle men and lads carry up all the blocks of slate upon their backs, walking upon steps cut in the rock; they come up with their hands upon the ground bent almost double under the weight of the block, which rests upon a thick pad. Again, the blocks of slate are still carried on the back from the actual working place to the nearest tram-road, in the slate mines of the Ardennes. In the Sicilian sulphur mines the same method is common, and it is found also in parts of Spain and China, where baskets are used, whilst bags are employed in Mexico and also in Japan. Even in England the system still survives in the Forest of Dean, where boys carry iron ore in wooden trays from the very irregular ore-producing cavities either to the surface or to the nearest shaft.

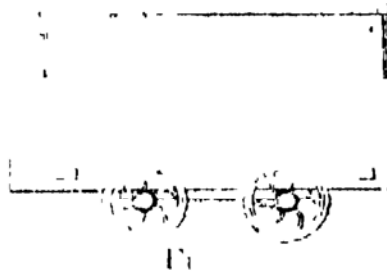
Sledges, or *sleds*, enable greater loads to be transported: but they are not available unless the conveyance is along roads sloping downwards. They have been largely employed in coal mines, and are still resorted to in some collieries for conveying the coal from the working place to the nearest tram-road.

We next come to wheeled carriages. The simplest is the wheelbarrow. The barrow used in Cornwall at the present day is not unlike that figured more than three centuries ago by Agricola. The navvy's barrow is more advantageous, but it requires a wider and higher level. The barrow runs upon the natural floor of the level, upon boards, or upon thin strips of iron. Carts drawn by horses may be used in large underground quarries. Excepting in special cases it is advisable to replace barrows by waggons running upon rails. The oldest form is the German *Hund*. It consists of a rectangular wooden body, with four wheels resting upon two boards as rails, and it is kept on the track by a pin which runs between the boards.

Cast-iron tram plates were introduced in the last century and were finally succeeded by iron rails, which are now in general use, though steel threatens to displace iron in this as in other departments of mining. Various forms of rail are employed. The simplest is a bar of iron set on its edge in transverse sleepers, or flat iron nailed to longitudinal sleepers. Small T-headed and bridge rails are not uncommon. In the Harz the rails sometimes lie on stone sleepers; a hole is bored in the stone, plugged with wood, and the rails nailed on. The gauge varies from 14 inches to 3 feet or more, 20 inches to 22 inches is a common gauge in metal mines. Arrangements of course have to be made for passing from one line to another by *points*, but the transference is frequently best effected by putting down flat plates of cast iron, upon the smooth surface of which the waggons can be handled with ease and turned in any direction, raised ledges guide the wheels into any particular track.

The form and size of the waggons running upon the rails necessarily vary according to the size of the underground roads and the manner in which the mineral is raised in the shaft. In some mines the practice exists of loading the mineral in the level into an iron bucket (*kibble*) standing upon a *trolley*, which is merely a small platform upon wheels. This trolley is pushed (*trammed*) to the shaft, the full kibble is hooked on to the winding rope and drawn up, whilst an empty kibble is placed upon the trolley and trammed back along the level, where it is again loaded from a shoot (*mill, pass*) or by the shovel. The usual plan, however, is to have a waggon, which is tipped on coming to an enlargement of the shaft (*plat, lodge*) where the level joins it. These waggons may be made of wood or sheet iron, and of late years sheet steel for the body and cast steel for the wheels have been coming into favour.

The most modern system in metal mines is to imitate collieries, and use waggons which are drawn up in cages. Fig. 83 represents the plain but strong waggon of the Vivian mines, consisting of a rectangular body of sheet iron resting on an oak frame, and provided with cast steel wheels. The wheels are loose upon the axles, which themselves run loose in the pedestals. The waggon is emptied by being run on to a "tippler," which enables it to be completely overturned with great ease. A common plan is to construct the waggon with a hinged door at one end, and the contents are discharged by opening the door and raising the bo



Fig

The motive power for tramming waggons along the levels in metal mines is generally supplied by men or boys, though, where large quantities have to be extracted, and where the roads are favourable recourse may be had to ponies and horses, and the various kinds of mechanical haulage described in COAL, vol. VI. p. 69.

Trains of cars are sometimes drawn along underground railways by locomotives; they have the great disadvantage of polluting the air with the products of combustion, and consequently they are not available unless the ventilation is very good. A small locomotive of 2 horse-power nominal is used on an 18½ inch track in the adit level of the Great Laxey Mine, Isle of Man, now approaching a mile in length, and full-sized locomotives ply along the adit of the Rio Tinto mines. Locomotives worked by compressed air improve the ventilation instead of vitiating it, and are not a source of danger in cases where fire-damp may be present; but, except in special cases, they cannot be worked so cheaply as engines fired with coal. Conveyance by electric railroads underground has hardly gone beyond the experimental stage, but the results obtained at the Zauke colliery in Saxony[1] show that electricity can be applied with profit in this department of mining.

A few instances of transport by boats may still be met with. The boats used in the underground canal at Klau-thal are 31

[1] *Jahrbuch für das Berg- und Hüttenwesen im Königreiche Sachsen auf das Jahr* 1883, p. 50.

long by 4 feet 6 inches wide, and 2 feet 11 inches deep. Each boat carries 5 or 6 tons.

Where roads have a strong gradient inclined planes are employed, either self-acting if the mineral has to be lowered, or worked by stationary engines if the mineral has to be raised (see COAL, vol. vi. p. 60).

9. *Winding, or Raising in the Shafts, with the Machinery and Apparatus required.* In speaking of the transport by underground roads we mentioned that the mineral is occasionally brought to the surface on the backs of men or boys. In other cases daylight is reached by adit levels provided with railroads; but in by far the greater number of mines it is necessary to hoist the mineral, and often much rubbish, up vertical or inclined pits generally known as shafts.

In beginning to sink a shaft from the surface, or in sinking a winze, hand power applied by a windlass is sufficient. The broken rock at the bottom of the shaft is shovelled into a wooden or iron bucket (*kibble*), which is drawn up by a rope passing round the barrel of the windlass. When a depth of 20 or 30 yards has been reached it is more advantageous to introduce horse power, and the usual machine by which this power is applied, called a *gin* or *horse whim*, is a common sight in many metalliferous districts. It consists of a vertical axis carrying a barrel or drum 8 to 12 feet in diameter, round which is coiled the rope, which after passing over a pulley hangs down the shaft. The axis carries an iron pin at each end, the lower one working in a stone and the upper one in a socket in the cross-beam or cross-bar of the supporting frame. Under the barrel is a long driving beam to which a horse is harnessed and as will be readily understood, the kibble is drawn up or lowered down as the horse walks round. It is most economical to have two kibbles, for then they balance each other.

Where steam and water power are not available, a large number of horses or mules are sometimes harnessed to whims and ore raised from depths of 900 fathoms. These, however, are exceptional cases; and, generally since the introduction of portable engines, the use of steam power even for comparatively small depths such as 100 yards, is daily increasing. In hilly districts water power is generally at hand, and huge reservoirs are frequently constructed for storing the rainfall and so affording an adequate and constant supply. It may be utilized by water wheels, turbines, and water pressure engines.

There are three systems of winding by steam or water power which are in regular use: (1) by buckets (*kibbles*), bucket, or bag-swinging boxes in the shaft; (2) by boxes working between guides (*skips*, Cornwall); (3) by cages carrying one or more waggons.

buckets are made of wood, sheet iron, or [illegible]. They [illegible] vary, or may be round or elliptical, [illegible] in the cycle [illegible] ton in the middle. [illegible] rope or [illegible] a [illegible] of cast iron. When the shaft [illegible] upon which the kibble slides [illegible] lined with wood, or strengthened [illegible] vertical iron bars. Plank of hard wood like [illegible] and separate layers that [illegible] to the kibble, poles [illegible] otherwise [illegible] the [illegible] of bearers which are sometimes [illegible] Great Britain. Even where [illegible] the permanent [illegible] nature of [illegible] be wanting [illegible] most suitable, [illegible] monthly [illegible] more modern [illegible] for the kibble, which [illegible] about. Another [illegible] the kibble and used for the [illegible] ascent and descent of the men. Mr Galloway has patented a method of sinking shafts with two kibbles, the upper ends of which are coiled upon drums in the same way. By adopting this expedient the guides can be left attached to the shaft as long as required.

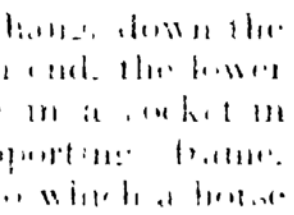


Fig. 84.

A word must be said about the actual hoisting and emptying of the kibble. Sometimes, as already mentioned, the kibble is filled at the working place or from a shoot (*pass*, Cornwall), carried down into the level, and then conveyed on a trolley to the shaft, where it is hooked on to the rope and drawn up. More frequently the filler standing in the *plat* load the kibble with a shovel; and in order to save time two kibbles are often provided, one being filled while the other is making the journey to and from the surface. In this case it is necessary to have some kind of *elevis*, which will enable the kibble to be readily detached from the winding rope, and quickly and securely fastened on again. On its arriving at the surface the *land keeper* attaches an eye or ring at the bottom of the kibble to a pair of tongs suspended by a chain, and the rope is now lowered. The kibble is then turned over and the contents fall into a tram-waggon.

The inconveniences of this method of winding are considerable, especially in inclined shafts, where the direction and amount of the inclination are not constant. There is great wear and tear on the bed plates and curving boards; and, unless constant attention is paid to repairs, places are worn out where the kibble catches, causing the rope to break. The fall of a kibble and its contents not only does much damage to the shaft, but also is a source of danger to the men. The introduction of boxes (*skips*) working between guides or conductors was therefore a decided step in advance, for these allow the winding to be carried on with less obstruction and with greater rapidity and safety. The guides are often made of pieces of timber (like *z*, fig. 53) bolted to the side pieces and dividers. They can only be employed in perpendicular shafts that are lined; made of wire rope or iron rods can be applied. The skip is a box of rectangular section, made of sheet iron or sheet-steel, with a sloping bottom and provided with a hinged door closed by a bolt or hasp on discharging its contents. Fig. 85[1] shows how the skip runs up

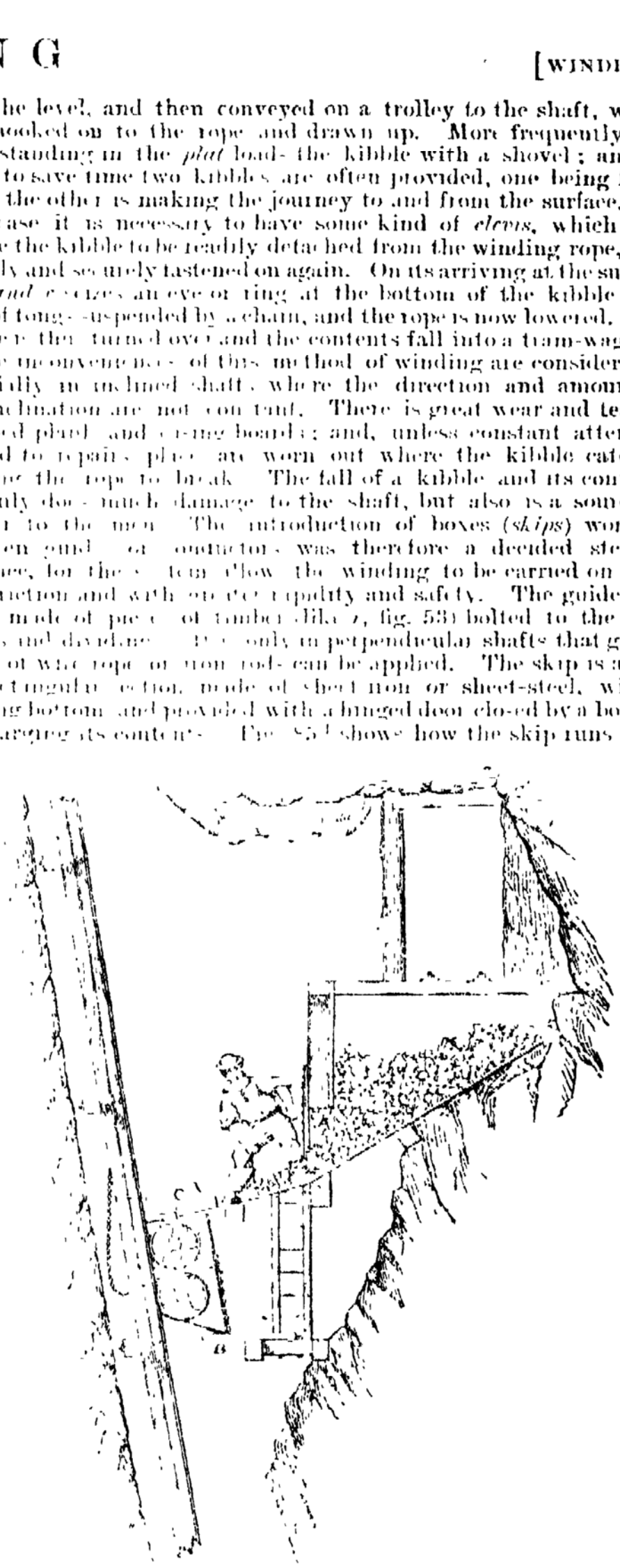


Fig. 85.

[illegible] guides [illegible] of cast iron or chetter) cast-steel wh[illegible] [illegible] the guides sometimes have iron rails lai[illegible] [illegible] with the wear. Some of the skips in Corn[illegible] [illegible] much as a ton and a half of tin-bearing [illegible] [illegible] filled by a hovel by a man standing in the plat[illegible] [illegible] arranged shoots leading from large hopper[illegible] [illegible] are made to run in without any shovelling. [illegible] time, tilted completely over instead of being emp[illegible] [illegible] door; this arrangement is in use in some of the Ge[illegible] [illegible] the skip is made of wood, and is guided on each [illegible] [illegible] of rollers running between two conductors. W[illegible] [illegible] up has reached the surface two catches are made to sup[illegible] [illegible] rollers, while the upper ones pass through opening[illegible] [illegible] guides, and the skip, turning upon the lower one[illegible] tipp[illegible] and so emptied.

The most satisfactory system of winding is by cages; the [illegible] handling of the mineral, and the hoisting proceeds at far gr[illegible] speed. This system, which is almost universal in collieries, [illegible] employed also for working deposits of other minerals, and, the[illegible]

[1] Monniot, *Annales des Mines*, ser. 6, vol. ii., 1862, plate v

n vein-mining the skip and kibble still prevail in England, the managers are beginning to recognize the advantages of the cage and quip their mines with more modern appliances than have hitherto been customary. The cages used in the mines on the Comstock ode are very light and simple in construction, as will be seen from ig. 86. The cage in fact is a mere timber platform, 5 feet by 4,

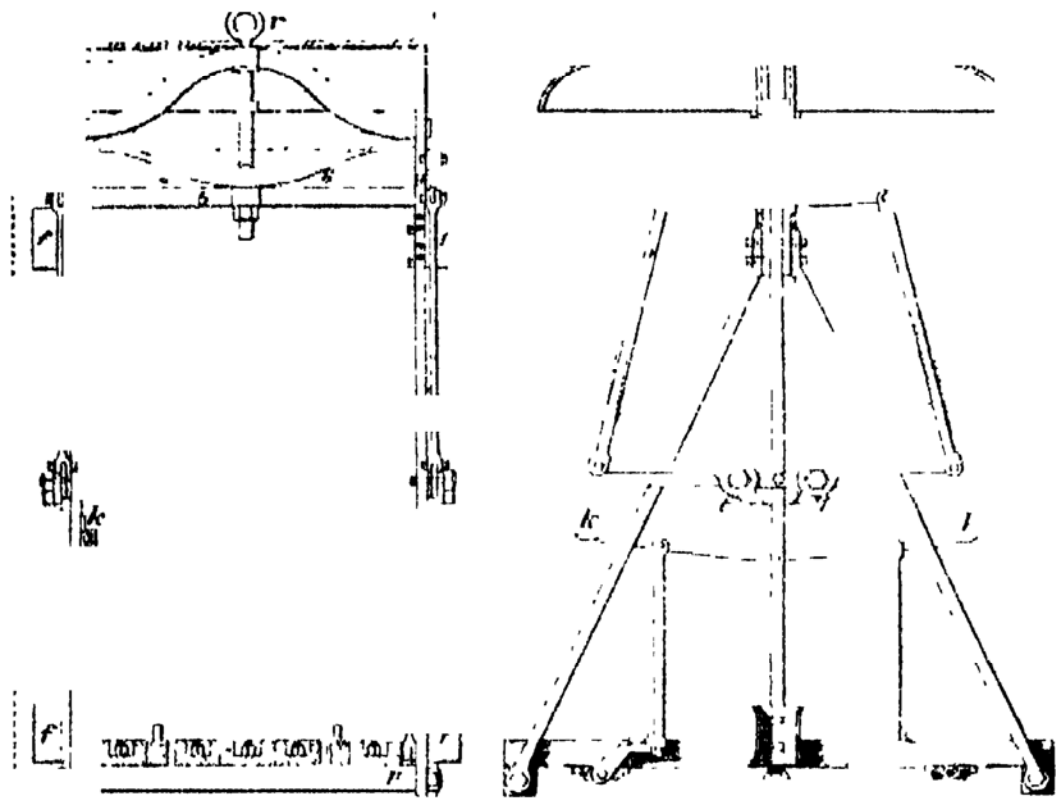


Fig. 86.—Cage used in Comstock Lode.

esting on iron bars *p*, and supported by iron rods on each side it is provided with a sheet iron hood to protect the men if they are nside, and also with safety catches *k*, *l*, which come into play if the ope breaks. The hand levers *k*, *k* at the ends of the cage raise up blocks which keep the car in its place during the ascent or descent *g*, *g* are guides for the end of the cross-bar *b*; *c*, bar working teeth *t*, *t* by levers; *f* "ear" or "shoe" embracing the guide-rod in haft; *r*, lifting bar; *s*, strong spring.

The most important details concerning the use of cages, ropes and other hoisting appliances, such as pulleys, pulley frames detaching hooks, and winding engines, have already been set forth n the article COAL, vol. vi. p. 74; and it is therefore needless o repeat these particulars, especially as the art of winding minera heaply, speedily, and safely has been carried to a far greater pitch of perfection in collieries than in the majority of metal mines. It s often convenient to fix winding engines underground for the purpose of sinking shafts and winzes, and drive them by com pressed air brought down in pipes from the surface.

The Koepe system of winding, which appears to be viewed with favour on the Continent, consists in having what is practically an endless rope with one large sheave over the shaft in the place of the two drums. There are two cages, and the rope below them acts as a counterbalance, so that the load is uniform throughout. The most novel hoisting apparatus is that of M. Blanchet (COAL, vol. vi. p. 76), which has now been regularly at work in the Hot tinguer shaft at Épinac in France for the last six years. M. Blanchet's method consists in fixing, in the shaft a large pipe in which is arranged a piston; from this is suspended a cage carrying waggons. By exhausting the air above the piston the load is gradually forced up by the atmospheric pressure below it. The Hottinguer shaft is 660 yards deep, and the pipe is 6 feet 5 inches in diameter, made up of a succession of cylinders of sheet iron about $\frac{1}{16}$ inch thick and 4 feet 4 inches high, joined by flanges and bolts. The 485 rings composing the long pipe weigh altogether 418 statute tons. The cage has nine decks, and arrangements are made for unloading three at a time; each waggon holds half a ton, so that the total useful load is 4½ tons. The speed of hoisting is 20 feet per second. If two hoisting pipes are connected the dead weights may be made to balance each other, and the power required is simply that which is necessary to overcome the weight of the useful load. All the men prefer the pneumatic hoist to the ordinary cage for descending and ascending the mine, and are regularly lowered and raised by it. The advantages claimed by M. Blanchet for this system are—(1) the possibility of hoisting from depths at which rope-winding would no longer be practicable; (2) getting rid of the costly ropes and dangers connected with rope winding; (3) better utilization of the engine power; (4) improvement of the ventilation and diminution of the amount of fire damp.

10. *Drainage.*—The mineral having been raised to the surface, the task of the miner might appear to be at an end; but this is not the case, for it is further necessary that he should keep his mine free from water and fresh air. These two indispensable operations of draining and ventilating frequently require special appliances which add considerably to the general cost of mining.

In all cases where it is possible, endeavours should be made to keep the water out of a mine, so as to save the expense of pumping it; and the method of putting in watertight lining (*tubbing*) in a shaft has been already described (COAL, vol. vi. p. 62). When large streams of water happen to be intersected by underground workings, and threaten to overpower the available pumping machinery, or when it is advisable to save the expense of draining abandoned workings, the entry of this water into the mine may often be prevented by stoppings called *dams* constructed of timber or brickwork.

In spite of all precautions, the miner generally has to contend with water which percolates into the workings. Four methods of getting rid of the water are available, viz., adits, siphons, winding machinery, and pumps.

An adit, day level, or sough is a nearly horizontal tunnel with one end opening at the surface, allowing the water to drain away naturally. In hilly countries mines are often worked entirely by adits, and even when a mine is deepened below the drainage level the utility of the adit is not thereby destroyed. It lessens the quantity of water which tends to percolate into the lower workings; it lessens the depth to which the water has to be pumped; and, by furnishing a certain amount of fall, it enables water to be applied as power. On account of these important advantages some very long and costly adits have been driven for the purpose of aiding the miners in certain metalliferous districts.

Thus in the Harz the Ernest Auguste adit ("Ernest August Stollen") has been driven a distance of nearly 6½ miles into the hills of that district. The total length of the adit, including the branches, is no less than 14 miles. It intersects many of the lodes at a depth of upwards of 600 yards from the surface. The total cost of the adit is estimated at £250,000.

Another long adit is the celebrated "Rothschönberger Stollen," which unwaters some of the most important mines at Freiberg in Saxony. The length of the main or trunk adit is more than 5½ miles, the gradient of the greater part of it being only 1 in 1000 yards. The branches of this adit among the mines are more than 16 miles in length, so that the total length of the main adit with its branches amounts to nearly 22 miles. Many of the mines are drained naturally to a depth of 200 to 300 yards. The cost of the main tunnel was £350,344, or nearly £4 per yard, but this included the cost of several shafts, heavy expenses due to pumping from these shafts, the walling of the adit for much of its length, and all connected with it. The length of time occupied in driving this adit was thirty-three years. The Kaiser Josef II. Erbstollen in Hungary is another remarkable mining tunnel which was commenced in 1782 and completed in 1878 at a total cost of £200,000 sterling. It is 10½ miles in length, extending from the valley of the river Gran to the town of Schemnitz, where it intersects the lodes at depths varying from 300 to 600 yards vertically to the elevation of the surface.

In Cornwall the Great County adit was driven for the purpose of relieving the Gwennap mine of their waters, and it was pushed nearly to Redruth. The only danger from the great work undertaken in connection by the men that if communication in the mine did not, and, that is the case, the drivages amounted to more than 50 miles, the water from the most distant mine does not rise more than about 6 inches before reaching the adit. The average depth is only 20 fathoms from the surface. In fact the great adit, the construction of great utility when the Gwennap district was in full work, is comparatively useless, drawing the lodes themselves at one mine and receiving the waters of a certain number from other mines to be conveyed to the great Scheuren, Poldice, Killivallan, and Tuscan adits, which have not been mentioned. Bigsweir Level in Northumberland is another adit which has been driven a distance of about 4½ miles, and it will have to be extended about 3 miles further before reaching Allenheads. Its depth from the surface at the place will be about 100 yards.

The main part of the Hallvan tunnel in Dumfriesshire is 2 miles 1256 yards in length, and the branch driven out to Rhodes mine intersected the vein at a distance of 809 yards, making a total of about 3½ miles. The greatest depth from the surface is 230 yards and the average depth in Hallvan Mountain about

5 yards. The length and depth of this adit are not remarkable; it the great quantity of water discharged at a point of considerable terest and importance. It is estimated that the adit now or 66,000 tons of water in twenty-our hours. The outflow is purely natural, but no mines re pumping we It is now easy to understand that he Rhos-mor though provided with powerful pumping achinery, to cope with the power encountered In the Comstock adit of which is the great Comstock lode 1,200 feet. The total cost of the tunnel, ing nine years, is estimated to have been The quantity of water running out daily in 1879 was 2 tons, at a temperature of 12 Fahr. at the mouth of the The water must otherwise have been pumped to the surface at a cost estimated at $3000 a day. The obstacles to ress were very great not only was the heat extreme, but water-ground was encountered which stopped the strongest timber. Thanks, however, to the untiring energy of Mr Adolph utro the difficulties were at last once fully overcome, and this great work will long remain a monument to his foresight, skill, nd great pertinacity.

The Atlantic Pacific tunnel, which was commenced in 1880, will ross the heart of the Rocky Mountains under Gray's Peak, olorado. It is being driven from both sides of the watershed, and ill have a total length of 6 miles from end to end.

Siphons have been used for unwatering workings in pecial cases, but of course they will not act unless the arrier over which the water is raised is very decidedly less han 33 feet.

When workings cannot be drained by tunnels or siphons it necessary to raise the water mechanically either to he surface or at all events to an adit through which it an flow away naturally. If the amount of water is not so considerable, it is often convenient to use the winding machinery and draw up the water in special buckets (*water ords*) or tanks. The bucket may be tilted over on reaching the surface, or it may be emptied by a valve at the ottom. This means of raising water is often adopted while sinking shafts, when it may be desirable to wait till he whole or a portion of the shaft is completed before utting in the final pumping machinery.

The varieties of pumps used in mines are numerous. In mall sinkings hand pumps, either direct acting or rotary, may be applied, steam jet pumps on the principle of the Giffard injectors are also used, and pulsometers, though equiring a large expenditure of steam, have the advantages f being quickly fixed, of occupying little space, and of orking with sandy or muddy water. They are capable, herefore, of rendering great service in special cases. When we come to the definitive machinery erected in arge mines of considerable depth, we find that the pre ailing types of pumps are few. They may be classified as follows: (A) lifting and force pumps worked by rods in the shaft actuated by wind, water, or steam power; (B) orce pumps at the bottom of the shaft worked by steam, ompressed air, or hydraulic pressure.

A. In connection with the first method we have to consider the motive power, the rods, and the actual pumps themselves.

Windmills have the great advantage, which is often fatal, that the power is not constant. By erecting an auxiliary steam-engine which can be set to work if wind fails, this evil is overcome, and at the Moor mine, Scilly, a windmill pumps its water from a depth of 32 fathoms at the rate of upwards of 90 gallons per minute. As the mine is breezy, there is wind enough to work the mill about half the time.

Water power was for long the principal agent employed in draining mines, and is still of the greatest utility in many districts. Reservoirs have been constructed to collect and store the rainfall. Some idea of the extent upon which these works are conducted will be gathered from the following figures relating to the Harz mines. In 1865 there were fifty-seven reservoirs covering an area of 642 acres, and having a storage capacity of 336,000,000 cubic feet. The total fall of the various leats,

races, and other water-courses, including the six principal adits, is about 170 statute miles. The net power extracted is reckoned at 1870 horse-power, but less than one-fourth of this is used for pumping.

Water-power is applied to pumping machinery by water-wheels, turbines, and rotary or non-rotary water pressure engines. Except ing the case of the latter, the rotary motion has to be converted into reciprocating motion by a crank; and furthermore with turbines the speed must be reduced very considerably by intermediate gearing.

Overshot wheels are the commonest prime movers when pumps are worked by water power, water-wheels are frequently constructed 40 or 50 feet in diameter, and at the Great Laxey mine, in the Isle of Man, one of the wheels is no less than 72 feet 6 inches in diameter and 6 feet in the breast. The power is conveyed from the water wheel by a connecting rod to a bell crank (*bob*) placed over the shaft and when, owing to the contour of the ground, the wheel has to be placed at a distance, it is connected to the bob by the so called *flat rods*, made of wood, bars of iron, or wire rope, travelling backward and forwards, and supported by pulleys or oscillating upright beams.

Water-pressure engines have the advantage of being able at once to utilize any amount of fall, and those which are direct-acting can be applied immediately to the main rod of the pumps.

Steam, however, is the power used *par excellence* in draining mines; indeed the first applications of steam-power were made for this purpose, and Watt's great inventions owed their birth to the necessities of mines which could no longer be drained by the water power at their command.

The principal type of engine is that known as the Cornish engine which is a single acting condensing beam engine working expansively. Its mode of action may be briefly described as follows. The steam is let in at the top of the cylinder and presses down the piston, which is connected with one end of a large beam, while the main rod of the pumps is attached to the other. When the piston has completed its course the equilibrium valve is opened by a cataract, and, the pressure on both sides of the piston being now equal, the weight of the pump rods, or rather the excess of their weight over that of the counterbalances, causes them to drop and force up the water from the mine by means of the plungers which will be described immediately. Double-acting rotative engines working the pumps by cranks may also be met with.

The rod in the shaft, known as the *main rod* or *spear rod*, is usually made of strong balks of timber butted together and connected by *strapping plates* fastened by bolts. It serves to work either lifting pumps or force pumps, or both.

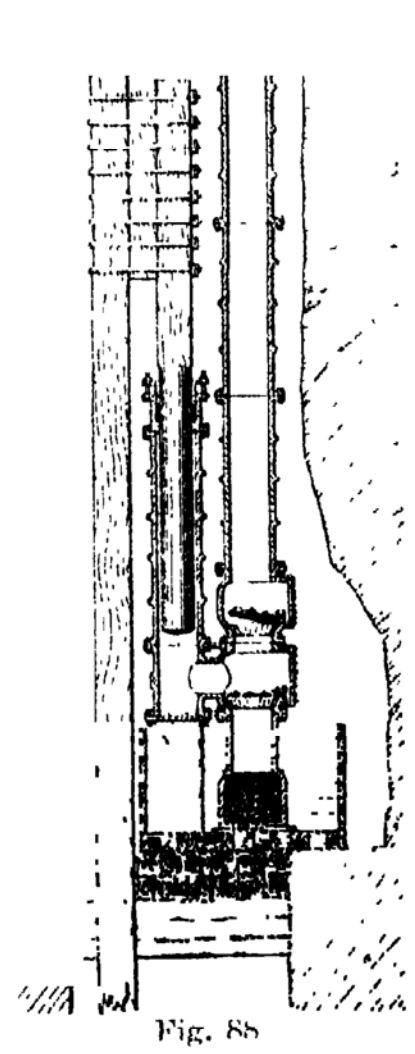


Fig. 88

The lifting pump, or drawing lift (fig. 87),[3] consists of the wind bore, the clack-piece, the clack-seat piece, the working barrel

[1] *Mining and Scientific Press*, San Francisco, 1882, vol. xlv. p. 241.

[2] "Notes on the new Deep Adit in the Upper Harz Mines," by H. Bauerman, *Report of the Miners' Association of Cornwall and Devonshire*, 1868, p. 21.

[3] Michell and Letcher on "Cornish Mine Drainage," *Forty-Third Annual Report of the Royal Cornwall Polytechnic Society*, p. 211.

mounted by pumps, and the bucket with its rod. The whole orks like any ordinary pump, and needs no special explanation.

The force-pump used in mines, known as the plunger-pump, onsists of a solid piston (*plunger*) (fig. 88)[1] working through a tuffing-box in a pump standing on the H-piece. This has a valve hich communicates with the *windbore* resting in the cistern elow the H-piece comes the *door-piece* with another valve, and hen a series of pipes, generally of cast iron, but occasionally of rought iron, constituting the column. The upward motion of he plunger, which is attached to the main rod, causes an inflow of ater, which is forced into the column when the plunger descends. t is usual to fix a drawing lift at the bottom of the shaft, which aises the water into a first cistern, and thence a plunger forces it nto a second cistern some 60 yards higher up, and it is continually oreed up from cistern to cistern until it reaches the adit or the urface.

There are numerous important matters which require special ttention, such as the valves, catches, balance-bobs, guiding rrangements for the rod in inclined shafts, the V-bobs, foul-oil obs, and running loops, which have to be used when there are ends in the shaft; but space will not permit of more than mere nention of these details.

Such then is the standard arrangement worked by steam or vater power for pumping from mines. The great advantage of the ystem consists in the employment of the plunger, because it is imply necessary for the machine to raise a weight slightly greater han that of the water, which is forced up afterwards by the down stroke of the rods. Leaks are readily discovered, and the stuffing-box can be easily screwed up as the packing wears, this is one great reason of the superiority of the plunger compared with a piston working in a barrel.

The modifications of this system relate more to the engines employed than to the actual pumps themselves.

The cylinder of the Cornish engine is sometimes reversed and stands over the shaft, the main rod being attached directly to the piston. This type of engine, known as the Bull engine in Cornwall, dispenses with the ponderous beam, but it has the great disadvantage of obstructing the mouth of the shaft. The use of two cylinders combined, as invented by Woolf, causes less strain upon the main rod and pumps (*put work*) and machinery generally, as the initial velocity of the piston is smaller and the engine starts with less jerk. The cylinders are placed side by side or one above the other.

Kley, of Bonn, has constructed engines on the Woolf system with steam acting on both sides of the piston. He makes the excess of the weight of the rod over that of the counterbalance sufficient to raise only half the weight of the water and to overcome the friction; and then in the descending stroke the steam acts on the top of the piston and so makes up for the insufficiency in force of the rods. As the steam acts on both sides of the piston the same amount is consumed, it is true, but a smaller cylinder will do the work, and the original cost of the engine is lessened. The same engineer of late years has put up several pumping engines in Belgium, Germany, and France of 30 to 560 horse power, with a fly wheel which serves simply to regulate the stroke of the piston, so that the crank always stops before or after the dead point till the cataract starts another stroke. The engines are double-acting, with two cylinders and beam. The advantage of working with the fly wheel is that the main rod and pumps are set in motion without the injurious jerk unavoidable with a Cornish engine worked at a high rate of expansion.

M. Guinotte, the well known Belgian engineer, also adopts a fly-wheel, and the engines he has erected at Marcinelle and elsewhere are single-acting rotary engines with one cylinder. The peculiarity of the fly-wheel is that he can weight it in any way he pleases; and he so overcomes the difficulty, which occurs in other rotary machines, of its being impossible to work them below a certain speed. His object has been to make the speed slow at the beginning and end of a stroke, so as to avoid the injurious shocks to the valves and machinery generally from sudden starts and stoppages. In order to make the main rod act by traction only and not compression, which may be advisable with iron rods, the plungers are sometimes reversed; whilst Kraft of Seraing has introduced the Rittinger pump, which consists of a hollow moving plunger with a valve inside, and a plunger case above it working over a hollow fixed plunger. By this arrangement both the up and the down stroke of the engine cause water to be forced up; and this pump is used with a double-acting rotary engine.

B. We must now speak of the second class of pumps, viz., force pumps worked by steam, water power, or compressed air at the bottom of the shaft.

The steam pumps are of very various descriptions,[2] but they mostly consist of one or two plungers, or rams, set in motion by a rotary or a non-rotary engine, which may or may not work with expansion and condensation. The plunger or ram is generally fixed directly on to the piston, and works in the same line, consequently the power is transmitted to the plunger with the least possible loss. The water is forced up the shaft in one long column. Engines and pumps of this kind are easily kept in order, all the parts are readily accessible. The miner is able to dispense with the heavy beam, the massive engine house, the long main rod and its connexions, and bobs, the various cisterns and plungers, and instead he has a compact and easily supervised machine and a simple line of pipes taking up but little space in the shaft; the pump can therefore be erected and set to work very quickly, and this is a matter of the utmost importance in emergencies. It is true that these direct acting steam pumps, even when worked by a compound engine, cause a greater consumption of coal than the Cornish engine; but, on the other hand, there is the economy in first cost, erection, and repairs which has led to their adoption more especially in collieries. The steam is generated by boilers underground, or is conveyed from the surface in well jacketed pipes.

If natural water power is available water pressure engines working the plunger directly are often employed, and indeed such water-power may be created artificially for use in workings where steam power is objectionable on account of the heat. There are other reasons too for employing water for transmitting power, where the length of the rods is very great, and they have to be worked quickly, there is a great liability to breakages, in order to overcome these difficulties at the mines on the Comstock lode, Mr Joseph Moore[3] uses a steam engine at the surface to work an hydraulic accumulator, and then by pipes conveys the water under pressure to hydraulic engines working plungers. These are fixed at 2100 feet from the surface, and force the water in one column, 13 feet high, to the level of the Sutro tunnel. The exhaust water is returned to the surface in pipes and used over again. The pumps now raising 1600 to 1700 gallons per minute.

Where compressed air is being supplied to a mine for drilling and winding purposes it is often convenient to employ it, by means of direct acting pumps, such as are generally used with steam, for the drainage of small temporary workings, and occasionally large pumps raising considerable quantities of water are worked in this way.

11. *Ventilation and Lighting.* The composition of the air of the atmosphere is about one fifth by volume of oxygen and four fifths of nitrogen, with a little carbonic acid gas; more exactly, the standard amount of oxygen may be taken at 20·9 per cent., and that of the carbonic acid gas at 0·03 per cent. The atmosphere of mines is subject to various deteriorating influences: not only do noxious gases escape from the rocks into the underground excavations, but also the very agents employed in the execution of the work itself pollute the air considerably.

The dangerous emanations of fire damp in collieries have been already described (Coal, vol. vi. p. 729); and with reference to this gas it is simply necessary to say that its presence is not entirely confined to coal mines. Large quantities have been observed in Silver Islet mine,[4] Lake Superior, where several explosions have occurred, whilst small quantities are met with in the stratified ironstone of Cleveland, and also in the Cheshire salt mines; jets of the gas may be seen constantly burning in the salt mine at Bex in Switzerland, a little has been noticed also in lead mines in Wales and Derbyshire. In the Sicilian mines the amount given off by the black carbonaceous shales interstratified with the sulphur beds is sufficient to cause dangerous explosions. It has been pointed out (vol. vi. p. 729) that carbonic acid gas exudes from coal;[5] it escapes also from some mineral veins. At the lead mines of Pontgibaud in central France it is so abundant that special fans have to be provided for getting rid of it; very distinct issues of this gas may be observed at the Foxdale mines in the Isle of Man, and in the Alston Moor district it is no

[1] Michell and Letcher on "Cornish Mine Drainage," *Forty Third Annual Report of the Royal Cornwall Polytechnic Society*, p. 211.

[2] Stephen Michell, *Mine Drainage*, London, 1881.

[3] *Transactions of Institution of Engineers and Shipbuilders in Scotland*, 1882.

[4] *Engineering and Mining Journal*, vol. [illegible] p. 42.

[5] [illegible] Schondorff, "Untersuchung der aus zu Tage tretenden Wetterströmen in den Steinkohlenbergwerken des Saarbeckens," *Zeitschrift für das Berg-Hütten- und Salinen-Wesen im Preussischen Staate*, vol. xxiv. p. 73; and C. Winkler, "Die chemische Untersuchung der bei verschiedenen Steinkohlengruben Sachsens ausziehenden Wetterströme und ihre Ergebnisse," *Jahrbuch für das Berg- und Hüttenwesen im Königreich Sachsen auf das Jahr* 1882, p. 65.

uncommon. This gas is likewise given off in the Sicilian sulphur mines, where also the highly poisonous sulphuretted hydrogen is of frequent occurrence, the water in the workings being often contaminated with it. Small quantities of mercurial vapour occur in quicksilver mines.

Such then are the principal gases which naturally pollute the atmosphere of mines, and have to be swept out by ventilation. In addition to these we have the products of the respiration of the men and animals in the pit, and those due to the combustion of candles or lamps, and the explosion of gunpowder, dynamite, &c.

Dr Angus Smith[1] reckons that two men working eight hours, and using [illegible] candles, [illegible] cubic feet of air [illegible] breathing, 12·27 [illegible] The products [illegible] studied by Captain [illegible] ing [illegible] show

[illegible] to be [illegible] Mo

Total solut[illegible]	[illegible]
Total reason	[illegible]
Water	[illegible]

The solid residue of the gunnies [illegible] potassium carbonate, potassium monosulphide [illegible]

Centesimal composition by volume of the gases produced

Curtis & Harvey

Carbonic [illegible]	[illegible]
Carbonic [illegible]	[illegible]
Nitrogen	[illegible]
Sulphuretted hydrogen	
Marsh gas	
Hydrogen	

The volume reduced to a temperature of 0° C. and [illegible] mm. of mercury of permanent gases generated by the [illegible] of 1 gramme of dry powder is

Curtis & Harvey No. 6 [illegible]	211·0 cubic cent.
Mineur [illegible]	360·1 "

MM. Sarrau and Vieille have communicated to the Academy of Sciences[2] the result of their researches concerning the decomposition of certain explosives, and more particularly gun-cotton and nitrated gun-cotton. The following table shows, in litres, the volume at 0° C. and 760 mm. of mercury of each of the gases per kilogramme of the substance exploded in a

CO	CO_2	H	N	CH_4	H_2S	Total
93·4	93·4	[illegible]	10·[illegible]	[illegible]	[illegible]	441
[illegible]	174·[illegible]	[illegible]	109·4	[illegible]	[illegible]	290

[illegible]

[illegible] composed of a pressure approximately equal to 0° C. and 760 mm. known below:

	CO	CO_2	H	N	CH_4	Total
[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]	305
potash (99 p[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	196
Gun-cotton (i[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	12	111	[illegible]	111
Nitro-glycerine	[illegible]	[illegible]	7	6	1	150

When explosives are [illegible] way they liberate nitric oxide and carbonic oxide, and the analyses of MM. Sarrau and Vieille confirm the practical experience of miners, who complain greatly of noxious fumes when, owing perhaps to a bad detonator, a charge of dynamite or tonite fails to explode properly.

The air of mines is finally deteriorated by organic matter contained in the exhalations of the men and animals employed and in the products of decaying timber, by dust, and by the solid particles constituting the smoke of explosives. It must be recollected also that the injury to the air is not confined to the addition of the gases and substances just mentioned; but the proportion of oxygen is diminished by the combustion of candles, by respiration, the decay of timber, and decomposition of some minerals such as iron pyrites. Dr Angus Smith[3] sums up the results of his analyses of the air of Barnsley coal mines as follows:

Percentage by volume
[illegible] 20·26
[illegible] 20·18
[illegible] 20·32
[illegible] 20·63
[illegible] 20·77
[illegible] 20·12
[illegible] 20·14
[illegible] 0·785

He considers a [illegible] per cent. oxygen as normal, and air with proportion [illegible] of 20·5 as impure; and where the percentage below 20·6 he calls the air exceedingly bad. In the [illegible] mine [illegible] only 10·67 per cent. of the samples [illegible] to be normal or nearly so; 24·69 per cent. were decidedly bad, while 64·63 per cent. or nearly two-thirds of the samples were extremely bad. The amount of oxygen in one specimen was as low as 18·52 per cent, whilst the carbonic acid often exceeded 1 per cent and in several instances 2 per cent. He says that twenty years ago the ventilation of British mines was bad, but satisfactory, and even now there is room for improvement.

Having explained the reasons why the air of mines must be constantly renewed, we must now point out how this desirable end is effected.

Two systems are employed,—natural ventilation and artificial ventilation; but, as both systems have been described (COAL, vol. vi. p. 70), little remains to be said here, especially as the ventilating machines in metalliferous mines generally cannot for one moment be compared with the powerful appliances employed in collieries. In vein mining there are generally many more shafts than in collieries, and natural currents are set up which are often considered sufficient for ventilating the mines; nevertheless, the advanced workings, such as the ends, rises and winzes, in fact all workings in the form of a *cul-de-sac*, are likely to require special means of ventilation as soon as they proceed a little distance from the main air current.

The means of ventilating a drift or heading are various. If a natural or artificial draught exists at the mouth of the drift, it may be diverted by an upright partition (*brattice*), or an airway may be constructed along the roof or floor by a horizontal partition of planks (*sollar*) (fig. 89). In this way a sufficient supply is directed at the end or fore breast.

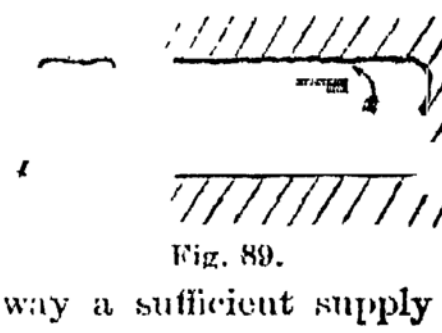


Fig. 89.

The water blast is another simple appliance; it is precisely the same as the well known trompe, and it blows a current of air through square pipes made of board, or better through cylindrical pipes of sheet zinc.

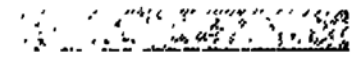


Fig. 90.

The fall of water may be applied by Williams's water-jet, shown in fig. 90. The jet of water acts like an injector and creates a powerful current.

Small fans driven by boys, or better by small water wheels or other machinery, are frequently applied, and the

[1] *Report of the Commissioners [illegible] tion of all Mines in Great Britain* [illegible] 23 & 24 *Vict.* c. 151 *dated* [illegible] Appendix.

[2] "On Fired Gunpowder," *Chemical News*, 1880, p. 278.

[3] *Letter to the Commissioners of the Act* [illegible], p. 224.

[4] "Recherches expérimentales sur la [illegible] explosifs en vase clos, composition des [illegible] 1880, pp. 1058 and 1112.

and Mr F. A. Abel.

[illegible] composition de quelques [illegible] mes," *Comptes Rendus*,

[4] *Op. cit.*, p. 222.

Harz blower (*duck machine*, Cornwall) (fig. 91) is not uncommon. This is merely an air pump of very simple construction which is worked by the main rod of the pumps, and can be arranged so as to exhaust the foul air or force in fresh air.

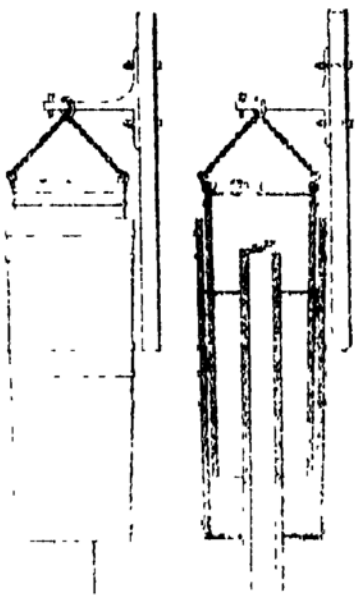


Fig. 91.

In working in blasting ground, boring-machines driven by compressed air are becoming more and more largely used every day, and the exhaust air escaping from the machines is invaluable for ventilation. At the same time, on account of volley firing, the quantities of deleterious gases generated in a short space of time are very considerable, and, in order to get rid of them speedily, the compressed air may be utilized for working a Korting aspirator or the somewhat similar ventilator of Mr Teagite, a jet of compressed air turned into a ventilating pipe, which creates an exhaust (fig. 92[1]). Naturally this ventilator is merely brought into play at the time of blasting, and while the boring machinery is out of use. When compressed air is being supplied on a large scale to a mine for boring and winding machinery, it is often convenient to convey it by a small gas-pipe to working places in which the ventilation is inadequate. Of course, in one sense, it is very uneconomical to compress air to a pressure of 60 or 70 lb to the square inch for ventilating purposes only; but, where compressing machinery is always at work on the mine, it may be better to be a little wasteful of cheap power at the surface than to go to the greater expense of having a man or boy to work a fan underground.

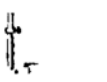


Fig. 92.

Mines are lighted by lamps, torches, candles, and electricity. The subject of safety lamps for fiery mines has already been discussed (see COAL, vol. xi. p. 72), and consequently the question of illuminating mines may be treated in a very summary manner.

Lamps vary very much in shape and size. The Silesian miner has a mere shallow cup of unglazed pottery, the Saxon a small tin or brass lamp in a wooden box lined with tinplate and open in front. In the Harz the miner prefers a heavy flat iron lamp with a hook by which it is stuck into the timber or any crack in the

Fig. 93.

iron lamp is lenticular in shape and also by a hook. In Scotland, and parts of Germany and the United States, a small tin lamp of the shape shown in fig. 93 is very common: the hook enables it to be carried on the hat while climbing ladders, and to be fixed up underground. Olive oil and rape oil are burnt in these lamps; petroleum lamps are employed occasionally.

The miners of England and Wales still cling to the tallow candle; and when surrounded by a lump of clay it can easily and quickly be fixed in the working place or carried upon the hat when climbing. Gas brought down from the surface answers for illuminating large excavations, such as on-setting places and engine rooms.

Up to the present time the electric light has been but little used underground on account of its want of portability, and the smallness of the spaces requiring illumination. Very often a few men only are employed in each working place, and consequently the expense incurred in fixing and shifting the lamps and maintaining them alight would be out of proportion to the value of the work executed. However, an incandescent electric lamp has been invented weighing only 10 lb, which gives the light of three candles for six hours, and it may be reasonably expected that improvements will be made which will render the electric light more available for underground purposes than it is at present. When the area requiring illumination is large, an arc-lamp may be used with advantage.

[1] *Trans. Roy. Geol. Soc. Cornwall*, vol. x. p. 142.

Among the first successful applications of electric lighting to underground excavations may be mentioned that of M. Blavier at the Angers slate quarries.[2] In the year 1879 he fixed two Serrin lamps in one of the large underground chambers with an area of 2400 square yards, and he found that they gave light enough for all the men at work. The total cost, reckoning everything, viz., coal, carbons, repairs, labour, depreciation of plant, and interest on capital, is 50 francs per day; the gas formerly in use cost 54 francs a day and gave much less light. It is evident, however, that the arc light can only be applied with advantage in special cases where a large number of men are concentrated in one working area which can be illuminated from one or two points.

The large chambers in the salt mine at Maros-Ujvár in Hungary have been regularly lighted up by electricity since 1880. The cost is somewhat greater than that of the tallow, oil, or petroleum formerly used, but, on the other hand, the illumination is better, the men can do more work and are more easily supervised, while the air of the mine is not deteriorated by the products of combustion of the lamps.[3]

12. *Means of Descending into and Ascending from Mines.* Where mines are worked by adit levels the men naturally walk in along the ordinary roadway, such mines, however, are exceptional, and the men generally have to climb down and up by ladders, or are raised and lowered by machinery. The means of access to and from workings may be classified as follows: (1) steps and slides, (2) ladders, (3) cages, (4) man-engines.

If a hole or seam inclined at an angle of 30° or 50° from the horizon, steps may be cut in the floor of the deposit if it be firm enough, or wooden steps may be put in with a hand-rail. Even with higher dips steps may be arranged by directing them in a line intermediate between the dip and the strike. In speaking of conveyance underground, reference has already been made to the practice of carrying sulphur ore in Sicily and slate in Germany up to the surface by steps, and steps may be found in other foreign mines and occasionally in Great Britain. They are much less fatiguing than ladders placed so flat that part of the weight of the body rests upon the arms. In some of the Austrian salt mines the men descend by wooden slides inclined at angle varying from 30° to 50°, flattening at the bottom to destroy the velocity gradually; the ascent is effected by steps.

Ladders are very largely used in metal mines all over the world, but they vary a good deal in different countries. The ladder consists of two sides and a series of rungs (*stores*, Cornwall). The sides are usually made of wood and the rungs of wood or iron. The distance between the rungs is important; 10 inches from centre to centre is sufficient, for climbing upon ladders with the rungs 14 inches apart is decidedly more fatiguing. On the Continent wooden rungs are commoner than iron ones, and oak is preferred. Sometimes the wooden staves, instead of being round, are flat, so as to stand more wear, and iron sides may be seen in places where dry rot is very bad. Platforms should be fixed at short intervals, not exceeding 3 or 4 fathoms in perpendicular shafts, so as to prevent falls from having fatal consequences.

In many cases sufficient attention is not paid to the angle of inclination of the ladder. A ladder is climbed with the least fatigue when the person uses his arms simply to steady himself, and is not compelled to pull himself up by them, as on a vertical ladder, or to support much of the weight of his body by them, as happens with a very flat one. The best angle is about 20° from the vertical, and in Belgium the authorities have very wisely decreed that no ladder shall be inclined at an angle of less that 10° from the vertical. Furthermore, of the two arrangements shown in fig. 94,

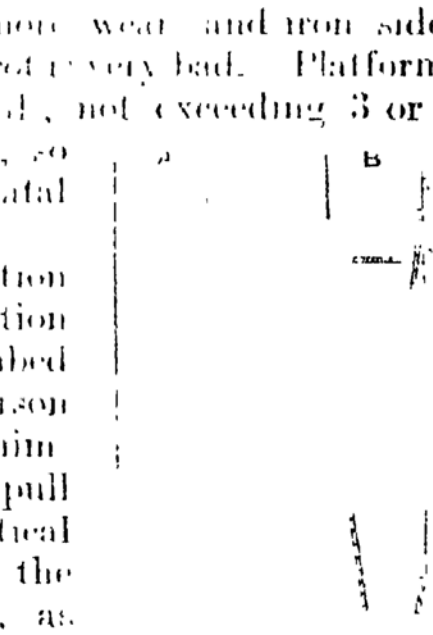


Fig. 94.

[2] M. Blavier, "L'eclairage electrique d'Angers," *Annales des Mines*, ser. 7, vol. xvii., 1880.

[3] *Oesterreichische Zeitschrift für Berg-*, 1882, N. 25, p. 296.

A is better than B, because it not only affords a greater inclination for the ladder, but also renders it less likely that a man will drop through the opening (*manhole*) in the platform (*sollar*) if he loses his hold and falls. These may seem trifling matters; but, leaving aside the question of safety, the economy derived from fixing the ladders at the best inclination is by no means small. To make this apparent we must recollect the depth to and from which men have to climb, viz., 300, 400, and even 500 and it is important, therefore, to avoid every unnecessary expenditure of energy, which, though trifling for one ladder, becomes considerable when repeated a great number of times. When a mine has reached a depth of 900 yards, and *a fortiori* when it exceeds it, mechanical appliances should be introduced for raising and lowering the men, because time and strength are wasted by climbing. Medical men also are agreed that excessive ladder-climbing is injurious to the health of the miner. Therefore, both upon hygienic and financial grounds, one of the first thoughts in working a mine should be the conveyance of the men up and down the shafts by machinery with the least possible fatigue.

In collieries and other mines worked by perpendicular shafts, it has long been customary to raise and lower the men by the ordinary winding machinery already described. In the United Kingdom it is necessary that guides should be used if the shaft exceed 50 yards in depth; safety catches and disengaging hooks (*Coal*, vol. xi. p. 60) are frequently applied for the purpose of preventing accidents. The simplicity of the method of ingress and egress naturally renders it popular, and statistics prove that, where proper precautions are used, it is exceedingly safe.

The first man engine was put up in the Harz in 1833, and one year later a similar machine was fixed in Treuvean mine in Cornwall. Since that time the very useful means of conveying workmen up and down shafts has been reported on in other mining districts, and especially in Belgium and Westphalia.

Two kinds of man engine are in use, the double rod machine and the single rod machine. The double rod or current man engine consists of two reciprocating rods like the main rods of pumps, carrying small platforms upon which the men stand. The stroke is from 6 to 16 feet, and the little platforms are so arranged that they are always opposite each other at the beginning and end of each stroke. Figs. 95 and 96 represent the rods in the two final positions. A man who wishes to descend steps upon platform *b* (fig. 95), the rod B goes down, and A goes up so that *a* (fig. 96) is brought opposite *b*. The man steps across from *b* to *c*, and then the rod A makes a down stroke, B an up-stroke. Platform *c* is now opposite to *a* (fig. 96), and the man again steps across, and so on, constantly stepping from the rod as it comes to its down stroke, the man is gradually conveyed to the bottom of the shaft. By reversing the process, in other words by stepping off on to the opposite platforms as soon as the rod has completed its up stroke to where it is level to the surface, without waiting to be beyond the reach of the next coming platform of stepping sideways. Boards should be fixed up and down the shaft at each platform to indicate the direction of the descent will be opposite to each.

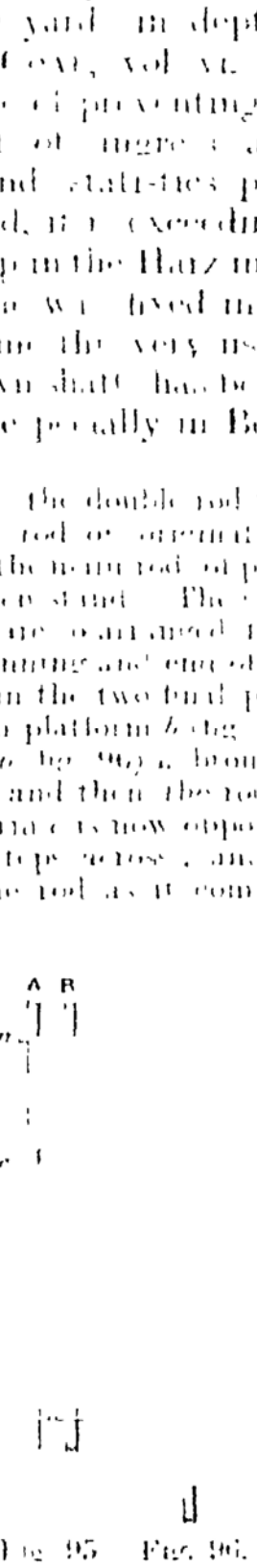


Fig. 95. Fig. 96. Fig. 97.

The single rod engine consists of one rod carrying steps instead of platforms arranged at the proper distance to correspond exactly with them (fig. 97). If a man wishes to go down, he steps on to A when the up stroke is completed; the rod goes down and A is brought down opposite to the fixed platform *b*, on to which he steps off. He then waits on *b* until the rod has finished its up stroke. B is brought opposite *b*; he steps on to B, the rod goes down and he is brought opposite *c*, where he steps off again on to it. By reversing the operation he is gradually lifted to the top of the shaft. The single rod engine may be used by men going up while others are going down, provided that there is sufficient room upon the fixed platforms (*sollars*). The best plan is to have sollars right and left, as shown in the figure, and then the ascending men step off to the left, for instance, while the descending men take the right-hand sollar. The ascending man steps on to the man engine as soon as the descending man steps off, and so the rod may be always carrying men up or down. The usual stroke in Cornwall is 12 feet, and there are from three to five or six strokes a minute. With five strokes the men descend 10 fathoms a minute, or in other words a descent of a depth of 300 fathoms occupies half an hour. The requisite motion is to be obtained from a crank, because in this case the speed is diminished gradually at the dead points, and the danger of an accident in stepping off and on is thereby diminished. Man-engines, however, are sometimes driven by direct-acting engine

Man engine rods are constructed of wood or iron; and at A[illegible] driven by the flat rods replaced by two wire ropes. Like a pump rod the man engine rod requires proper balance bobs and catches, and for the safety of the men a handle is provided at a convenient height above each step.

The man engine has one great advantage over the cage, which consists in the fact that it can be safely applied in inclined and even [illegible] worked both in adopted in many [illegible] for this reason that man-engines have been Careful comparison mines unprovided with vertical shafts. in Prussia [illegible] records safety of travelling have been made accidental d[illegible] cage, man engine, and cages. The average shown by the accompanying table, which [illegible] of five years, 1871 to 1880 —

	Ladders		Cages
Average	3,919	2,491	64,071
Total no.	[illegible]	41	74
Per 100	0·101	0·579	0·115

The table [illegible] the cage is nearly as safe as ladders. [illegible] tance travelled were taken into account, the appar[illegible] ently, because we may fairly assume that [illegible] mate tool by cages are on the whole very much deeper than those in which men ascend and descend by ladders. The men on the appear to be decidedly more dangerous than other [illegible] Here again a distinction requires to be made between the single rod and the double rod machines, and the Prussian statistics include many of the latter. It will be readily understood that a fall in a naked shaft with few fixed platforms is much more likely to be fatal than a fall in the shaft of a single-rod man engine which is closed with the exception of the manhole intervals of 12 feet. The Belgian *warocqueres* are rendered safer than the Harz or Saxon man engines by having a railing round the back of each platform on the rod. Some of the double-rod machines are made with large platforms so that two persons can stand on them, one going up and the other going down, or both travelling in the same direction. The use of double rod man engines has been entirely abandoned in the United Kingdom. The death-rate from accidents on man-engines in Cornwall and Devon during the nine years 1873 to 1881 was 0·17 per 1000 persons using them, whilst the annual death rate per 1000 persons using ladders was slightly higher, viz., 0·19. If the actual distance travelled were taken into account, the scale would turn more decidedly in favour of the man engine.

The cost of raising and lowering men by the man-engine is small. At Dolcoath, a tin mine in Cornwall approaching 400 fathoms in depth (see figs. 62, 63), it is reckoned that 1½d. per man per day covers all expenses, including interest upon the capital expended and depreciation of plant.

13. *Dressing or Mechanical Preparation of Ores.*—In a large number of cases the mineral, as it is raised from the mine, is not ready for sale. It usually requires to be subjected to mechanical processes whereby the good ore is entirely or partly freed from valueless veinstone. These processes, which in a few special instances are aided by calcination in furnaces, are known as the dressing or mechanical preparation of the ores. As a rule the valuable ore is specifically heavier than the veinstone, and most of the separating processes are based upon the fact that the heavy particles of ore will fall in water more quickly than the light particles of veinstone.

The processes of mechanical preparation may be classified as follows: (1) washing and hand-sorting; (2) disintegration, or reduction in size; (3) classification by size or equivalence; (4) concentration.

(1) Sometimes the ore coming from the mine requires simply to be freed from adhering particles of clay in order

o be rendered fit for sale, at other times the washing is ecessary as a preliminary process previous to sorting by and. The operation is performed either by raking the re backwards and forwards upon a grating under a stream f water, or in a box containing water, or, thirdly, by neans of an inclined revolving iron drum worked by hand r any other motive power. The machines used for this urpose, known as washing trommels, are revolving ylinders or truncated cones of sheet iron provided with eeth inside. The ore is fed in at one end, is subjected to he action of a stream of water, and is discharged at the ther end.

The *stuff*, *i.e.*, the mixed ore, veinstone, and country ock, having been cleansed, it is now possible to make a eparation by hand. Women and children are generally mployed for this work, as their labour is cheaper and heir sight sharper than that of men. The stuff is spread ut on a table, and various classes are picked out according o the nature of the products furnished by the mine. Thus in a lead mine we may have (*a*) clean galena, (*b*) ixed ore, *i.e.*, pieces consisting partly of galena and artly of barren veinstone, (*c*) barren veinstone and country ock. This is a most simple case; very frequently we ave to deal with a vein producing ore of two metals, specially in the case of lead and zinc, and then the lassification into various qualities becomes more complicated.

(2) Reduction in size is necessary for two reasons. Even when an ore is sufficiently clean for the smelter the large umps are often crushed by the miner for the sake of obtaining a fair sample of the whole or sometimes a product which is at once fit for the furnace. The chief eason, however, for disintegration lies in the fact that the particles of ore are generally found enclosed in or adhering o particles of barren veinstone.

The disintegration is effected by hand or by machinery. Large blocks of ore and veinstone are broken by men with arge sledge hammers, and the reduction in size is continued very often by women with smaller hammers. Sometimes he blow of the hammer is directed so as to separate the good from the poorer parts, and hand picking accompanies his process, called *cobbing*. Ore may be crushed fine by a flat-headed hammer (*bucking iron*) on an iron plate.

The machines used for reducing ore to smaller sizes are very numerous; here it is impossible to do more than briefly call attention to those most commonly used. These re stone-breakers, stamps, rolls, mills, and centrifugal pulverizers.

The stone-breaker, or rock breaker, is a machine with two jaws, one of which is made to approach the other, and

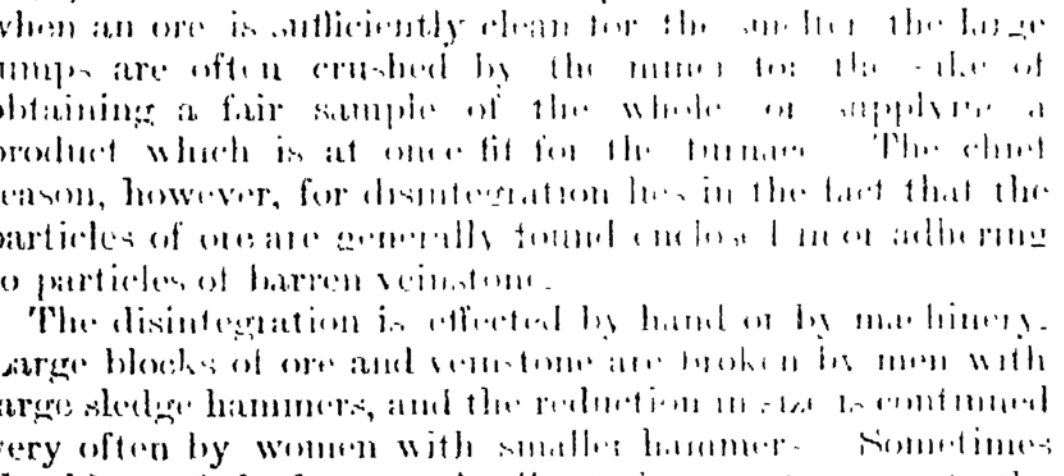


Fig. 98. Blake's Stonebreaker, improved by Marsden.

so crack any stone which lies between them. The best-known stone-breaker is the machine invented by Blake, which has rendered inestimable services to the miner for the last twenty years, and the introduction of which constituted a most important step in advance in the art of ore dressing. Its mode of action is very simple. When the shaft A (fig. 98) revolves, an excentric raises the "pitman" B, and this, by means of the toggle-plates C, C, causes the movable jaw D to approach the fixed jaw by about ¾ inch at the bottom. When the pitman descends the jaw is drawn back by an india rubber spring. The jaws are usually fluted, the ridges of one jaw being opposite the grooves of the other, and they are so constructed that the wearing part are quickly and easily replaced.

Mr Marsden of Leeds has lately introduced a pulverizer constructed on the principle of the stone-breaker, which will reduce large stones to the finest powder in one operation. The moving jaw has an up-and-down as well as the old backward and forwards motion, and the stones are first cracked and then ground by the double action.

Stamps are perhaps and mortars worked by machinery. The construction of the modern California stamp mill with revolving head-gear explained in Globe, vol. x. p. 717, and the description need not be repeated. In Cornwall the older form, with rectangular heads, still prevails.

It is impossible to give any correct average figure representing the work done by a stamping mill, because this varies with the hardness of the stuff treated and the fineness to which it must be reduced. However, it is usual in Cornwall to reckon 1 ton of tin-stuff and in California to 1½ ton of gold quartz stamped per horse-power in twenty four hours.

Stamps are principally used in dressing the ores of gold, silver, and tin, but are occasionally employed for those of copper and lead. The stamps described at vol. x. p. 717 act simply by gravity. Another form, which has met with favour in the Lake Superior district, is the direct acting or Ball stamp, which works like a steam hammer, the blow of the head being assisted by the pressure of steam. At the Calumet and Hecla Mill, Lake Superior, each Ball stamp is capable of crushing 130 tons in twenty four hours. In a third kind of stamps, the heads are lifted by a crank and the power of the up-stroke compresses a cushion of air (pneumatic stamps) or a spring, storing the power which makes the down-stroke strike a heavier blow.

Revolving rolls were introduced in the west of England in the early part of the present century to replace *bucking* by hand. The machine, now often known as the Cornish crusher, consists of two cast iron or steel cylinders which revolve towards each other, whilst at the same time they are kept pressed together by levers or springs. The cylinders or rolls are generally from 18 inches to 2 feet 2 feet 8 inches in diameter and 12 to 22 inches wide.

Stone mills constructed like flour mills are employed in some countries for reducing ores to powder; and the *arrastra*, which consists of heavy stones dragged round upon a stone bed, has rendered good service in grinding amalgamating gold and silver ores, in spite of its being slow and comparatively crude. Edge runners (Chilian mills) also deserve mention.

Iron mills, known as *pans*, with grinding surfaces made of chilled cast iron and arranged so that they can be quickly and easily replaced when worn out, are greatly in vogue in the United States for the treatment of ores of gold and silver. The ore delivered to them is already finely divided, and they are intended, not only still further to reduce the size of the particles, but also and more especially to effect the amalgamation of the precious metals with quicksilver. The pulverizers used in Cornwall for grinding grains of tin ore with a little waste still adhering to them are also iron mills.

The centrifugal pulverizers are machines by which

ieces of ore are thrown with great velocity against bars or rms, or against each other, and so reduced to powder; in ther machines iron balls or iron rollers are whirled by entrifugal force against an iron casing and grind any ineral contained inside it. These pulverizers are much ess used than stone breakers, stamps, and rolls for the dis ntegration of metal.

(3) Classification of crushed ore into sizes is absolutely necessary in some cases and advisable in others, because the success of concentration is dependent upon the fall of the particles in water, as will be presently explained. The classification by size is effected by sieves. Hand sieves and flat sieves placed one above the other have been superseded at most dressing establishments by cylindrical or conical revolving screens known as trommels. These are made of wire web or of perforated sheets of metal, and they are often arranged so as to discharge one into the other, so that the ore from a crushing machine can quickly be separated into classes of various sizes.

With sizes of less than 1 millimetre ($\frac{1}{25}$ inch) trommels are no longer employed and recourse is had to the so-called pulsators or classifiers. These consist of boxes in the shape of inverted cones or pyramids into which the finely crushed ore is brought by means of a current of water; a jet of clean water is often made to rise up in the bottom, the finer and the specifically heavier particles fall and are discharged with a stream of water at or near the bottom, whilst the smaller and specifically lighter particles flow away at the top. The separators do not effect a true classification by size, they merely cause a division by *equivalence*, a term which will be explained immediately.

(4) We now have to deal with the enriching of the ore,

bulk as is economically advantageous. The concentration generally brought about by the fall of the particles in water. Occasionally the fall in an artificial mercury is employed as a collecting agent in the case of gold and silver, and in a few instances magnetism can be applied.

The concentration in water depends upon the difference in specific gravity of the valuable ore and the waste vein stone or rock. A piece of galena with a specific gravity of 7·5 will sink to the bottom more quickly than a similar piece of quartz, the density of which is only 2·6. Nevertheless a large piece of quartz may fall to the bottom more quickly than a small piece of galena. Particles which have equal velocities of fall though differing in size and specific gravity are said to be *equal falling*, or *equivalent*. Even thus a piece of flat quartz of $\frac{1}{4}$ inch in diameter would sink in water exactly as quickly as a piece of galena of $\frac{1}{8}$ inch in diameter, and these two particles would therefore equal falling. Consequently, before we can successfully proceed by water it is necessary to classify the ore in such a manner that equivalence shall not prevent a proper separation of the substances. It is nevertheless true that in the case of the fall of equivalent grains the difference of specific gravity preponderates, and the denser particles fall the least; therefore, by a frequent repetition of the operation of falls, particles which have not been completely separated by a heavy one are separated.

The principal machines for concentrating particles of sizes ranging between 1 inch and $\frac{1}{10}$ inch is the jig or jigger. The hand jigger is a circular round sieve which is charged with the crushed ore and worked up and down in a box full of water. The process is to rationally arrange them selves in layers the heaviest at the bottom and the lightest at the top. On lifting out the sieve the light waste can be skimmed off with a scraper, leaving the concentrated product below ready for the sieve or for further treatment. Similar sieves worked by machinery were for a long time employed in dressing establishments, but the introduction of the improved continuous jiggers has led to their abandonment in all works of any importance. The continuous jigger is one of the most useful dressing machines of the present day. It consists of a box or hutch divided by a partial partition into two compartments; in one is fixed a flat sieve *s* (fig. 99), which carries the ore, and in the other a piston *p* is made to work up and down by means of an excentric. The hutch being full of water, the movement of the piston causes the water to rise up and fall down through the ore, lifting it and letting it fall repeatedly. The effect of these frequent lifts and falls is to cause a separation of the previously sized ore into layers of rich mineral at the bottom, light waste at the top, and particles of ore mixed with waste in the middle.

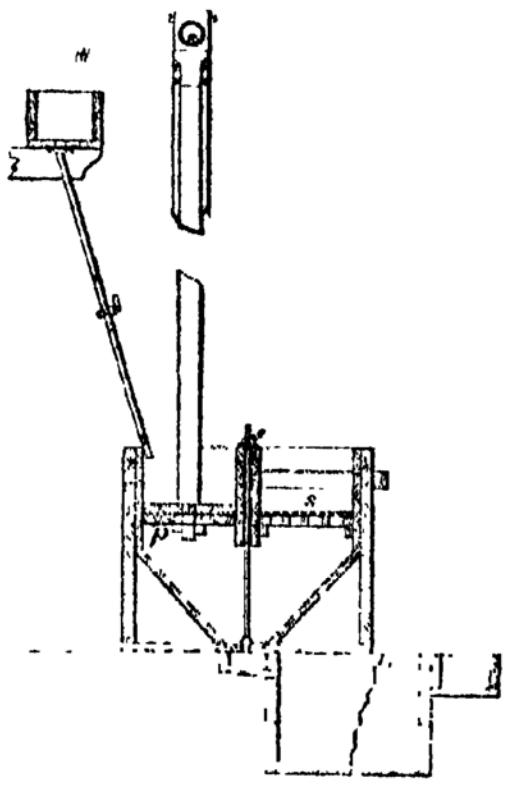


Fig. 99.

The great value of the apparatus is the continuous discharge of the products without stoppage for their removal. Several methods are in vogue viz., the end discharge, the central discharge, and the discharge through the meshes of the sieve. With the first, the enriched product lying at the bottom of the sieve passes out through openings at the end of the jigger, and the amount escaping is governed by an adjustable shutter, by which the size of the [illegible] diminished at pleasure; the middle product can be discharged by openings placed a little higher up, whilst the waste is washed over the top of the end of the jigger at each pulsation. Very often a first sieve simply separates a concentrated product and discharges the poorer product into a second sieve, where a similar separation is effected. With the central discharge, a pipe is brought up through the bottom of the sieve, and the size of the opening for the escape of the concentrated ore is regulated by a cylindrical cap which can be raised or lowered by a screw. The discharge through the case specially adapted for the finer products, the crushed though it is also used in some cases for grains up to $\frac{1}{2}$ inch in diameter. The mesh of the sieve is chosen so that the particles of [illegible] treatment will not pass through, but above the sieve a layer of clean ore is placed which prevents anything but the heaviest particles from being discharged. The pulsations of the water, as before, cause a separation into layers, and the heavy rich particles find their way through the bed and drop into the hutch, whence they can be drawn off through a hole at pleasure. The poorer part passes over a simple sill at the end of the sieve on to a second sieve if necessary. Three or four sieves are occasionally arranged in a row in one machine.

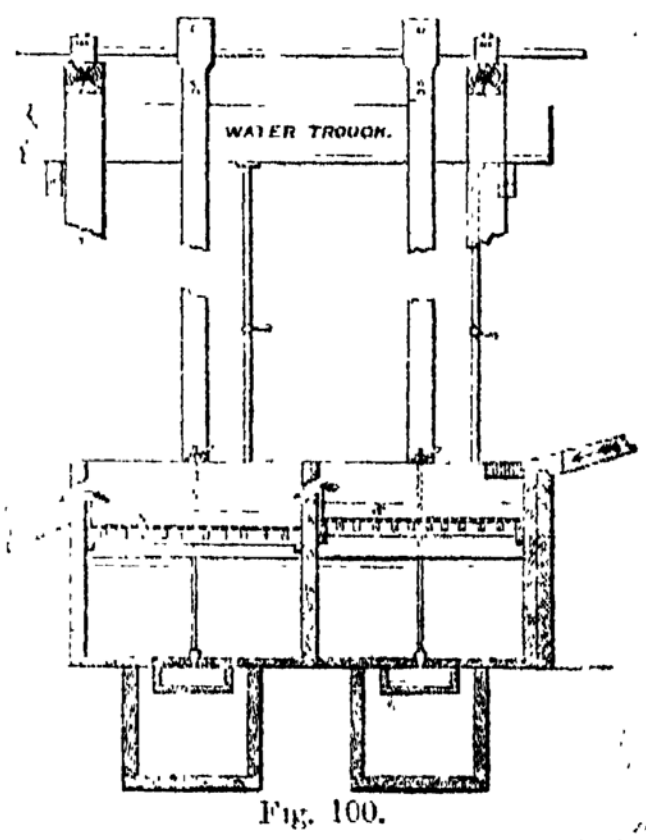


Fig. 100.

Fig. 100 is a section through the two sieves of a Harz sand jig. The pistons act in the manner explained by fig. 99.

The smaller sizes are concentrated by a variety of machines. The action of many of them is based upon the behaviour of particles carried down an inclined plane by a thin stream of water. If the gradient of the plane and the strength of the thin current are properly arranged, the denser particles will be deposited and the specifically lighter ones washed away, although they may be *equal-falling* if allowed to settle in deep water.

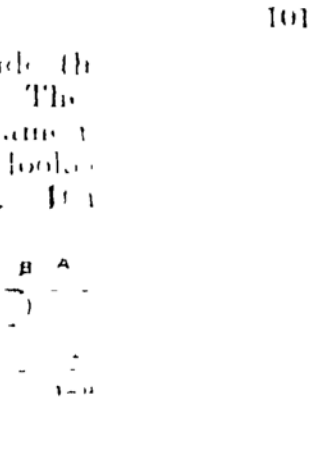
The principal machines for concentrating fine sands and slimes are the frame, rotating frame, percussion frame, side-blow percussion frame, revolving belt and Frue vanner, the hand buddle, the round buddle, and the keeve.

The frame is simply an inclined wooden table upon which a thin deposit is formed by the sheet of ore and-waste-bearing water which is made to flow over it gently. The stream is then stopped and the deposit washed off by hand or automatically, and collected in pits for subsequent retreatment by similar appliances if necessary.

The rotating frame is a round table with a very flat conical surface; the ore for suspension flows on at or near the centre and forms a thin deposit which is richest at the centre and poorest at the bottom, and thus deposit is washed off in two classes by means of jets of water, under which the table as it turns round. Concave rotating tables, fed at the centre, are also employed.

The percussion frame, the *Stossherd* of the German, consists of a table suspended by four chains which receives a succession of slows from a cam in the direction of the stream flowing over the table. Each blow it bumps against a piece of timber before receiving the next blow. These bumps cause the ore to settle, and when a sufficient deposit is formed it is dug off with the lowest part being richer than the middle or the tail.

Rittinger's side-blow percussion frame consists of a square table ABCD (fig. 101), receiving blows and compressed air on the end. A stream of ore and water S is fed on at the corner A; clean water W is supplied by the other head-boards H, H, H, and the table is pushed out by cams in the direction of the arrow, and is driven back by a spring so that the cross-piece E strikes against a jumping-block K. The light particles travel down the table much faster than the heavy ones, and take a comparatively straight course; whereas the heavy and richer particles remain on the table, subject to the influence of the side-blows, for a much longer time, and travelling along a curved path reach the bottom at F. The middle class is discharged at G and the poor waste at K. The exact degree of richness of the products can be regulated by altering the pointers, strips of wood which can be turned so as to divide the where thought most desirable. The machine over the old percussion frame.



101.

The Frue vanner (fig. 102) may be looked of Brunton's simple revolving belt. It rubber cloth, flanged on each side, which revolves slowly in the direction of the arrows, whilst at the same time it is shaken sideways by a crank motion. The ore-y water is fed on at A, clean water at B. The natural path of the particles is down the inclined belt, but the specifica t and are carried upwards. Those that can resist the action of the stream of clean water at B go over the end and are washed off as the belt passes through the tank. The poor stuff falls into the waste launder. The degree of concentration can be regulated by the slope and speed of the belt and the strength of the stream of ore and water. The Frue vanner has the disadvantage that it makes only two classes, rich and poor, without any intermediate product.

The hand buddle is a rectangular wooden box with a sloping bottom. A stream of fine ore and waste suspended in water is fed in at the upper end and gradually forms a deposit on the bed of the buddle. A boy with a broom keeps the top of the sediment smooth, so as to ensure regularity of action. After a thick deposit has accumulated, it is dug out in sections which decrease in richness from the upper end (*head*) to the lower end (*tail*).

Round buddles, like rotating frames, are of two kinds, convex and concave. The convex round buddle (figs. 103[1] and 104) is a circular pit with a truncated cone, or head, of varying size in the centre, and a bottom sloping towards the circumference. The ore-y stream falling over this head runs down gently, depositing the heaviest particles near the top, the lighter ones further down, whilst the lightest of all flow away at C. The surface of the sediment is kept even by revolving brushes D.

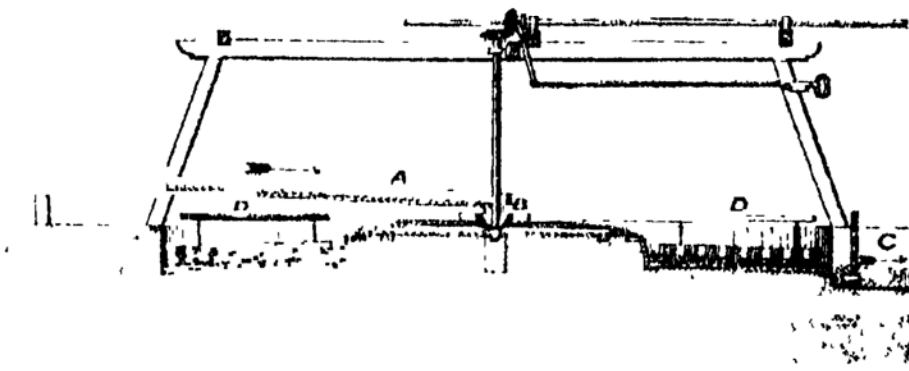
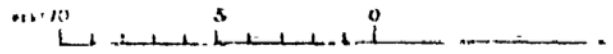


Fig. 103.



a number of hand buddles arranged radially round a centre. The deposit that is formed is dug out in rings of varying richness

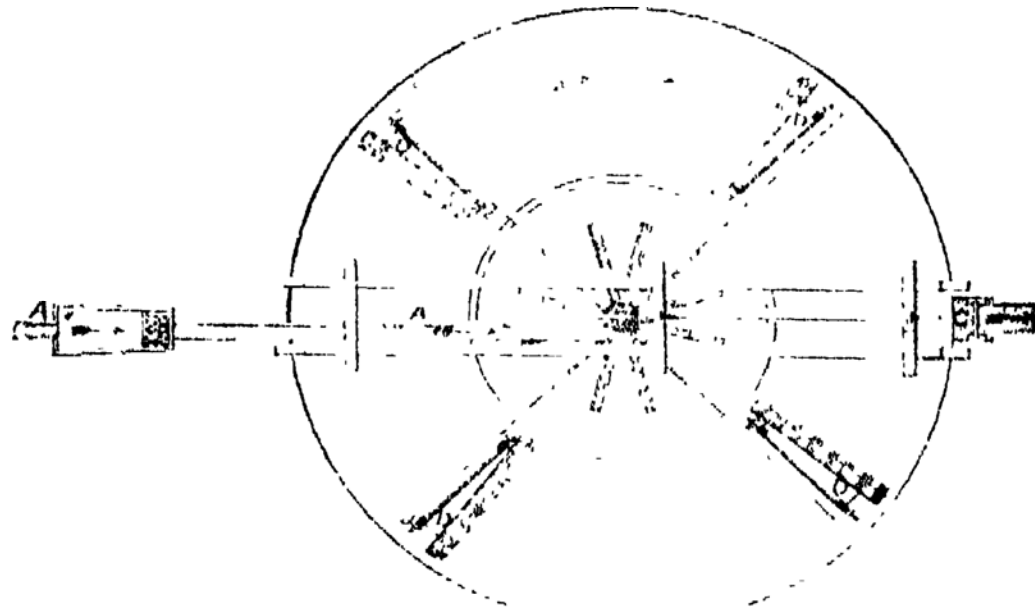


Fig. 104.

The concave buddle is a circular pit with the bottom sloping towards the centre. The stream of ore is fed all round the circumference, and runs inwards to the middle where the lightest particles escape. The rich head is formed near the circumference.

The keeve is a large tub in which the fine stuff is stirred with water and then is allowed to settle from a state of suspension while blows are being struck on the side of the tub. The deposit is afterwards scraped out in layers which increase in richness as they approach the bottom.

The series of processes employed in dressing an ore varies not only according to the nature of the particular mineral to be concentrated, but also according to the size of its particles and the nature of the other minerals with which it is associated.

With gold the reduction in size is usually effected by stone-breakers and stamps and much of the metal is then caught by mercury, whose vapour is concentrated with its accompanying pyrites by inclined tables covered with blankets, or by buddles, and the concentrate is treated by amalgamation or chlorination. See GOLD, vol. x. p. 746.

In the case of silver the ores are frequently pulverized by stamps, and the resultant *pulp* amalgamated in pans or barrels. The ore may also be concentrated by any of the various machines described, and delivered to the smelter. Many of the ores of silver are sent to the smelting works without any concentration by water, as this would cause serious loss.

Lead ore is generally crushed by rolls, often after a preliminary reduction in size by the stone-breaker. The crushed ore is classified by revolving screens down to the size of 1 mm., and the resulting grains concentrated by jigging (*dressing*, or grains of ore and matrix, must be crushed, sized, and jigged. The finer ores are classified by pyramidal boxes and concentrated by frames, rotating tables, and buddles.

Zinc ore is dressed in the same way as lead ores; and, as galena and zinc blende are frequently intimately associated together, it is necessary to separate them by the use of the jig, buddle, and frame.

[1] Henry T. Fergusou, "On the Mechanical Appliances Used for Dressing Tin and Copper Ores in Cornwall," *Proc. Inst. Mech. Engr.*, 1873 pl. 41.

Tin-bearing rock is crushed by the stone-breaker and then stamped fine. The resulting sand and slime may be concentrated by the repeated use of the round buddle, with the kieve for final cleaning; but often the sand only is enriched by the buddle, whilst the very finest particles, constituting an abnormal impalpable mud (*slime*) when mixed with water are treated by frame. When much pyrites is present it is necessary to make a preliminary concentration and roast the enriched product (*calf*) in a furnace. The roasting converts the heavy iron and arsenical pyrites into a light oxide which can be got rid of with the rest of the waste by buddling and framing. The final product from the kieve is clean enough to approach pure tin-stone in the percentage of metal. Alluvial tin-ore is concentrated in *Cornish boxes*, and sometimes by jiggers, after a preliminary treatment in a *puddling machine* (Gould, of which presently). Here there are balls of clay which have to be broken up. When the alluvial ore occurs as a hard conglomerate (*growan*), it has to be stamped.

Copper ores are treated by crushing by rolls and sometimes stamps, sizing by trommels, and then jigging and buddling; but, as some of the ores are very friable and easily carried away by water, hand-picking is employed to a greater extent than with lead and tin ores, and the enrichment by water is not carried so far on account of the inevitable loss that would ensue. The amount of concentration depends upon the distance from the melting works, and the mine-owner has to calculate whether it is best to get a low price for a large quantity of ore, after paying the carriage, or a higher price for a smaller lot (*parcel*) when due allowance has been made for the cost of dressing and loss sustained in that process. Thus, for instance, in Cornwall, the ore containing copper (pyrites) is dressed so as to contain only from 5 to 8 or 9 per cent. of metal, because it can easily be conveyed to Swansea by sea, and because further reduction in bulk would cause greater loss in value than the saving of freight. The loss in dressing is very considerable. P. von Cottinger estimates it at from 30 to 50 per cent., and rubbish facts bear out his conclusion. Heaps of refuse from dressing floors are frequently worked over again with profit, and in the year 1881 no less than 909 tons of "black tin" (*i.e.* concentrated tin ore fit for the smelter), worth £35,283, were extracted from the muddy water allowed to flow away from the dressing floors of some of the principal Cornish tin mines.

The fall in air has been employed instead of the fall in water for underground purposes, and several ingenious air-jets have been contrived and worked upon the principle

[illegible] pound case magnetic attraction may be utilised. Magnetic iron ores separated in this way, and the magnetic product is [illegible] the non-magnetic cassiterite and chlorite, the specific gravity of which is so nearly that under concentration by water practicable. The roasting of the calf and the lode-tin is thus converted into magnetic oxide, which can be extracted by a magnetic separator, as above.

Before concluding the present part of the subject we will briefly enumerate the principal improvements that have been made in metal mining during the last quarter of a century. They are as follow: diamond drill for prospecting; machine drills for driving, sinking, and stoping; use of compressed air for winding underground, stronger explosives, especially the nitro-glycerin compounds dynamite and blasting gelatine, increased use of steel for various purposes; Blake's stone-breaker and continuous jiggers; extended application of hydraulic mining, larger employment of electricity both for blasting purposes and for signalling by telegraph and telephone. It may be reasonably hoped that ere long electricity will render increased services to the miner for lighting the workings and for the transmission of power.

14. *Recent Legislation affecting Mines in the United Kingdom.*[1] In England the person owning the surface of a freehold is *prima facie* entitled to all the minerals underneath, excepting in the case of mines of gold and silver, which belong to the crown. The crown, however, does not claim gold and silver extracted from the ores of the baser metals. The ownership of the minerals can be, and often is, severed from that of the surface, the latter being sold whilst the mineral rights are reserved by the original owner. Local customs, now regulated by Acts of Parliament, are still in force in Derbyshire (High Peak Mining Customs and Mineral Courts Act, 1851, 14 & 15 Vict. c. 94, and the Derbyshire Mining Customs and Mineral Courts Act, 1852, 15 & 16 Vict. c. 136) and in the Forest of Dean (1 & 2 Vict. c. 13, and 21 & 25 Vict. c. 40). The Stannaries Act (32 & 33 Vict. c. 19) regulates the commercial dealings of mining companies in Cornwall and Devon, and provides for their liquidation.

The working of mines in the United Kingdom is controlled by five Acts of Parliament, viz., "The Coal Mines Regulation Act, 1872" (35 & 36 Vict. c. 76), "The Metalliferous Mines Regulation Acts, 1872 and 1877" (35 & 36 Vict. c. 77, and 38 & 39 Vict. c. 39), "The Stratified Ironstone Mines (Gunpowder) Act, 1881" (44 & 45 Vict. c. 26), and "The Slate Mines (Gunpowder) Act, 1882" (45 Vict. c. 3). The last three Acts simply refer to the annual returns, and exemptions from certain restrictions concerning the use of gunpowder.

The Coal Mines Regulation Act applies to mines of coal, stratified ironstone, lead, and fire-clay. The Metalliferous Mines Regulation Act applies to all mines not included under the Coal Mines Act, and therefore controls not only workings for lead, tin, copper, and iron, commonly known as mines, but also the salt-mines, and underground quarries worked for stone, slate, or other earthy minerals. The principal provisions of the Coal Mines Regulation Act have been set forth at vol. vi. p. 78; those of the Metalliferous Mines Regulation Act are similar, but less strict, owing to the almost complete absence of fire-damp. One important difference is that the manager of a mine under the Metalliferous Act need not hold any certificate of competency or service.

Other Acts of Parliament are the "Explosives Act, 1875" (38 Vict. c. 17), regulating the manner in which explosives are stored; the "Elementary Education Acts, 1876 and 1880" (38 & 39 Vict. c. 79, and 43 & 44 Vict. c. 23), regulating the employment of children; the "Factory and Workshop Act, 1878" (41 Vict. c. 16), which applies to the dressing floors of mines under the Metalliferous Mines Regulation Act.

The statute of Elizabeth (43 Eliz. c. 2) which was passed for raising money for the relief of the poor mentions coal mines, but omits other mines; these have been made subject to poor rates by "The Rating Act, 1874" (37 & 38 Vict. c. 54). The "Employers' Liability Act, 1880" (43 & 44 Vict. c. 42), extends and regulates the liability of employers to make compensation for personal injuries suffered by workmen in their service. Finally, if, as sometimes happens, works are put up at a mine for roasting [illegible] ores with [illegible] salt in order to extract the metal by the wet way, the provisions of the "Alkali, &c., Works Regulation Act, 1881" (44 & 45 Vict. c. 37), must be attended to.

It is thus very evident that the laws affecting mines have received most important additions during the last few years.

15. *Accidents in Mines.* Mining is one of the occupations that may decidedly be called hazardous. This fact has been thoroughly impressed upon the public mind by explosions of fire-damp in collieries; but, though accidents of this kind are appalling, owing to the number of victims who perish at one time, fire-damp is by no means the worst enemy with which the miner has to contend. Falls of roof and sides, both in collieries and metal mines are far more fatal in their results. With the risks attending the collier's calling we need not deal, as statistics upon

[1] For information concerning the laws relating to mines in the United Kingdom, see W. Bainbridge, *A Treatise on the Law of Mines and Minerals*, 1878, and Arundel Rogers, *The Law relating to Mines, Minerals, and Quarries in Great Britain and Ireland, with a Summary of the Laws of Foreign States*, 1876.

bject have been already given (see COAL, vol. vi. ; but the figures below relating to metalliferous mines prove that the occupation of the metal mi very little less dangerous.

Mines classed under the Metalliferous Mines Regulation Act in Great Britain and Ireland.

	Employed.			Number of Deaths from Accidents.				Death-rate from Accidents per 1000 persons employed.	
				Under Ground.					
	Under Ground.	Above Ground.	Total	Falls of Ground	In Shafts	Miscellaneous	Total	Above Ground	Under Ground and Above Ground
1874	31,036	23,325	54,361		4	15	19	10·5	1·85
1875	34,903	25,165	60,068				19	11·9	2·05
1876	34,109	23,258	57,367		16	24		1·85 0·75	1·21
1877	34,095	25,300	59,395		21	24		2·59 0·47	1·63
1878	30,624	20,834	51,458		19	25			1·49
1879	28,265	18,295	46,560		16	15			1·06
1880	32,045	20,617	52,662		21	29			1·53
1881	33,291	21,651	54,942						1·80
1882	33,811	21,649	55,460						1·63

tlavera, nine ye

able I shows that the average accidental mortal employed *underground* in metalliferous mines is During the ten years 1873-82 the coal-producing mines under the Coal Mines Act was 2·95, the e of only 0·20 per 1000 in favour of the metal mi e take the well-known metalliferous district of C on we find a death-rate for the heavy department of 1000, which therefore exceeds that of coal-mine nce to the table shows that more than one-third of t were caused by falls of ground. The other percentage of hs are as follows:—fall of ground in coal-mines 29·7, neons 25·1, on surface 13·1. The accidents to shaft-m all from ladders, cages, and men-engine rods and chains g, overwinding, and other causes, while the miscellaneous s include numerous fatalities connected with hoisting ns. The surface accidents are mostly caused by persons g entangled in machinery, and there have been several fatal xplosions.

te, however, of all the dangers to which miners are exposed, less likely to be the victims of accident than railway ser mong whom the rate of fatal accident varies from 1·5 per passenger traffic lines to 3·5 per 1000 on line-present me goods traffic.

ries concerning accidents in mines are published by many countries; the most minute are those prepared by the nent mining engineers in Prussia. The average annual tes per 1000 persons employed below ground and above from accidents in mines in Prussia during the fifteen years 1881 have been:—coal mines 2·952, lignite mines 1·174, mines 1·446, other mines 1·693, all the mines together 2·176. ing any comparison between the figures and those we have r Great Britain, it is necessary to recollect that the mines he Coal Mines Act include some workings which in Prussia e classed as metalliferous, and that British mines under alliferous Act include underground stone-quarries.

e concluding the subject of accidents, it is necessary to t that successful efforts have been made of late years to their results. In the first place, persons equipped with ss breathing apparatus can now enter mines after explosions, of the noxious and irrespirable gases, and save lives which otherwise be sacrificed.[1] Secondly, by means of the instruc- forded by classes established by the St John Ambulance tion, miners are learning how best to render first aid to the before the arrival of a medical man, and there is no doubt ny valuable lives have been lost in times past for want of owledge. Thirdly, a vast amount of good has been done establishment of Miners' Permanent Relief societies in t districts, which afford aid to persons disabled by accidents the dependent relatives of those who have unfortunately ir lives by any mining fatality.

Useful Minerals produced in Various Parts of the Globe

Britain and Ireland. The mineral produce of the United m for the year 1881 is summed by Mr Robert Hunt[2] as :

	Value.
Gold	
Silver from ore	
Silver from lead	6
Pig-iron	9,261
Tin	859
Copper	
Lead	
Zinc	
Other metals (est	1
Total value of me	42,041

The total valu of metal obtained from th and other mineral it of Kingdom in 1881

Coal	
Metallic ore	42,041
Miscellaneous	881
	690,60

From these tables it is evident that coal and iron are by most important mineral products of the United Kingdo per cent. of to the value of these two substance

From The year tons of France[3] for the year of 1880 in the

	Metric T	V
Mineral fuel	19,367	24,6
Peat	948	2
Asphaltic rock and bituminous shale	111	1
Iron ore	2,271	11
Iron pyrites and sulphur	1,[illegible]	2,1
Metallic ores	[illegible]	1
Rock salt	3,[illegible]	11
Lake salt	967	6,7
General total		290,7

[1] *Reports of H. M. Inspectors of Mines for the year* 1882, p. 1.

[2] *Rate of Fatal and Non-Fatal Accidents in and about Mines and Railways, with the Cost of Insurance against such Accidents*, James G. P. Neison, London, 1880.

[3] *Reports of H. M. Inspectors of Mines for the year* 1881. Mr Hunt's Report, p. 463.

[4] *Mineral Statistics of the United Kingdom* for 1881, p. ix.

[5] *Statistique de l'Industrie Minérale et des Appareils à Vapeur en France et en Algérie*, Année 1880. Paris, 1882, p. 45.

uantities of metal produced in France from native and
ores in 1880 were—

.....	1,725,0	Nickel.....	30 metric tons
.....	6,5	Gold	31 kilogrammes
.....	5 1	Silver.....	40,100 ,,
.....	10	Aluminium ...	1150 ,,

The industry of the German empire is of high importance. The output of the mines in 1881 is sho the following table,—taken from the *Stat. Jahrb. für das D Reich*, Berlin, 1883, p. 27. The production of common potassium chloride, and other salts from brine is also consid The total quantity for the German empire in 1881 was 6 metric tons, worth 33,567,000 marks, including 113,200 t potassium chloride valued at 14,090,000 marks.

Lignite	Rock Potash	Iron Ore	Zinc Ore	Lead Ore	Copper Ore	Silver and Gold Ore.	Iron Pyrites and other Vitriol and Alum Ores.	Other Mining Products.	Total of all Min Prod
	Unit 1000 Metric	Metric Tons		Unit 1000 Metric	Un 10 Me	Unit 1000 Metric	Unit 1000 Metric Tons.	Unit 1000 Metric Tons.	Un 10 Ma
							112 0	33·2	326
							1 1	1 6	5
							0 1	1 2	33
		19·5					0 1	...	
								0·0 3	
		1 3 8						0·6	1
								...	
								1·4	1
								18·0	1
								2 1	6
									6
									384
									1
	P			16 1					3 8

n-Hungarian Au the Austrian
n empire may be mentioned those
anza for gold and silver, Styria (iron ore
er is yielded by the mines of Idria in
those of Přibram in Bohemia, all
Alps and in Galicia, which also produ

roduction of minerals and met Austria during the
l was as follows

...	784 metric tons	Metallic		Rock formations
...	12383 ,,	,,	,,	,,
ore ...	48704 ,,	,,	,,	,,
...	1115 ,,	,,	,,	,,
	615963 ,,	,,	,,	,,
...	15512 ,,	,,	,,	Litharge, Metallic zinc

1 249
8 961,198
6,317 31·

of salt the value of the produce of the Austrian mine
14,693,692 florins. The total output of salt in 18
279 metric tons, valued at
0,198 florins.

ers in 1879 produced

Lignite (brown coal)	Iron
1880	Coal
Metric tons	Lead
1881	Lead

gnite or coal, the output in 1881 being no
n 10,8 metric tons, valued at 16 1 204,712 florins
ron ores it is largely dependent upon other
the grand duchy of Luxemburg, for supplie
The principal lead mines is that
the deposits in the neutral territory of Moresnet have
by the celebrated Vieille Montagne
, who also own some mines in Belgium, Germany,

ake Russia it is not surprising that
west of a great variety of mineral
the auriferous districts of the Ural
n 1880 yielded 115,940 troy lb of
sterling. Platinum is found associ-
all of the Urals, the output in 1880
0 troy lb. Zinc
ks worked in Poland. Import-

Statistique de la Belg ... *Travaux Publics en France et en*
Année 1880, Par
and statistics ...

50 tons
of the
and Hu

Statistik (Berlin)
1881, Berlin, Lief. 1,

Berg- und werksbetrieb Preussens im Jahre 1879," *Oesterreichische Zeitschrift für Berg- und Hüttenwesen*, 1881, p. 271.

ore derived from the Ural
tion. The metallic copper pr
nd the oil wells of Baku yie
o-ram. Russia also possesses
of iron ore, manganese, lead ores, silver, coal, and lignite. A li
ore is found in Finland.

Italy. The most important mineral in Italy[7] is sulphur, 3
tons (metric), worth 6,115,[illegible] lire, having been obtained i
and mainly from the tertiary rocks containing the native element
Miocene rocks of Sicily and Romagna.

lebrated iron mines of the island of Elba have been
from early times, and furnish a valuable ore, and the
of co ne, lead ore and silver ore in Sardinia form no sm
portt the mineral wealth of the Italian kingdom. T
and near the Val Anzasca (Piedmont) are producin
than 0 ounces of metal yearly.

Spain is justly celebrated for its mineral weal
more cupreous pyrite than any other country in the
amount of lead ore and quicksilver; and its i
and of excellent quality. The principal lea
vinces of Jaen (Andalusia) and Murcia, and f
pa al in Spain or from Spanish

Cinnabar, the heavy red ore of mercury, naturally attracte
ted at a very early date, and the world-renowned Almade
has been worked from time immemorial. The output in 1
1[illegible] tons metric of quicksilver.[9]

The cupreous pyrite often known as sulphur ore, is
from the province of Huelva, where vast deposits occur over
country nearly 100 miles long by 20 miles wide. The R
mines are the largest in the district, and are worked on a
cal. The company employs upwards of 10,000 hands,
per cent are engaged in all the Cleveland iron mines,
output is upwards of a million tons per annum. About one
of this, containing 3½ per cent of copper, is exported, manu
manufacture of sulphuric acid and subsequent treatment fo
and silver, while the remaining three-quarters, with 2½ to 2½
of copper, is treated on the spot. The ore contains rather
1 oz. of silver to the ton, and a few grains of gold. These are p
extracted from the burnt ore by Claudet's process, and som
the importance of the copper and silver will be gained by
to the following figures.[10] During the year 1881 there were
from cupreous pyrites imported into the United Kingdom
principally from Spain and Portugal, 14,000 tons of copper, 258
of silver, and 1490 oz. of gold. The total value of the si
gold was £64,195.

The total output of iron ore in 1880 was 3,565,338 metri
more than two-thirds, viz., 2,683,627 tons, being obtained
celebrated mines near Bilbao in the province of Biscay. I
France, Belgium, and Germany are all glad to draw sup

[illegible]

7 *Notizie statistiche sulla Industria Mineraria in Italia dal* 1860 *al* 18
1881, p. 406.

8 *Estadística Minera de España, correspondiente al año de* 1880, Ma
p.

9 Hunt, *Mineral Statistics*, &c., p. 4

10 *Estadística Minera*, &c., *ut supra*, p. 15.

ent red and brown hæmatite from the Bilbao mines. Murcia
next in importance to Biscay, with a production of 539,328

tugal.—The great mineral belt of Huelva extends into Portugal,
deposits of cupreous pyrites almost identical with that of
into have been wrought from very early ages. The principal
San Domingos, is close to the Spanish frontier. It is estimated
he workings had yielded up to the year 1877 no less than
,745 English tons of cupreous pyrites, by far the greater part
s having been extracted in recent times. The quantity of ore
from the mine in 1882 was 405,029 tons.
rtugal possesses notable manganese mines, but produces com-
ively small quantities of iron, lead, and copper.
way.—The mines at Kongsberg are famous for the large
ities of native silver they produce, and enormous masses are
imes met with. The annual output is from 10,000 to 12,000
ounces. Copper ore and cupreous pyrites are also found in
ay, and there are important workings for nickel and cobalt
or apatite. Alluvial gravels have been washed for gold in
egian Finland.
eden. The most important mineral obtained in Sweden is
re, much being in the form of magnetic and hæmatitic iron
ned, and brown hæmatite is dredged up from the bed of the Gul
rincipal iron-producing districts are those of Nordmark, Dann-
Nora, and Perseberg. The output of the Swedish mines in
was

e.
ie

ece.—One of the most interesting incident
has been the re-working of the Laurium
ed in the southern extremity of Attica, and
a by Cordella furnishes many curious detail
ds of mining, washing, and smelting employe
workings for lead and silver appear to have
the greatest vigour between 600 B.C. and the Christian
and were finally abandoned in the 1st century of the Christian
Huge piles of slag which had accumulated from the old
ing works were found to be well worth being re-worked for
and lead, and operations were commenced in 1864. Five
later the old heaps of mine refuse began to be treated, and at
n 1875 a French company resumed working the mine. A
company employing some 3000 persons is now producing
lly from the old mine heaps no less than 8000 to 9000 tons
lead, yielding 45 oz. of silver to the ton, whilst the mines of
mpagnie française des mines du Laurium made an output in
of 36,664 tons (metric) of roasted calamine, with 50 to 60 per
of zinc, in addition to lead ore and mixed ore. Cordella cal-
s that during the three hundred years the Laurium mines were
d by the ancients the total amount of lead produced was
,000 tons, with 22½ million troy oz. of silver. Besides this the
nts left behind two million tons of lead slag containing on an
ge 10·67 per cent. of lead, 109 million tons of mine refuse
½ to 18 per cent. of lead, and excavations to the extent of 51
n cubic yards with lead ore still in sight. They did not
the calamine deposits.[1] Next in importance to lead, silver
ine comes bay-salt, and after that emery. The island of
s furnished 3300 metric tons of emery in 1877, valued at
00.

rica.—Algeria is rich in iron, and three-fourths of the value
total mineral output are due to ores of that metal. In
the iron mines produced 614,000 metric tons of ore, Mokta
lid mine, near Bona, alone yielding about 300,000 tons.
a also possesses mines of copper, lead, zinc, and antimony.
e name "Gold Coast" applied to part of the shore of Africa,
es its productiveness of the precious metal, and it is probable
very important supplies of gold will one day be derived from
ns districts of the Dark Continent.
pe Colony possesses rich copper mines in the Namaqualand
on, which in 1882 produced ore and metal worth £331,546;
ver, the most valuable and remarkable mineral deposits of
a at the present time are the diamond mines. The first
onds were obtained from recent gravel in the bed of the Vaal
and it was afterwards discovered that the precious stones
be obtained from the so-called dry diggings. The most rich
nt of these, the Colesberg Kopje, now known as the Kimberley
produced in 1881 diamonds weighing 900,000 carats, worth
5,000. Three other neighbouring mines are Old De Beer's,
yielded 300,000 carats in 1881, worth £600,000, Du Toit's
and Bultfontein. The value of the diamonds raised in South
a since 1870 amounts to forty millions sterling,[2] and the
erley mine alone was estimated in 1877 to have already pro-
d ten million pounds worth of diamonds, extracted from 4
on tons of diamantiferous rock.

dia.—For many centuries India was regarded as p
fabulous mineral wealth, and a strong basis for this rep
found in the existence of traces of mining on a very exten
No doubt in early days India did supply what then appea
very large quantities of metals, and a country that produ
and precious stones is apt to be endowed by the popular m
boundless riches. The actual amounts of mineral raised
at the present day are comparatively small. Gold exists
siderable areas, but it remains to be proved that the gold
the Wynaad and Mysore can be profitably worked by Brit
prise. Diamonds occur and are worked in alluvial
and in a conglomerate belonging to the Vindhyan fo
Sapphires and rubies are obtained from Upper Burmah.
produced in 1883 no less than 10,286 tons of graphite of pl
value of £92,570. Petroleum is abundant in Upper Burm
oil from wells has been worked for upwards of twenty c
The total output in 1882 was estimated to be about 10,
yearly. Tin ores occur and are worked in Tenasserim. Pres
Siam and the Malay Peninsula we find deposits of alluvial
per, the produce of which is known in commerce as Straits tin. A
these are the Island of Banca and Billiton, which for ma
have been a source of wealth to the Dutch Government. T
of Banca tin in 1882 amounted to 13,670 tons, and that of Bil
to 4750 tons, whilst 11,670 tons of Straits tin were export
Perak and Singapore. Stanniferous alluvia are also wo
Karimon Sincang, and Sumatra, whilst the latter island p
also valuable coal.

Borneo furnishes coal, antimony ore, and some cinnabar
river-gravels are washed for diamonds, gold, and platinum.
There is no doubt that the mineral wealth of China is a
In addition to important coal-beds it possesses numerous
mines. The province of Yunnan in the south of the empi
to be specially favoured with regard to metalliferous wea
mines of gold, silver, copper, lead, tin, and iron are worke
whilst jade and precious stones are found in the beds of riv
Japan produces more than 3000 tons of copper yearly, or
much as the British Isles. The output of lead and tin is r
cent, but the quantity of silver exceeding 300,000 oz. y
worthy of notice. Gold, iron, and petroleum are other pro
Japan.
The gold of Siberia has been mentioned in speaking of R
Canada.—The Dominion of Canada is rich in minerals
bearing quartz veins are worked in Nova Scotia, whilst in
Columbia alluvial deposits are the main source of the
Silver occurs on Lake Superior, the most important mine be
of Silver Islet, which from 1868 to the spring of 1877 yi
million ounces of silver, and gave a profit of £200,000.
Rocks containing the copper-bearing strata of the Unite
territory are mined at Michipoten Island in Lake Superio
ores, in the form of mine refuse, red hæmatite, limonite, and
are worked in various parts of Canada.
Petroleum is derived from oil wells in Western Ontario,
quantity refined in 1875 was about 210,000 barrels, eac
gallons. It is in Ontario also that the veins of apatite ex
which a large amount of that mineral manure has been rai
United States.—The mineral wealth of the United S
admirably summed up by Mr Richard P. Rothwell in his
to the Year-book for 1883. Mining Re-

Metal, etc.		of 1881
Arsenic		1240 lb)
Bitumen	12 417	
	1444	
	10	

2 000 lb. = 1 ton of 763 lb. av
31 500 000 = 1 411 411 oz.
4 000 000 = 33 860 000 oz.)
27 264 000 barrels of 42 gall

of mineral and metals shows an equally
year to the production of precious stone
Cape to 900 tons, and in 1871 was 1 700
estimated to be less than 1 444 000 tons, an
year
1 000 tons in 1852, varied but little from t
coal into the argentiferous lead-mining
s, Nevada, Utah, and more recently Colo
raised the production from 18 000 tons
is in 1877, and 105 000 tons in 1881.
steel. Pig-iron from 1000 tons in 1
output of that manufactured from Calumet
notwithstanding the duplication of the b
de fluctuations due more to trade combina
s. In 1882 the out amounted to 29

[1] See the Report by the Secretary of State and other Papers relating to the Kimberley Diamond Fields from 1870 to 1876, London 1877, pp. 27.
[2] Hunt, *Mineral Statistics* for 1881, p. 2.
[3] *Engineering and Mining Journal*, vol. xxxi. p. 114.
[4] The total production of coal in the United States in 1882 amounted to 86,862,614 tons of 2240 lb. (*Colliery Guardian* for 1883, p. 771). The quantities of metals produced in 1882 are estimated to be pig-iron 4,623,327 gross tons of 2240 lb. each, lead 123,000 gross tons, copper 40,000 gross tons (*The Iron, Steel, and Allied Trades in 1882*, p. 188; *Iron and Min. Journ.*, vol. xxxv. p. 27).

[1] Cordella, "Mineralogisch geologische Reiseskizzen aus Griechenland," *Berg- und hüttenmännische Zeitung*, vol. xlii., 1883, p. 21.
[2] J. Macdonald, "The Value of the Cape as a Dependency of Great Britain," *The Times*, 3d May 1883.

vent as low as 10,000 flasks in 1878, and rose to 59,000 flasks five years
ton this fell to 14,000 flasks in 1875, though in the following year
to 75,000 flasks. Last year it produced 59,000 flasks.
ld is the only State whose silver production has been decreasing. In 1852
unted to $22,000,000 (gold), but with some fluctuations, it has now declined to
an $12,000,000 (silver).
e production of silver, on the contrary, has largely increased. Commence
1859 it
ocks
ly by about $1,000,000.
ic coast, that great American industry has grown with
commenced with only 5000 barrels and, after an
reached last year the enormous figures of 24,000,000
district has recently raised a note of warning in this
ore area of ore producing territory and its approaching

le details are concerning the production of the precious
the United States are contained in a report issued by the
Bureau. The output for the year ended 31st May last is
ed as follows:

...ona	1,013,974	21,444 2	31,716 97	$11,002,296	$67,581 18
	300,267	12,005 41	30,177	10,761	1,109,172
...ines	1,614,241	59,979 67	31,746 74	41,410,961	1,990,620

State producing the greatest value is Colorado, $12,
9,172, or gold 130,607 oz. and silver 12,800,119 oz., Cali-
come next, having produced $10,301,828 of bullion, and then
, with $47,318,909 of bullion.
greatest gold producer among the States and Territories is
na, with 829,676 oz. of gold, half from deep mines and half
placer. Next follows Nevada, with 230,168 oz. of gold, of
only about 1 per cent. came from placer mines; then Dakota,
oz. of gold, nearly entirely produced by deep mines, and in
urth rank Colorado, 130,607 oz., with a placer production of
an 5000 oz.
greatest silver producer is Colorado, with 12,800,119 oz.,
Nevada 9,614,561 oz., then Utah, 4,968,365 oz., Montana,
,838 oz.; and fifthly Arizona, 1,498,900 oz.
n the limits of this article to attempt to convey
quate idea of the enormous mineral resources of the United
We can merely very briefly allude to one of the principal
s, which are of commercial value on account of their magni-
scientific interest owing to their mode of occurrence, and of
al importance as having led to the introduction of consider-
improvements in the art of mining, smelting, and dressing
ong these may be mentioned the coal and anthracite mines
wells of Pennsylvania, the gold and quicksilver mines of
nia, the silver mine of Nevada, the lead and silver mines
rado, and the copper mines of Lake Superior. The articles
vol. xi. p. 69) and Gold (vol. x. p. 743) may be referred to
ormation concerning the occurrence of these metals and
thod of extracting gold by hydraulic mining and improved
ng machinery.
k occurs in the form of native mercury and cinnabar occurs in
rable abundance in California, and much of it is found in
ion with serpentine, either in the serpentine itself or in sand-
ar in connection with serpentine. The most important mines
e of New Almaden in the southern part of the State near
. The deposit at Sulphur Bank in Lake County is of much
est interest. It consists of native sulphur, gypsum, and
e in a decomposed andesitic lava close to an extinct geyser
ere hot sulphur water still issues. The top of the bank was
t worked for sulphur, and then for sulphur and cinnabar,
ent account mining is carried on in stratified sandstone
e copper mixed with cinnabar and underlying the lava
The most marvellous silver mines in the world are those
Comstock lode in Nevada. A horizontal section of part
t of which is shown on Plate IV., copied from the excellent
Mr J. D. Hague.[2] The strike is nearly
and north and south, the dip about 16° to the east. "The vein
of the Comstock consists of crushed and decomposed
rock, clay, and quartz." Up to January 1, 1880, the
ock had yielded in fifty years about $345,000,000 worth
ion. The total length of its drifts and galleries is about
The number of men employed in the mines in January
was 2800, earning an average of $4 a day. At the same
340 men were at work in the amalgamating mills.[3] The
f the Comstock lode is a true fissure vein. On the 2700 feet level
Yellow Jacket mine Mr Hague found the temperature of the
to be 104°, that of the water 96°. In the water in the Yellow
shaft at a depth of 3000 feet the temperature of 170° Fahr.[4]

During the last few years the Comstock lode has been fal
in productiveness. In 1876 the total yield of the Comstoc
was $or 572,981 (gold, $18,002,906, silver, $20,570,078).
the census year ending May 31 1880, the product of the
Comstock district, including outlying veins, was $6,922,330
$3,109,156; silver, $3,813,174), showing a decline of $31,65
or 82·06 per cent., since 1876.[5]

Though the extraction of silver from its ores may be re
as the business of the metallurgist rather than of the min
must not forget to mention that it is to the necessities of the
ment of the Nevada ores that we owe the system of pan ama
tion first developed in that State and practised since in Colo

Another district in Nevada which cannot be passed
silence is that which contains the Eureka and Richmond mines,
are celebrated, not only for the silver they have produced, b
for the important trial in which the issue hinged upon the
tion of the term vein or lode (p. 111). The bullion produced
Eureka district from ore raised and treated during the censu
ended May 31, 1880, was gold, 62,893 oz.; and silver, 2,0
oz., worth altogether $3,934,621.[6]

The history of Leadville in Colorado seems like a romance
we read of the rapid development of the mines, the creatio
large and important town, the erection of smelting works a
building of railways, under very adverse conditions, in the h
the Rocky Mountains, all within the space of four or five yea
affords additional proof that the miner is the true pion
civilization. The main facts concerning the Leadville depos
admirably summed up by Mr S. F. Emmons, from whose r
we borrow, not only the following facts, but also the geo
section across the district (Plate IV.).

The principal deposits of the region are found at or ne
junction of the porphyry with the Blue limestone, which
lowest member of the Carboniferous formation. This bed is
150 or 200 feet thick, and consists of dark blue dolomitic lime
At the top there are concretions of black chert. The por
occurs in intrusive sheets which generally follow the beddin
almost invariably a white porphyry is found overlying the
limestone. This porphyry is of Secondary age; it is a white
gneous-looking rock, composed of quartz and felspar o
granular texture, in which the porphyritic ingredients, wh
accidental rather than essential, are small rectangular crys
white felspar, occasional double pyramids of quartz, and fresh
gonal plates of biotite or black mica. Along the plane of c
with the porphyry the limestone has been transformed, by a
of gradual replacement, into a vein consisting of argent
galena, cerussite, and enargyrite mixed with the hydrous ox
iron and manganese, chert, granular cavernous quartz, clay,
spar, and "Chinese tale," a silicate and sulphate of alumina.
vein seems to have been formed by aqueous solutions, whic
up their contents from the neighbouring eruptive rocks and b
about the alteration of the limestone as they percolated down
through it. In Carbonate Hill, a gradual passage may be ob
from dolomite into earthy oxides of iron and manganese. The
of workable ore are extremely irregular in shape, size, and di
tion. They are often 30 to 40 feet thick vertically, and occasi
80 feet, but only over a small area. The rich ore bodies are co
est in the upper part of the ore bearing stratum. At Fry
the blue limestone is almost entirely replaced by vein mater

In the census year ended May 31, 1880, Lake County, Col
which includes the Leadville district, produced 28,226 gross
lead with 28·30 oz. of gold and 8,853,946 oz. of silver, of
value of $15,032,464.[8]

The most important copper mines of the United States are
on Lake Superior, where the native metal occurs "in veins, i
masses, or scattered more or less uniformly in certain beds
are either amygdaloid or conglomerates."[9] The principal c
producing districts are in Michigan, where the Portage Lak
trict in Houghton county, contains the famous Calumet and
mine, which alone produced 15,857 tons of copper in 1880, or
half the entire output of the United States. The deposit
whence this vast amount of copper was obtained is a bed o
conglomerate generally called a vein, dipping about 38° north
It has been worked for a depth of 2750 feet on the inclin
and the rock stamped yielded 1½ per cent. of copper.

In conclusion, we will point out that the value of the m
industry in the United States exceeds that of any other coun
the world, Mr Porter estimating it for 1879–1880 at 360 m
dollars, and that of Great Britain at 325 millions.[10] Germany

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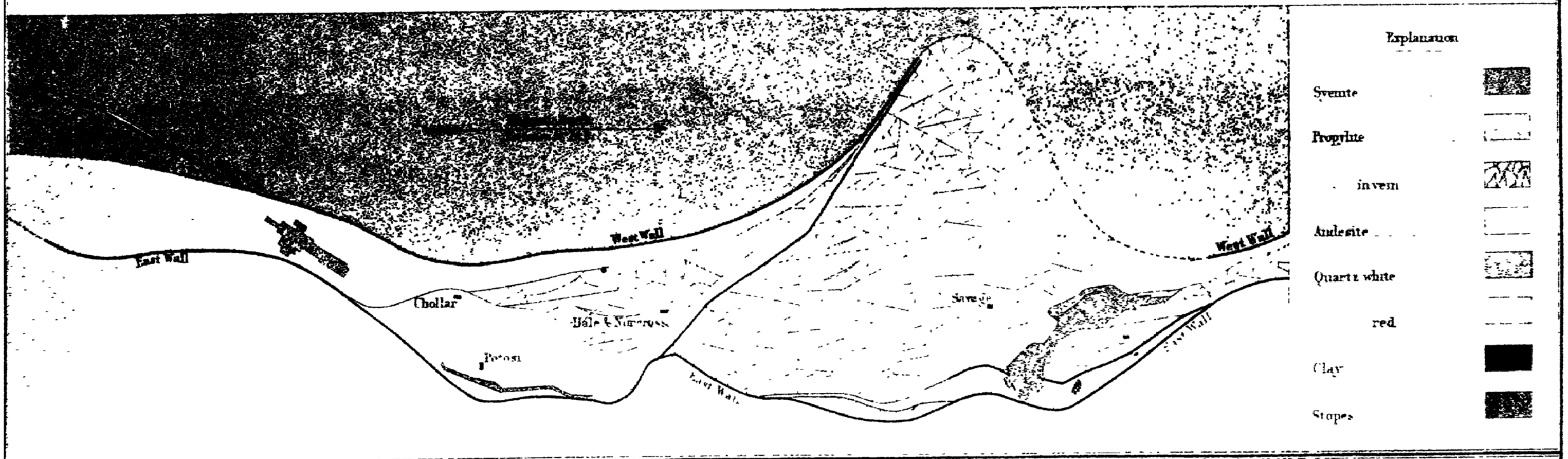
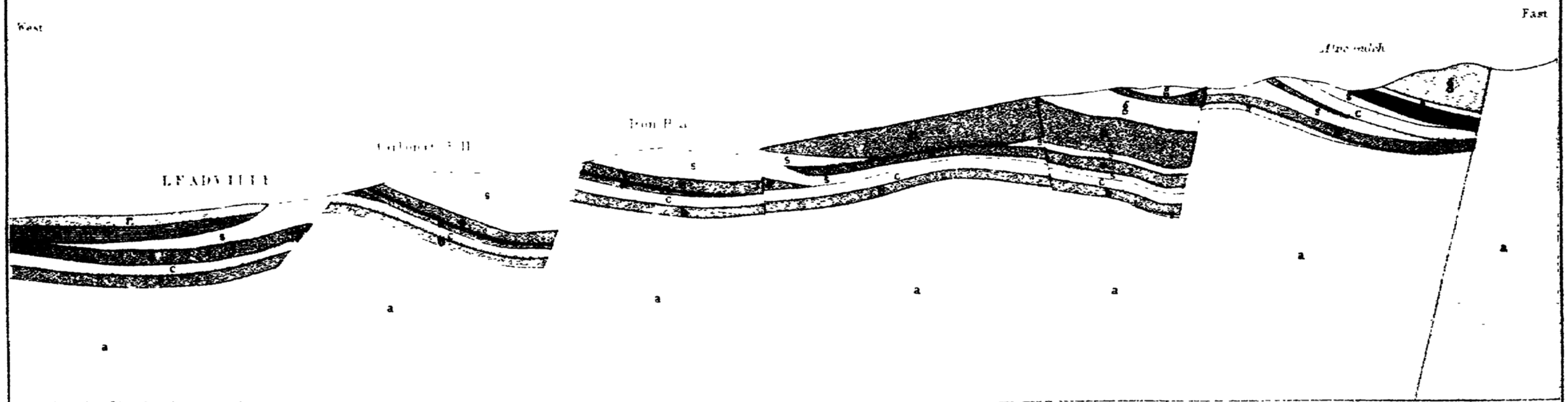
[2] Clarence King, *Statistics and Technology of the Production of the Precious Metals in the United States*, Washington, 1st paper.
[3] *United States Geological Exploration of the Fortieth Parallel*, vol. iii. Mining Statistics, plate II.
[4] Clarence King, *First Annual Report of the U.S. Geological Survey*, p. 39.
[5] *Op. cit.*, pp. 41–42.
[6] Clarence King, *Statistics and Technology of the Production of the Precious Metals in the United States*, Washington, 1884, p. 19.
[7] *Op. cit.*, p. 21.
[8] *Abstract of a Report upon the Geology and Mining Industry of Leadville, Colorado*, Washington, 1882.
[9] Clarence King, *op. cit.*, p. 17.
[10] Charles L. Wright, commissioner, *Annual Report of the Commissioner of Mineral Statistics for the State of Michigan for* 1880, Lansing, Michigan, 1881.
[11] Robert P. Porter, *The West from the Census of* 1880, Chicago and New York, 1882, p. 19.

Scale 400 feet to 1 inch



EAST AND WEST SECTION ACROSS PART OF THE LEADVILLE MINING DISTRICT.

Horizontal & Vertical Scal



CARBONIFEROUS
SILURIAN
CAMBRIAN
ARCHAEAN
IGNEOUS

l rank, followed by France and Russia. The United States 33 per cent [1] of the gold yield of the whole world, 50 per the silver, 22 per cent. of the pig iron,[2] 29 per cent. of the d about 25 per cent. of the lead

o has been renowned for its gold and silver mines ever since nards first took possession of it, and its production is still siderable. Indeed, after the United States, it still produces silver than any other country in the world. The average output of silver during the twenty five years 1851 to 1875 ated by Dr Adolf Soetbeer at 501,520 kilogrammes or 235 oz ;[3] whilst the average annual output of gold during e period was 1785 kilogrammes, or 57,389 oz Tin ore n considerable quantities in Mexico, and is likely to be on a large scale as soon as the tin district is opened up by y.

l America possesses numerous gold mine

America.—Venezuela produces gold, copper, and a little The copper is found at Aroa near the north coast and the the province of Guiana, which is now producing upwards of oz. annually. It is highly probable that the existence of l was known to the Indians, who reported it to Sir Walter , and so led him to undertake his unfortunate expedition in f "El Dorado." French Guiana contains workable deposits and yielded 72,168 oz. in 1880.

ham of the Andes forms a long belt of mineral-producing . Beginning with the United States of Colombia we have ry rich in gold,—the State of Antiquoia being especially l in this respect. The annual yield of all the States is about oz. Colombia has mines of rock salt, yielding 12,000 tons and the emerald mine at Muzo has long been famous. Peru ned for its silver mines, the best known are those of Cerro , situated at an elevation of 14,000 feet above the sea-level into Bolivia, we must notice the silver mines of Potosi, lth of which is proverbial Chili is best known as the l copper-producing country of South America but its silver re not unimportant, and beds of nitrate of soda are largely h.

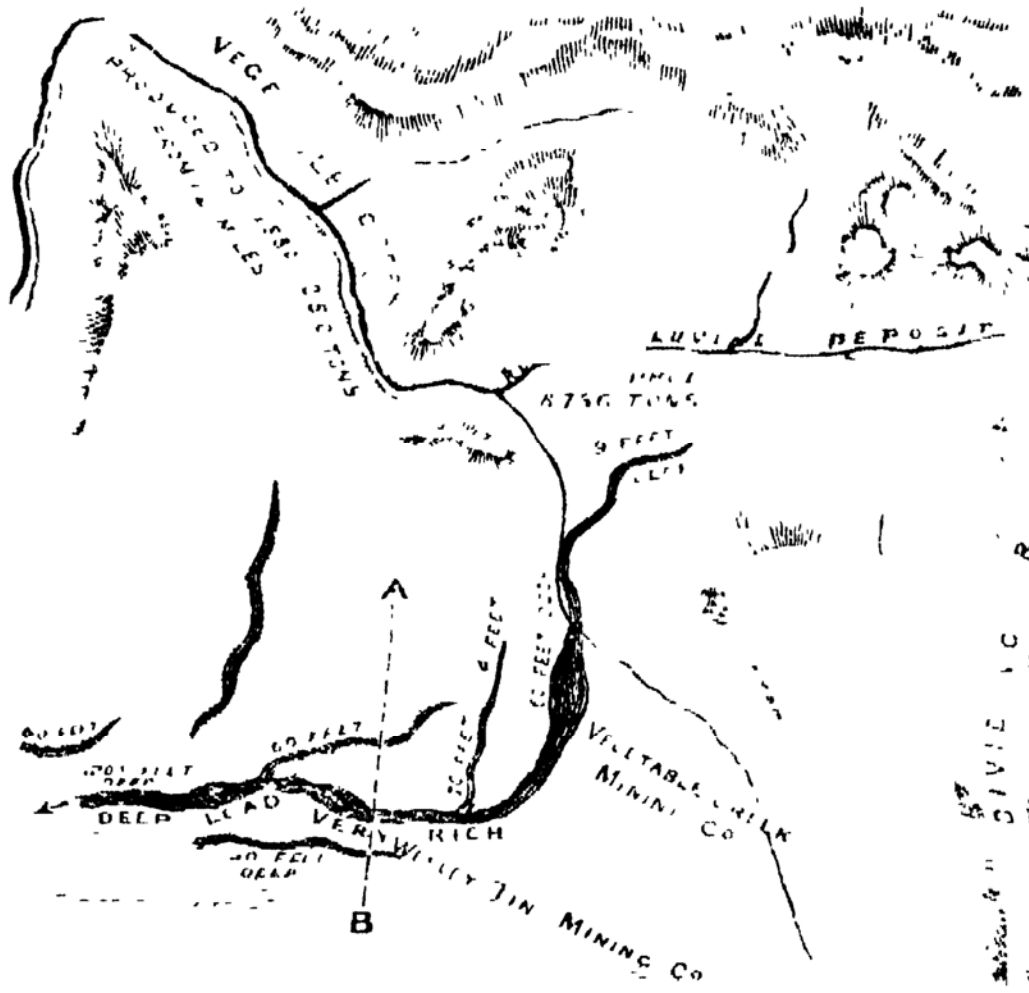
most remarkable gold mines of Brazil lie in the province of Geraes, whilst diamonds are obtained in that of Matto In the Argentine Republic gold, silver, and copper mine ked, especially in the provinces on the eastern flanks of the

otal annual output of the precious metals in South America ated to be upwards of 300,000 oz. of gold, and 2,000,000 oz. r. In 1877 Chili exported 35,198 metric tons of metallic in addition to ore and regulus

alia.—Australia is remarkably rich in minerals, especially e Gold, vol. x. p. 744), tin, and copper, and its coal depo-its ly to be largely utilized in the future.

nsland, though a young colony, has already made itself for gold and tin, and it also possesses vast resources of coal pper, in addition to the ores of other metals. The quantity sent by escort from the different gold fields was 204,388 oz. , in addition to what was carried by private hands. Tin ore t worked in 1872 near the border of the colony with New Wales, and large quantities of stream tin have been obtained ery shallow alluvial diggings near Stanthorpe. Lake gold, the tin ore is not confined to one district; it occurs and is w at the North Palmer diggings; a little to the south is Western, rich in tin ore, and so is Herberton to the north-e the other side of the Dividing range.

In 1881 New South Wales[4] produced minerals and metals £2,373,191, viz., 149,627 oz. of gold, 1,775,221 tons of coal tons of tin, 5193 tons of copper, 6560 tons of iron, besides oil-shale, and antimony. In addition to the facts concern occurrence of gold already mentioned (*loc. cit.*), it is interest note that auriferous conglomerates containing the precious m payable quantities have been discovered and worked in this in rocks of the age of the Coal Measures.[5] The most import district is that of Vegetable Creek in New England, whic 1872 to 1880 produced 20,988 tons of tin ore The accompa map (fig. 105[6]) shows the recent alluvium which has hitherto



Mile 1 0 1

FIG. 105.—Sketch Map of Part of Vegetable Creek, New South showing recent and ancient tin deposits. The stippled p presents tin bearing alluvium. The shaded part AB basalt which has covered the lower portion of the ancie bearing alluvia (deep lead), as explained in fig. 106. The granite.

FIG. 106.—Enlarged Section (on AB of fig. 105) across Deep Lead in Vegetable Creek, New South Wales.

vol. x. p. 743), are old alluvia preserved under a capping of lava. There are also numerous tin lodes which are begin to be worked.

oria heads the list of gold-producing British colonies, having in 1882[7] as much as 861,610 oz., of which 352,078 oz. were l from alluvial deposits, and 512,532 oz. from quartz mines ons of tin ore were raised and 375 tons of antimony ore h Australia is the great copper producing province, though ld is not so great as it was ten years ago. The principal mines now at work are on Yorke's Peninsula. In 1881 Australia produced 6524 tons of copper, worth £263,370, and tons of copper ore, worth £151,926.

In 1881 Western Australia exported 1400 tons of lead ore at £11,201.

Tasmania, the smallest of Australia, is rich in tin ore is now obtained principally from an alluvial deposit at Br-choff. The ore is now almost entirely smelted in the colo in 1880 the exports were 3951 tons of metal and 3 tons of ore altogether £411,256.

New Zealand furnishes a considerable amount of gold from reef- and alluvial digging. The annual export during years 1862 to 1872 were often 600,000 and even 700,000 oz. year the yield has gradually diminished, and in 1880 only oz., valued at £1,220,263, were exported. Silver is exporte

[1] Clarence King, *op. cit.*, p. 93.
[2] James M. Swank, *Statistics of the Iron and Steel Productions of the United* Washington, 1881, p. 179.
[3] Adolf Soetbeer, *Edelmetall-Produktion*, Gotha, 1879, p. 60.
[4] *Annual Report of the Department of Mines, New South Wales, for the year* elbourne, 1882, p. 8.
[5] *Annual Report of the Department of Mines, New South Wales, for the year* dney, 1877, p. 173.
[6] Furnished by Mr W. H. Wesley.
[7] *General Statistics of Victoria for the year* 1882, Melbourne, 1883, p. 7.

[8] *Statistical Register of the Province of South Australia for the* Adelaide, 1880.

of 20,000 to 30,000 c annually, it is mainly derived from l obtained in the Thames district, which contains about 30 t. of the le valuable metal. Coal is worked in several but the total output is at present comparatively small.

Caledonia The discovery of nickel ore in this island by mer in 1 was one of great mineralogical interest, and it e home from of considerable commercial importance. The de ore ne hydrous silicate of nickel and magnesium, ur in veins in serpentine, and contain from 7 to 18 per cent of Ni. The material is found on the Mont d'Or not far Most of the ore is sent to France to be treated.

To the list of works on mining mentioned in the article Coal (vol the following may be added Callon, *Cours d'exploitation des Mi* 1874, and English translation by C. Le Neve Foster and W. Gallow *Leitfaden zur Bergbaukunde* Berlin, 1878; Zoppetti, *Arte minerar* 1882; A. von Groddeck, *Die Lehre von den Lagerstätten der Erze*, Lei P. von Rittinger, *Lehrbuch der Aufbereitungskunde*, Berlin, 1867; *Jah das Berg- und Hüttenwesen in Königreiche Sachsen*, Freiberg, annually *Reports of H.M. Inspectors of Mines*; *Preliminary Report of Her in Mines*, Lond *Annales des Mines*, Paris, 6 parts published yearly; *The Engineering a Journal*, New York, published weekly; *Transactions of the American I Mining Engineers*, Philadelphia; *Die Berg- und hüttenmännische Zeitun* weekly; *Oesterreichische Zeitschrift für Berg- und Hüttenwesen*, weekly. (C. I

ISTRY. Ever since the introduction of monarchical tion into England the sovereign has always been vided by a select body of confidential advisers to he crown in the government of the country. At ol could a king of England act, according to law, t advice in the public concern of the kingdom, stitution of the crown of England and the meth of the privy council are coeval. At the era of rman Conquest the Long council, or as it is now the privy council, was composed of certain chief n, of the aristocracy and great officers of state, y summoned by the crown, with whom the sove natually advised in matters of state and government. e earlier stages of English constitutional history ng's councillors, as confidential servants of the h, were present at every meeting of parliament in to advise upon matters judicial in the House of but in the reign of Richard II. the privy coun solved its judicial connexion with the peers and l an independent jurisdiction of its own. It was reign of Henry VI. that the king's council first l the name of privy council, and it was also during nority of this sovereign that a select council was ly emerging from out of the larger body of the ouncil, which ultimately resulted in the institution modern cabinet. Since the Revolution of 1688, and elopment of the system of parliamentary govern- the privy council has dwindled into comparative ficance when contrasted with its original authority sition. The power once swayed by the privy council exercised by that unrecognized select committee of uncil which we call the cabinet. The practice of ing a few confidential advisers instead of the whole ouncil had been resorted to by English monarchs very early period, but the first mention of the term council in contradistinction to privy council occurs ign of Charles I., when the burden of state affairs usted to the committee of state which Clarendon s anxiously called the "cabinet council." At first nent by cabinet was as unpopular as it was irregular he formation of the first parliamentary ministry by s III. the ministers of the king occupied no ted position in the House of Commons; it was a moot point whether they were entitled to sit at the lower chamber, and they were seldom of one in the administration of matters of importance. the Revolution of 1688 there were ministers, but istry in the modern sense of the word; colleague d again to cohere in the council chamber, and it uncommon thing to see minister opposing one in parliament upon measure that ought to have upported by a united cabinet. As the exchange overnment by prerogative to government by parlia- onsequent upon the Revolution of 1688, developed, House of Commons became more and more the and force of the state, the advantage of having rs in the legislature to explain and defend the es and policy of the executive Government began gradually to be appreciated. The public authority crown being only exercised in acts of administration other word, through the medium of ministers, it absolutely necessary that the advisers of the sov who were responsible for every public act of the cr well as for the general policy they had been called administer, should have seats in both Houses of Parli The presence of ministers in the legislature was the consequence of the substitution of government by ment for the order of things that had existed before Still nearly a century had to elapse before unanimity in the cabinet was recognized as a maxim. From the first parliamentary ministry of W III. until the rise of the second Pitt divisions in the were constantly occurring, and a prime minister ha to fear from the intrigues of his own colleagues tha the tactics of the opposition. In 1812 an attem made to form a ministry consisting of men of political principles, who were invited to accept offi avowedly as a coalition Government, but with an the Whig leaders that their friends should be all majority of one in the cabinet. This offer was d on the plea that to construct a cabinet on "a sys counteraction was inconsistent with the prosecution uniform and beneficial course of policy." From tha it has been an established principle that all cabinets be formed on some basis of political union agreed u the members composing the same when they accep together. It is now also distinctly understood th members of a cabinet are jointly and severally resp for each other's acts, and that any attempt to se between a particular minister and his colleagues i matters is unfair and unconstitutional.

The leading members of an administration constitu CABINET (*q.v.*) The members of an administratio are sworn of the council, but who are not cabinet ters, are the lord-lieutenant of Ireland, the vice-pr of the council for education, the judge advocate g and the chief officers of the royal household. Th ordinate members of an administration who are ne the cabinet, and who are seldom raised to the distinc privy councillors, are the junior lords of the treasu joint secretaries to the treasury, the paymaster gener junior lords of the admiralty, the parliamentary secretaries of state, and the law officers of the crown.

During the present century the power of ministe been greatly extended, and their duties more dis marked out. Owing to the development of the sys parliamentary government, much of the authority formerly belonged to English sovereigns has been del to the hands of responsible ministers. As now interp the leading principles of the British constitution a personal irresponsibility of the sovereign, the respons of ministers, and the inquisitorial power of parliamen the head of affairs is the prime minister, and the diff between theory and practice is curiously exemplif the post he fills. The office is full of anomalies. Li cabinet council the prime minister is unknown to

e constitution, for legally and according to the of the constitution no one privy councillor has as ny superiority over another, yet practically the r is the pivot on which the whole administration He is the medium of intercourse between the and the sovereign; he has to be cognizant of tters of real importance that take place in the t departments so as to exercise a controlling e in the cabinet; he is virtually responsible for sposal of the entire patronage of the crown; he his colleagues, and by his resignation of office s the ministry. Yet, though entrusted with this and wielding an almost absolute authority, he ecory but the equal of the colleagues he appoints ose opposition he can silence by the threat of dis olu The prime minister is nominated by the sovereign ered,' said Sir Robert Peel on his resignation of no opinion as to the choice of a successor That ost the only act which is the personal act of the gn; it is for the sovereign to determine in whom nfidence shall be placed.' Yet this selection by the is practically limited. No prime minister could n the government of the country for any length of no did not possess the confidence of the House of ons; and royal favour, if it were ever unadvisedly d, would ultimately have to yield to a regard for olic interests. As a general rule the prime minister he office of first lord of the treasury, either alone or nexion with that of chancellor of the exchequer. 1806 the premiership was occasionally held in ion with different other offices, a secretaryship of he privy seal, and the like, but it is now almost bly associated with the post of first lord of the y. With the exception of the premier, who e duties re general than departmental, the work of the other rs of the administration is exemplified by the title offices to which they are called. The lord chancellor, ition to the jurisdiction which he exercises in his l capacity, is prolocutor of the House of Lords by ption, the keeper of the sovereign's conscience, the l guardian of all infants, idiots, and lunatics, and to elongs the appointment of all the justices of the hroughout the kingdom. In former times the lord llor was frequently prime minister, the earl of don in the reign of Charles II., however, was the ho occupied that position. The lord president of ncil, who is always a member of the Upper House, es over the department of the privy council, exercises ral superintendence over the education department, s to frame minutes of council upon subjects which belong to any other department of state. Subte to his department are separate establishments in n to public health, the cattle plague and quarantine ost of lord privy seal is one of great trust, though ies are not very onerous, since they simply comit lying the privy seal once or twice a week to a r of patents. Ever since the days of Henry VIII. ivy seal has been the warrant of the legality of from the crown and the authority of the lord llor for affixing the great seal. The lord privy seal ays a member of the cabinet. As his official duties ght he is at liberty to afford assistance to the istration in other ways, and he has often to attend tters which require the investigation of a member Government.

secretaries of state are among the most important members ministry, and within the present century their number has creased and their duties more specially consolidated. The English monarchs were always attended by a learned ecclesi nown at first as their clerk, and afterwards as secretary nducted the royal correspondence; but it was not until the end of the reign of Queen Elizabeth that these functionari called secretaries of state. Upon the direction of public passing from the privy council to the cabinet after 1688, th taries of state began to assume those high duties which now their office one of the most influential of an administration. the reign of Henry VIII. there was generally only one secr state, but at the end of his reign a second principal secret appointed. Owing to the increase of business consequent u union of Scotland, a third secretary, in 1708, was created vacancy occurring in the office in 1746 the third secretaryship dispensed with until 1768, when it was again instituted charge of the increasing colonial business. However, in 1 office was soon abolished, and the charge of the colonies ferred to the home secretary; but owing to the war with F 1794 a third secretary was once more appointed to superint business of the war department, and seven years later the business was attached to that department. In lieu of a fourt tary of state for the exclusive charge of the war department 1858 a fifth secretaryship for India were created. There a four now five principal secretaries of state, four of whom, wi political under secretaries, as they sit in the House of Co One of these secretaries of state is always a member of the H Lord. The secretaries of state are the only authorized c through which the royal pleasure is signified to any part body politic, and the countersignature of one of them is ne to give validity to the instruments thus, while the p immunity of the sovereign, correlative responsible advice t acts provided who is to answer for whatever course the his pursued. The secretaries of state constitute but one of are coordinate in rank and equal in authority. Each is co in general to execute any part of the duties of the secretary the division of duties being a mere matter of arrangement duties are of the deepest importance to the welfare of the The home secretary controls all matters relating to the affairs of the country. He is responsible for the preservation public peace and for the security of life and property thr the kingdom, he exercises extensive powers over the c military authorities of the country, and has a direct con power over the administration of justice and police in the m boroughs, over the police in and around London, and o county constabulary, and he is especially responsible for t exercise of the royal prerogative in the reprieve or pardon of offenders or the commutation of their sentence. The foreig secretary, as his name implies, is the official organ of the crow communication between Great Britain and foreign pow negotiates all treaties or alliances with foreign states, British subjects resident abroad on demand afford protection requires, they may, in case of the failure of ordinary means of enforcement. The s of state for the colonies has to superintend the government various colonial possessions of the British crown, to appo governor over the different dependencies of the crown, an tion or disallows the enactments of the colonial legislatures latter powers by of late years been much curtailed owing establishment of responsible government in most of the c still it is the duty of the secretary of the colonies to secure pe the colonial governments and to offer such instructions as expedient to assist the deliberations of the colonial council promote the welfare of colonial subjects. Until the year direction of military affairs was practically divided betw commander-in-chief at the head of the board of ordna secretary at war, and the secretary of state for war and the Upon the declaration of hostilities between Russia the duties of war minister were separated from those of s secretary, and a secretary of state for war appointed, in who the supreme and responsible authority over the whole business of the country connected therewith is vested by the various orders in council are placed. By orders of the commander-in-chief subject to the approval of the secretary of state for war. The the commander-in-chief exercises command, discipline and p army and the direct superintendence of the *personnel* of th with the exception of those duties everything connected w improvement of the army in peace or war its *matériel* admiralty, the business of which is transacted by the board of the war minist subordinate powers of the commander-in-chief, the secretary British secretaries of state in many instances. The secretary for war is responsible for the crown and not of parliament a is responsible to parliament for the advice he may give sovereign, or act for in the execution of the royal autho prerogative that he is superior to the officer commanding The principle of the constitutional army act that enlistment and honour come to it from the crown but be gone expense equally unquestioned that for all pecuniary purpose is liable to depend on parliament. By the constitution th exercises its authority only through responsible advisers, a it follows that the secretary of state for war is supreme authority in the army, including the officer commanding From 1784 to 1858 the territories belonging to the British

Indies were governed by a department of state called the control in conjunction with the court of directors of the dia Company. In 1858 this double government was d, and the entire administration of the British empire in as assumed by the crown, and all the powers formerly exer- the East India Company and the board of control were ed to a single principal secretary of state. The secretary for is responsible for everything connected with the Indian ment at home and abroad, the whole of the Indian revenues , and the governor-general of India is subject to ion from him in his capacity, not to act a check upon of his otherwise arbitrary administrative powers, this by the aid of a council of state for India, consisting of en, of which however, but the president. The members ncil for India cannot sit in the House of Commons. ature of the other members of the ministry can be briefly . The chancellor of the exchequer at present exercises all s which formerly devolved upon the treasury board; he entire control of all matters relating to the receipt and ment of public money. He frames the annual estimate of the quired to defray the expenditure of government in every of the public service; and it is his duty to lay before the the annual statement of the estimated expenses of govern- of the way and means by which it is proposed to defray harges, including the imposition or remission of taxes. The of the admiralty (since the abolition of the office of lord ral), with the aid of the naval lords who are called the the admiralty, conducts the administration of the entire ce of the empire both at home and abroad, and is re- parliament for all its political proceedings. The admiralty executive board, it is however, subject on certain matters mber of men required for the naval service, the distribution et, the strength of foreign squadrons, &c., to the control binet. The president of the board of trade takes cognizance atters relating to trade and commerce, and has to protect mmercial interests of the United Kingdom; until 1864 it was ssary for the president to have a seat in the cabinet, but date he has always been a cabinet minister in order to his advice on commercial matters a due consideration, in office of vice-president of the board was abolished. The or of the duchy of Lancaster exercises jurisdiction over all of equity relating to land held of the crown in right of the f Lancaster, the office is, however, practically a sinecure, nually filled by a leading statesman whose time is at the t the Government for the consideration of such important s as do not come within the province of other departments. the public works and buildings of Great Britain were for time placed under the control of a responsible minister of n, and were assigned to the charge of the commissioners of d forests; but in 1851 the department of public works was d from the woods and forests and erected into a board under e of the office of her majesty's works and public buildings. commissioner of works is the head of the board and in his placed the custody of the royal palaces and parks and of all buildings not specially assigned to the care of other depart- Since the establishment of his office the first commissioner uently had a seat in the cabinet. The duties of the post eneral of the president of the local government board, and nor members of the administration are so obvious from the the offices they hold as not to call for any special mention. ime minister is responsible for the distribution of the chief of government between the two Houses of Parliament the development of the House of Commons within the entury it is now considered advisable that a larger propor- abinet ministers should have seats in that chamber than now the case. In the first cabinet of George III. only one cabinet was in the House of Commons and thirteen in the Lords. In 17[illegible] Mr Pitt was the sole cabinet minister in mons. In 1801 four cabinet ministers were in the Commons the Lords. In 1804 Mr Pitt and Lord Castlereagh were abinet of twelve, the only ministers in the Commons. In invisible numerals "All the Talents"), of a cabinet of eleven, ere in the Lords and four in the Commons. In 1809 of oval cabinet were peers and four commoners. In 1812, Liverpool cabinet ten were peers and only two commoners , out of a cabinet of fourteen, six were commoners; and in t of a cabinet of fifteen, nine were peers. Since the Reform 1832, however, the cabinet members of Government have ore equally apportioned between the two Houses.

Constitutional History of England; Cox, *Institutions of the English Government*; Alpheus Todd, *On Parliamentary Government*; Cooke, *History of*

(A. C. E.)

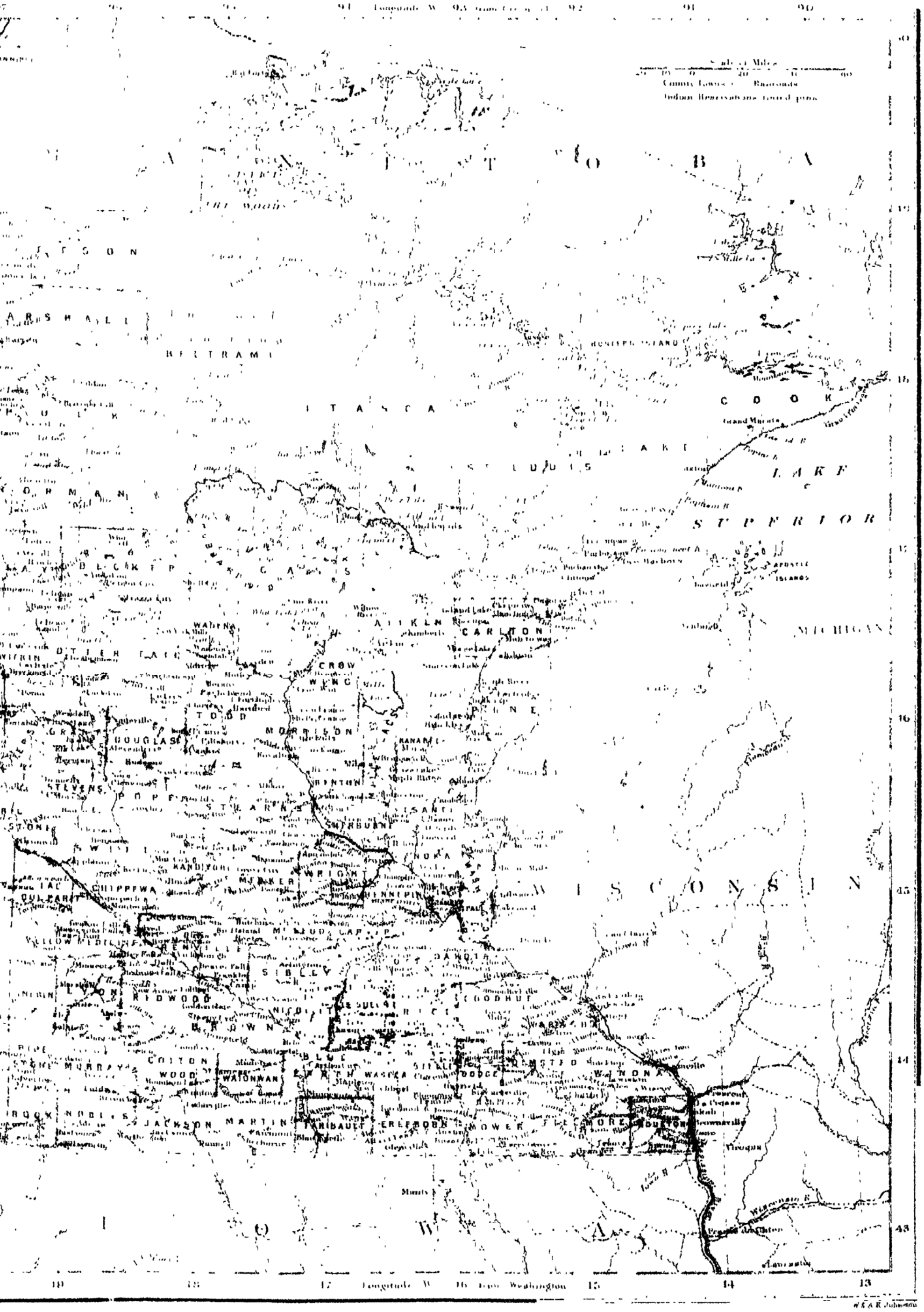
MINK. The genus *Putorius*, belonging to the family *Mustelidæ* or Weasel-like animals (see MAMMALIA, vol. p. 140), contains a few species called Minks, distinguished from the rest by slight structural modifications, and especially by semiaquatic habits. They form the subgenus *Lutreola* of Wagner, the genus *Vison* of Gray. As in members of the genus, the dental formula is $i \frac{3}{3}$, c $m \frac{1}{2}$; total 34. They are distinguished from the Polecats, Stoats, and Weasels, which constitute the remainder group, by the facial part of the skull being narrower more approaching in form that of the Martens, by the molar teeth (especially the first of the upper jaw) larger, by the toes being partially webbed, and by absence of hair in the intervals between the naked pads the soles of the feet. The two best-known species, alike in size, form, colour, and habits that although they wide y separated geographically some zoologists consider their specific distinction, are *P. lutreola*, the *Nörz* or *Nerz* (Marsh Otter) of eastern Europe, and *P. vison* Mink of North America. The former inhabits Poland, and the greater part of Russia, though not east of the Ural mountains. Formerly it extended ward into central Germany, but it is now very rare extinct, in that country. The latter is found in which suit it habitat throughout the whole of America. Another form, *P. sibiricus*, from eastern of which much less is known, appears to connect the Mink with the Polecats.

The name mink has been adopted from the Swedish *mank* to the European animal. Captain John Smith, in his *H* at p. 27, speaks of "Martins, Powlecats, and Minkes," showing that the animal must at that time h distinguished by a vernacular appellation from its congene later authors. Law (1709) and Pennant (1784), if written "Minx." For the following description, chiefly tak the American form though almost equally applicable to Europe we are mainly indebted to Elliott Coues's *Fur Animals of North America*, 1877.

In size it much resembles the English Polecat,—the length head and body being usually from 15 to 18 inches, that of to the end of the hair about 9 inches. The female is consi smaller than the male. The tail is bushy, but tapering at The ears are small, low, rounded, and scarcely project bey adjacent fur. The pelage consists of a dense, soft, matted u mixed with long, full, lustrous hairs on all parts of the b tail. The gloss is greatest on the upper parts; on the bristly hairs predominate. Northern specimens have the fi most glistening pelage; in those from southern regions the difference between the under and over fur, and the whole coarser and harsher. In colour, different specimens presen considerable range of variation, but the animal is ordinarily dark brown, scarcely or not paler below than on the gener parts, but the back is usually the darkest, and the tail black. The under jaw, from the chin about as far back angle of the mouth, is generally white. In the European M upper lip is also white, but, as this occasionally occurs in A specimens, it fails as an absolutely distinguishing character. the white on the chin, there are often other irregular white on the under parts of the body. In very rare instances th tipped with white. The fur, like that of most of the anima group to which it belongs, is an important article of comm

The principal characteristic of the Mink in comparison congeners is its amphibious mode of life. It is to the wat the other Weasels are to the land, or Martens to the trees, essentially aquatic in its habits as the Otter, Beaver, or M and spending perhaps more of its time in the water than it land. It swims with most of the body submerged, and di perfect ease, remaining long without coming to the su breathe. It makes its nest in burrows in the banks of breeding once a year about the month of April, and produc of six young at a birth. Its food consists of frogs, fish, fre molluscs and crustaceans, as well as mice, rats, musk-rats, and small birds. In common with the other animals of the it has a very peculiar and disagreeable effluvium, which, a to Coues, is more powerful, penetrating, and lasting than any animal of the country except the Skunk. It also posse courage, ferocity, and tenacity of life of its allies. Whe young, however, it can be readily tamed, and lately Min been extensively bred in captivity in America both for the their fur and for the purpose of using them in like manner a in England, to clear buildings of rats. (W. H

MINNEAPOLIS, the county seat of Hennepin Minnesota, United States, and in 1880 the first the State as regards population, lies on both banks


Scale of Miles
Capitals
County Towns
Railroads
Indian Reservations
Longitude W
From Washington
KITTSON
MARSHALL
ROSEAU
BELTRAMI
LAKE OF THE WOODS
ITASCA
CASS
HUBBARD
CLEARWATER
KOOCHICHING
ST. LOUIS
COOK
LAKE
SUPERIOR
BECKER
WADENA
AITKIN
CARLTON
OTTER TAIL
CROW WING
PINE
TODD
MORRISON
KANABEC
GRANT
DOUGLAS
POPE
STEARNS
SHERBURNE
ISANTI
STEVENS
WRIGHT
MEEKER
HENNEPIN
CHIPPEWA
SWIFT
MCLEOD
CARVER
SCOTT
DAKOTA
WASHINGTON
RENVILLE
SIBLEY
GOODHUE
WABASHA
LYON
REDWOOD
BROWN
NICOLLET
LE SUEUR
RICE
STEELE
DODGE
OLMSTED
WINONA
COTTONWOOD
WATONWAN
BLUE EARTH
WASECA
MURRAY
NOBLES
JACKSON
MARTIN
FARIBAULT
FREEBORN
MOWER
FILLMORE
HOUSTON
WISCONSIN
IOWA
Wisconsin R.
Mississippi R.
Iowa R.
Minnesota R.
Red R.
Grand Marais
Grand Portage
Apostle Islands
Lanesboro
Preston
Chatfield
Winona
Rochester
Albert Lea
Austin
Owatonna
Faribault
Northfield
Hastings
Red Wing
Wabasha
Lake City
Zumbrota
Pine City
Mora
Cambridge
Princeton
Milaca
Aitkin
Brainerd
Crosby
Deerwood
Pequot Lakes
Walker
Hackensack
Park Rapids
Bemidji
Cass Lake
Grand Rapids
Virginia
Hibbing
Chisholm
Eveleth
Duluth
Two Harbors
Cloquet
Moose Lake
Sandstone
Hinckley
Mille Lacs
Onamia
Isle
Milaca
Elk River
Anoka
Minneapolis
St. Paul
Stillwater
Hudson
Forest City
Willmar
Litchfield
Hutchinson
Glencoe
Gaylord
Arlington
Sleepy Eye
New Ulm
St. Peter
Le Sueur
Mankato
North Mankato
St. James
Fairmont
Blue Earth
Waseca
Owatonna
Albert Lea
Austin
Rochester
Lanesboro
Preston
Chatfield
Winona
Wabasha
Red Wing
Hastings
Northfield
Faribault
Mankato
Fairmont
Jackson
Worthington
Luverne
Pipestone
Slayton
Windom
Fulda
Tracy
Marshall
Redwood Falls
Morton
Olivia
Benson
Montevideo
Granite Falls
Ortonville
Appleton
Madison
Milbank
Wheaton
Breckenridge
Fergus Falls
Detroit Lakes
Moorhead
Glyndon
Hawley
Ada
Crookston
Thief River Falls
Roseau
Warroad
Baudette
Lake of the Woods
Red Lake
Bemidji
Park Rapids
Wadena
Staples
Motley
Little Falls
Pierz
Sauk Centre
Melrose
Albany
Avon
St. Cloud
Sartell
Sauk Rapids
Waite Park
Rice
Foley
Milaca
Mora
Cambridge
Isanti
Anoka
Coon Rapids
Fridley
Minneapolis
St. Paul
Bloomington
Richfield
Edina
Hopkins
Minnetonka
Wayzata
Plymouth
Golden Valley
New Hope
Crystal
Brooklyn Park
Maple Grove
Osseo
Champlin
Dayton
Rogers
Hanover
Buffalo
Monticello
Otsego
St. Michael
Albertville
Hasty
Clear Lake
Becker
Big Lake
Elk River
Zimmerman
Princeton
Milaca
Onamia
Isle

Mississippi, at the falls of St Anthony, 14 miles by river above St Paul. The east side was first settled, under the name of St Anthony, which was incorporated as a city in 1860. The west side settlement, named Minneapolis, was incorporated as a city in 1867, and soon surpassed St Anthony in population. In 1872 the two cities were united under the name of Minneapolis. The chief industries are the manufacture of flour and of lumber, for which the falls supply abundant water-power. The Mississippi here flows over a limestone bed resting upon a friable white sandstone; hence erosion is rapid, and the river banks show that the falls have receded from a position at the mouth of the Minnesota river. In 1851 90 feet of the limestone gave way at once, and, as the rock bed extended but 1200 feet above the present site of the falls, the destruction of the water-power was threatened. This has been averted by the construction of an apron, or inclined plane, of timber, with heavy crib-work at the bottom, and the building of a concrete wall in the bed of sandstone behind the falls and underneath the channel of the river. For this work the United States Government appropriated $550,000 and the citizens of Minneapolis contributed $331,500. The city has twenty-seven flour mills, which can produce 29,272 barrels a day. The total product for the year ended September 1, 1882, was 2,301,667 barrels. The shipments of lumber for 1880 were 161,620,000 feet. The population in 1870 was 18,079, and in 1880, 46,887.

MINNESANGER. See GERMANY, vol. x. p. 625.

MINNESOTA, one of the north-western States of the American Union, extending from 43° 30′ N. lat. to the British Possessions (about 49° N. lat.), and from Wisconsin and Lake Superior on the east to Dakota on the west, between the meridians of 89° 39′ and 97° 5′ W. long. Its area, including half of the lakes, straits, and rivers along its boundaries, except Rainy Lake and Lake of the Woods, amounts to 82,365 square miles.

The surface of Minnesota is diversified by few elevations of any great height. In general it is an undulating plain, breaking in some sections into rolling prairie, and traversed by belts of timber. It has an average elevation above sea-level of about 1000 feet. The watershed of the north (which determines the course of the three great continental river systems) and that of the west are not ridges or hills, but elevations whose inclination is almost insensible. The southern and central portions of the State are chiefly rolling prairie, the upper part of which is crossed from N.W. to S.E. by the forest belt known as the Big Woods, a stretch of deciduous forest trees with an area of about 5000 square miles. North of the 47th parallel the great Minnesota pine belt reaches from Lake Superior to the confines of the Red River valley, including the region of the headwaters of the Mississippi and its upper tributaries, as well as those of the Superior streams. North of the pine region there is but a stunted growth of tamarack and dwarf pine. In the north-east are found the rugged elevations of the granite uplift of the shores of Lake Superior, rising to a considerable height; while in the north-west the surface slopes away to the level prairie reaches of the Red River valley. The surface elevation of the State varies from 800 to 2000 feet above sea-level. A short line of hills in the north-east reaches the latter altitude, while only the valleys of the Red River, the Mississippi, and the Minnesota fall below the former.

Geology and Soil.—The geology has not yet been mapped out with the precision attained in other States. The great central zone, from Lake Superior to the south-western extremity of the State, is occupied by granitic and metamorphic rocks, succeeded, in the south-east, by narrower bands of later formation. Within the great Azoic area lies the central watershed of the continent, from which the St Lawrence system sends its waters towards the A[tlantic], the Mississippi towards the Gulf of Mexico, and t[he] River of the North to Hudson's Bay. These pri[mary] rocks carry back the geologic history of Minnesota [to] Silurian times. They form in the north-east, [in the] neighbourhood of Lake Superior, an extremely rou[gh] hilly country, but as they reach the central and [south-] western portions of the State they for the mos[t] disappear beneath the surface drift. The central [is] succeeded, on the south and east, by a stretch of sa[nd-] partially the true red Potsdam and partially a simi[lar] lighter coloured stratum, which some have prop[osed] designate the St Croix Sandstone. Isolated beds [of] stone are found in various parts of the State. The [south-] western corner, stretching east from the Red River [Valley] is believed to be Cretaceous, but the great de[posits] drift and alluvium disturbed by no large rivers, p[resent] a positive conclusion. The Lower Magnesian lim[estone] underlies the extreme south-eastern portion of the [State] and extends along the west side of the Mississi[ppi] point a little below St Paul; thence it takes a [course] almost semicircular, and finally passes out of the S[tate] the south-western boundary. The Trenton lim[estone] occupies a large field in the south and south-e[ast] comes to the surface in long irregular bands, and a[lmost] of it underlies the cities of Minneapolis and S[t Paul] with the adjacent districts. The Galena limesto[ne], Maquoketa shales, the Niagara limestone, and th[e beds] of the Devonian age in turn prevail in the other [parts] of the south and east, while the existence of the S[t Peter] sandstone would scarcely be known but for its outc[rops] along the bluffs of the Mississippi, and at the [famous] waterfall of Minnehaha. From these various for[mations] numerous kinds of stone valuable for building purp[oses] obtained. The grey granite of St Cloud is extreme[ly] [hard]. The Lower Magnesian limestone [yields] especially handsome building stones, the pink li[mestone] known as Kasota stone, and the cream-coloured s[tone] Red Wing, both easily worked, and hardening by e[xposure] to atmospheric changes. Naturally, from its [position] underneath the principal cities of the State, the [Lower] limestone is the most widely used. Sand suita[ble for] glass-making, and argillaceous deposits abound[ing in] clays which make up so large a portion of t[he] surface drift of the State are almost wholly of [Quaternary] origin. Overlying the deposits of sand, gravel, b[owlder] and clay is, in most portions of the State, a [dark] loam, very finely divided, rich in organic matte[r], brown or black in colour, and of the greatest [fertility]. It is this soil which has given to the State its rep[utation] for productiveness. Its depth varies from 2 to 5 [feet] various parts of the State and it has been descr[ibed] Dr Owen as "excellent in quality, rich as well in [organic] matter as in those mineral salts which give rapidit[y of] growth of plants, while it has that durability which [adapts] it to sustain a long succession of crops."

Rivers and Lakes.—The State holds a unique place in [the] water system of the continent. The Mississippi, which [rises] near the centre of the State in Lake Itasca, and [flows] [south-]eastward [across] the State limits a great river, ha[ving] [a width] of 200 feet deep. It drains with its tribu[taries] [the] central portions and a large area of the [western] portion of the [State]. It is navigable as far as St Pe[ter] Minneapolis, the falls of St Anthony afford unrivalled [water-]power for manufacturing. Of the many affluents of t[he] Mississippi the most important is the Minnesota, whic[h], course of about 440 miles flows into the main stream [at] Snelling, 3 miles above St Paul. The source of the Mi[ssissippi] but 1 mile from Lake Traverse, the origin of the Red Ri[ver of the] North, and it is navigable during the high water season [for] 238 miles. Its principal tributaries are the Blue Earth, [Cottonwood], Redwood, Lac qui Parle, and Pomme de Terre. The [Red River] system drains the north-western part of the State, and

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pass into Hudson Bay, as also do those from the drained by streams flowing to the Rainy Lake river and s along the northern boundary line. East of this lies the ributary to Lake Superior and the St Lawrence system. upon is an area within the State estimated at 9000 square It principal rivers is the St Louis. There are altogether 00 miles of navigable water in Minnesota.

mber of lakes is estimated at seventeen hundred. They are of all t are found chiefly in the northern two thirds of the State. e are divided geologically into glacial or drift lakes,

upwards of

lacustrine basins scooped out by the action of glaciers or relative position of different geological formations. By ers, number give evidence of glacial action in their origin ered over the region most deeply covered by the surface s are peculiarly prevalent in the same district, formerly centre of the Laurentide area of North America. With ce of the ice sheet which once overspread Minnesota a ndless lakes came into existence, and the gentle activity ges, precluding rapid erosive action, has tended to give ce to the depressions constantly there forming. The ers have their sources within the Most of the lakes are characterized by picturesque spots in their sur s. Forest and timber lines which are seldom more water, abounding in various kinds of fish, present ides the sanitary advantages afforded by the lake places for recreation and delightful summer resort they climate to one's taste, temperate, the extreme cold pervaded by northern latitude. The fact that many of are gradually diverted to permit the replacement by agricul- cultivations. The Lake of the Woods, Lake of Superior, lying ot in part in Minnesota are as follow: Lake of the of Spruce miles; Red, 342; Mille Lacs, 198; Leech, 104 46; Winnibigoshish, 72; and Vermilion 63.

and Forests. The flora and fauna present no marked from those of other States on the same latitude. In a of the birds of Minnesota, two hundred and eighty-one e commercial or winter birds, fifty-two species have been , twenty-three of them being permanent residents.

The State lies so far north as to have a low mean temperature and so far inland as to have the character- tal climate. Its elevation above sea level gives an agree- fection to the atmosphere, and makes the prevalence of damp weather unknown. Between June and January an annual variation from the summer heat of southern he winter cold of Montreal. The winters usually com- in November and continue till near the end of March ormal of intense continental cold but is subject to consider- ation. A study of the comparative dryness of the atmo- attained by even the extensive cold. The snowfall ively light during most of the winter, but a prime e precipitation becomes copious, and there are frequently nowfall in February and March. The change from winter ver is rapid, vegetation sometimes seeming to leap into full e growth within the space of a few weeks. The summer some days of intense heat, but, with comparatively rare e, the nights are delightfully cool. Hot days and cool make the ideal weather for a wheat crop, and the ent of animal production in luxuriant growth the vegetable h belong to the middle States. The South-eastern part of Minnesota has an average temperature for the hottest week ed from 85 to 90°, and for the coldest week in winter ven below zero. The mean annual average for all ty of latitude, at sea level, is 40°. Observations at St Paul, over a period of more than thirty-five years, show the ean temperature of spring, 42°.9; summer, 70°.6; r, 47°.1; and winter, 11°.6. The average annual ll is 30 inches. While this is not large, it is ample the purposes of vegetable growth. The average evapo- ration during the spring and autumn months, or in ter part of the year the precipitation, which ches, is sufficient to about 12° for the sum- the annual available growth is done 70 per cent. of the 75 per cent. of the rainfall, and 76 per cent. ring the prevailing winds are from the south- The number of snow-fall on 150 days, and in 16. The extremes of cold which mitigate the actual of the climate, and which for short periods produce a large amount ure on the atmosphere, are those which render a climate l in the highest degree. Minnesota has been for many favourite resort for invalids. The curative properties of its are especially marked in the case of pulmonary complaints.

Agriculture. The leading industry of the State is agriculture. aracter of the surface soil varies in different parts of the h the character of the underlying strata. The fertile land about three fourths of the entire area of the State. The drift soil proper of the south and centre, including the Minn valley and the greater part of that of the Mississippi, contains and calcareous matter, and is interspersed with alluvial bottoms. The limestone soil, in which there is a large calca element, lies chiefly on the western slope of the Mississippi. Red River valley consists of an argillaceous mould, rich in or deposits. Around Lake Superior, wherever arable land is found, it is marked by a rich trap soil. North of the central f area, and in the neighbourhood of the sources of the Mississip much swampy land, susceptible of easy drainage, with a large of sand and other drift detritus, unfavourable to production. and potatoes flourish, and the uplands, which support hard rubers, are suited to general agriculture. To the extreme n the latter, while indicating mineral wealth, is utterly unfit, ex on over broad cultivated areas, for purposes of tillage.

Wheat has hitherto been the staple product of the State and climate are conducive to ensure a large average yield, while superior quality of the grain has given it a wide reputation. other cereals are also cultivated with success. The tenden diversity agriculture, especially in the southern part of the S has been stimulated by several partial failures of the wheat the local ravages and the competition of the farther north-

The area of the State includes 39,791,265 acres surve 19,968,575 acres not surveyed and 2,709,000 acres of lake su The total sale of public and railroad lands in 1879 and 1880 wer ta from 1,000,000 to 1,500,000. It is estimated that the aggrega lands yet unsold consist of three-fourths of which may be profi cultivated, namely 30,000,000 acres, exclusive of the lands be me to the State. White Earth Indian reservation has thirt lower hills of prairie and timber land, and Red Lake reserv contains 3,200,000 acres.

Forestry. A special census bulletin estimates the amoun merchantable white pine standing May 31, 1880, as amounting to 100,000,000 feet. The entire cut for the census year was 340,000,000 feet. Of hardwood forest 3,840,000 acres re capable of yielding 5,000,000 cords of wood.

Every encouragement is afforded both by the railway co tion and the State, to tree-planting on the prairies. A qu section to any one who will plant and keep in good from 10 acres of timber for eight years. In 1880 there were pl 25,331 acres of trees, exclusive of those bordering highways the windbreak along the railroad lines.

Manufactures. The manufactures of Minnesota are yet in infancy. The abundant water power of the State, its proxim the coal belt of lower Lake superior transportation facilities, an large demand for manufactured commodities are, however, ra developing the branch of industry. The most important indus are the manufacture of flour and that of lumber. The former relative profitableness is stated to depend on wheat yield and abun water power. It received its great stimulus from the inve and adoption of the middlings purifying process, which pro the high grade of flour, and to which the hard spring whe Minnesota is especially adapted. Among other manufactu industries actively prosecuted are the making of brick, pot stoneware, and agricultural implements, and also meat-packin

Commerce. The geographical position of Minnesota gives i for its commercial interests. Two continental waterways term within the State. The Mississippi affords continuous navig to European ports during eight months of the year. From D numerous lines of vessels traverse the chain of great lakes, ing from port the products of the west to the eastern seaboard. The great trans-continental railway lines are connected more or directly with the railroad system of the State. Twelve lines of way from every part of Minnesota converge at the contiguous of St Paul and Minneapolis, and three great trunk lines from centre to Chicago secure the advantages of a lively competitio

Education. The common school system is supported by grant, a local tax, and a State tax. The superintendent of instruction is appointed by the governor. County superinten are chosen by popular vote. Common school districts have be of three members each. Six directors are appointed for indepen district. The permanent fund in 1881 was $4,850,000, and current fund $707,8.5. The State university, located at Mi polis, is governed by a board of regents, consisting of the gov of the State, the superintendent of public instruction, the pres of the university, and six others; both sexes are admitted, the sexes. The State supports three normal schools. F two academies and six colleges are sustained by denomination private enterprise.

Administration. — The departments of Government are, as i the States, the legislative, the executive, and the judicial. State contains seventy-eight counties, of which some are subject to change of boundary. From these are elected by dis forty-seven senators and one hundred and three members o House of Representatives. The State officers are a gove lieutenant-governor, secretary of state, treasurer, and atto general, all elected by the people. The term of office is two y

ernor has power to veto separate items of a money bill. The y is elective, and the term of office seven years. The State ents for citizenship are residence in the United States , in the State four months, and in the election district preceding an election. Women are allowed to vote for fficers and upon questions relating to the management of and are also eligible to such offices. No county can con- e than 400 square miles. The legislature meets biennially, ssions may be called, but no session can exceed sixty days h. Under the last apportionment the State is entitled to esentatives in the national Congress.

nnual valuation of property for 1882, as equalized by the ard, gives the personal property as $79,219,11- the real 242,938,170. This represents a total actual value of not le 50,000,000.

Minnesota was still a Territory. But after it had adopted constitution, an amendment was added to the constitution ing the issue of a large amount of bonds in aid of railway- tion. Shortly afterwards, the companies having failed to on contracts and defaulted payment, the State foreclosed gage on the land, franchises, etc., of the roads, and turned ver to other companies. By another amendment to the tion, the payment of the bonds was made contingent upon it of a popular vote. Several proposals having failed to his sanction, the necessity for it was removed, and a

of the supreme court declaring unconstitu- ad. The legislature immediately proceeded to frame an nt proposed by the bondholders, the over 00 worth of new bonds were declared payment of the principal and interest th fied November 1882, by the cession of 500,000 acres of land in lieu of the nent fund, the deficit to be paid out of . These bonds include all the State A tax of 3 per cent. was imposed on all oads within the State, which, after deducting n for educational, penal, and charitable *ution*. The population of the State was 1,2,023 in 1860, 439,706 in 1870, and 361,624 females in 1880. According whites had been born in the State oreign inhabitants of the State, 47,770 c ntries, and 68,277 from the United States, while 77,505 acknowledged the German. The increase of population in the State alone was 75 per cent. The metropolis, capital, and Minneapolis were in 1870 pectively, in 1880; Winona had to, 98 ; ty.—Missionary efforts and the trading en to venture as far into the wilderness of what is now the State of Minn s of its natural features and native ittings. The "Relations" of 1670-71 las. In 1678 a company was formed to with the Du Luth was leader of this expedition, and for ke Superior to the Mississippi by canoe. But

count is that of Louis Hennepin, a R visited the falls of St Anthony, and gave them their name, at of his patron saint. For a century only a few adventu- wild region were a few missionaries and a number of fur who found the profit of the journey to more than counter its perils and hardships. To the latter class belongs Perrot ched the Mississippi by way of the Fox and Wisconsin riv d founded at Lake Pepin the first trading-post in the State. Sueur, a Canadian, who ascended the river from its and established another post above Lake Pepin. Captain ver, the explorer of the country of the upper Mississippi, he falls of St Anthony in 1766, being the first British trad ho reached the spot. On March 30, 1805, Upper Louisiana nized, consisting of Arkansas, Missouri, Iowa, and a large of Minnesota. From this time onward the progress of explo as rapid, and settlement followed in its train. The first xtensive exploration of any large part of what is now ta was made between 1817 and 1823, by Major S. H. Long, nited States engineer corps, in command of a Government on. About the same time the Red River received its first Thomas Douglas, earl of Selkirk, an Englishman of character, went, in 1817, to what is now Winnipeg, by York river. Having been struck with the agricultural ties of the region about the Red River of the North, he a colony of Swiss farmers to settle there. These were dis- d in the country, and unused to the severity of the climate, they finally removed to the vicinity of St Paul and con to the earliest development of the agricultural in- of the State. In 1821 Colonel Snelling built, at the of the Minnesota and Mississippi rivers, a stronghold e named Fort St Anthony. The name was changed to Fort Snelling in his honour, in 1824, and the fort is still an im post as a base of supplies for the newer north-west. T steamboat made its appearance at the head of navigation The settlement of St Paul, one of the oldest towns as wel capital, is commonly dated from 1846, at which time there w shanties on its site. Population now began to arrive in co increasing numbers, and on March 3, 1849, a bill passed Con organizing the Territory. It was proposed at one time to Itasca, but the name Minnesota, meaning, "sky tinted and originally applied to the river bearing that title, wa retained. The western boundary of the territory was fix Missouri river. The population was but 4907, the large had but a few hundred inhabitants, and a large part of th the State still belonged to the Indians. But progress now carried. Upon admission was adopted in 1857, and on May 1 Minnesota was admitted as a State, with a population, ac to the first Territorial census, of 150,037.

One of the first acts of the new State was the issue of f rail bonds noticed above. Soon after came the civil war two months of Lincoln's first call for troops the first Mi regiment, over one thousand strong, was mustered into serv Year of 1862 ten regiments had been called for, and furnish all the States supplied to the Union 25,052 men, one seventh of its entire population. At the outbreak of the

In the meantime there occurred, in 1862, the horrible knowing the Sioux nation. Settlements were cut off, settlers murdered, and even a strong post like Fort Ridg attacked. The outbreak, which swept over a large portion of the several severe encounters were fought, and it was not u State had a thoroughly equipped military force ready for p pose that the Indians began to flock in to give themselves u the time over 760 persons had been murdered, 200 chiefly taken captive, eighteen counties were devastated, and 4,000 were homeless. The property loss was more than $5,000

During the civil and internal disturbances the material prosperity of the State was unabated. Notwithstanding the ha of the civil war, not the least severe the census of 1865 showed a population of 250,099. Railroad construction began to actually carried forward, and in 1870 300 miles were made, a mile were in operation, a road to Lake Superior was com and the Northern Pacific was actively under way. In 1873 to some extent in Texas, over the devastation of locusts d the crops of the south-western counties. The effects relieved by the State, and never to a second the county has experienced.

MINNOW (*Leuciscus phoxinus* or *Phoxinus laevis*), the smallest British cyprinoid readily distinguished by its very small scales, 97 round and in rivers, streams, lake, railway swimming in shoals and shifting its in search of food, which consists of every kind of w and animal substance. It ranges from southern to Scandinavia, and from Ireland into north eastern in the Alps it attains to a height above the sea Cyprinoid viz. to nearly 8000 feet. In natural co between 2 and 3 inches, but in suitable localities p in Germany, it is known to reach a length from inche . The colour varies with age and season, a dark pot or olive-brown above the side always p but the males at some seasons assume a copper-red or purple on the lower parts of the head and The minnow is a very hardy fish, and can also be intr with facility and with great advantage into pond- n there is otherwise a scarcity of food for more v to the pike, trout, perch, and eels.

MINO DI GIOVANNI (1431–1486), called da F was born at Poppi, in the Casentino, in 1431. property at Fiesole whence his usual name account of him is very inaccurate and full of contrad Mino was a friend and fellow worker both with Settignano and Matteo Civitale, all three being ab same age. There is considerable similarity in their showing mutual influence. Mino's sculpture is rem for its gem-like finish and extreme delicacy of de well as for its spirituality and strong devotional No other sculptor portrayed the virginal purity Madonna or the soft infant beauty of the Divine Ch greater tenderness and refinement. Of Mino's works, the finest are in the duomo of Fiesole, the alt

mb of Bishop Sabinata, executed about 1164. In
lia of Florence are some of Mino's most important
re an altar-piece, and the tombs of Bernardo
, 1166, and the Margrave Hugo, 1181—all sculp-
n white marble, with beautiful life-sized recumbent
and standard angels. The pulpit in Prato
d, signed in 1473, is very delicately sculptured,
relief of great minuteness, but somewhat weakly
Soon after the completion of this work Mino
went of some years to Rome, where he executed
fine pieces of sculpture, such as the tomb of Pope
(now in the crypt of St Peter's), the tomb of
Tornabuoni in S. Maria Sopra Minerva, and a
ul little marble tabernacle for the holy oils in
in Trastevere. There can be little doubt that he
the sculptor of several of the very lovely monu
in S. Maria del Popolo, especially those in the
of Bishop Gonnel and Archbishop Rocca, 1482,
marble reredos, also in the sacristy, given by Pope
ler VI. Some of Mino's portrait busts and delicate
bas-reliefs are preserved in the Bargello at Florence;
full of life and expression, though without the
realism of Verrocchio and other sculptors of his
He died in 1486.

Milanesi ed., 1878–85; Perkins, *Italian Sculptors*,
mann and D'Agincourt, *Storia della Scultura*, 1815.

OR. See INFANT.

ORCA. See BALEARIC ISLANDS.

ORITES. See FRANCISCANS.

OS, a legendary king of Crete, in whom both
al and religious elements are united. The historical
lies in the fact that an early civilization and mari
ower had its seat in Crete. The Phœnician inter
played a great part in developing this island state,
nos is sometimes called a Phœnician. The name Minoa
found where Phœnician influence was strongest,
Megara. The laws and constitution which existed
very early time in Crete were attributed to Minos,
n they were revealed by Zeus. After his death he
the judge of the dead, he is one of the forms
d by the old conception of the first man, who is
eath king and god among the dead. It is therefore
probable that the name Minos is the Greek form of
mal *Manu*, i.e., "endowed with thinking," which
n the Hindu Manu and the Germanic Mann. As
ther heroized forms of the god of the dead, there
a terrible and a wise and beneficent side in the
r of Minos. Cretan legends described him as the
nt man of the forests and mountains, the lover of
mphs, though his love means death to them. His
localized in the far west, in the land of sunset;
was shown at Camicus near Agrigentum, attached
ple of Aphrodite. He pursued Daedalus thither,
daughter of Cocalus, the king of Agrigentum,
ed by pouring boiling water over him in the bath,
ed with the sun dying in the sea. Minos, the
the dead according to the primal rule, the sun god,
ns over the dead when he dies on the earth,
ted with the moon goddess, who had an oracle
um at Thebes (cf. Europa). The union of the sun
e moon, the bull and the cow, gave rise to many
and ugly legends. Pasiphaë loved the bull of Minos,
ed by the contrivance of Daedalus, and gave birth to
inotaur, half bull and half man. The Minotaur is
those monstrous forms which were suggested to the
fancy by the ghastly and all too common in Oriental
t was shut up in the LABYRINTH (*q.v.*), which was
ted by the skilled artist Daedalus. Now a son of
named Androgeus had been killed by the Athenians,
nos as a punishment required that seven Athenian
youths and seven maidens should be sent every nint
and given up to the Minotaur to be devoured. Wh
sacrifice took place for the third time Theseus came
of the hostages, and slew the Minotaur with the
Ariadne. Throughout these legends we see the
relation of Minos to the Phœnician sun-god Melkart
perceive the way in which different places where Pho
influence can be traced, Athens, Sicily, &c., are b
together in religious myths.

MINOTAUR. See MINOS.

MINSK, a western government of Russia, is bo
by Vilna, Vitebsk, and Moghileff on the N. and E
by Tchernigoff, Kieff, Volhynia, and Grodno on
and W., and has an area of 35,175 square miles
surface undulating and hilly in the north-west, w
narrow plateau and a range of hills of the Tertiary
tion runs to the north-east, separating the basin
Niemen, which flows into the Baltic, from that
Dnieper, which sends its waters into the Black Sea
range, which averages from 800 to 1000 feet, culmin
Lysaya Gora (1129 feet). The remainder of the p
is flat, 150 to 650 feet above the sea-level, covere
sands and clays of the glacial and post-glacial periods
broad shallow depressions, drained by the Berezina a
Pripet, cross the province from north to south an
west to east; and these as well as the triangular
between them, are covered with immense marshes
occupying 200 to 600 square miles), numberless poo
small lakes, peat bogs, downs, and moving sands,
as with dense forests. This country, and especia
south-western part is usually known under the n
Polyesie ("The Woods"). Altogether, marshes f
15 per cent. and marshy forests no less than 55 pe
of the entire area of the province (60 to 71 per c
several districts). The forests, however, consist
grown trees in the higher districts of the nor
only, those which occupy the marshy ground consis
small and stunted pine, birch, and aspen. The cli
the Polyesie is harsh and extremely unhealthy; m
and an endemic disease of the bulbs of the hair
plica Polonica) are the plagues of these tracts, t
being intensified by the dreadful poverty of the
tion. Communication is very difficult. The railwa
Poland to Moscow lies, so far as Minsk is concerned
advantage of the plateau above mentioned; but stil
to cross the broad marshy depression of the Berezi
successful attempt was recently made to drain the
of the Polyesie by a system of canals, and mor
1,500,000 acres have thus been rendered suitable for
and agriculture. Two great tributaries of the Dnie
Berezina and the Pripet, both navigable, with num
subtributaries, many of which are also navigable,
natural outlets for the marshes of the province
Dnieper flows along its south-eastern border for 160
and the Niemen on the north-western for 130 miles
affluent of the Baltic, the Duna (Dwina), and the Vis
connected by three canals with tributaries of the I
The population of the province (1,183,200 in 187
be estimated at about 1,350,000, mostly White R
(67 per cent.), there are also Poles (about 11 per
especially in the western districts, Jews (more t
per cent.) Little Russians (5 per cent.), and Russian
cent.). About 70,000 are considered to be Lithu
there are also 1000 Tartars, whose presence can be
to the raids of their ancestors on Lithuania in th
century, and about 2000 German agriculturists who
in last century.

The chief occupation of the inhabitants is agriculture, w
however, very unproductive in the lowlands; in the Pol
peasants rarely have pure bread to eat. Only 23·8 per cen

nder crops, the average yield being 1,600,000 quarters of
d 1,170,000 quarters of potatoes. Cattle breeding is very
tly developed, the meadows being marshy throughout the
s. Hunting and bee-keeping are sources of income in the
, and fishing gives occupation to about twenty thousand
The chief source of income for the inhabitants of the low
the timber trade. Timber is floated down the rivers, and
h, various products of bark, potash, charcoal, and numerous
imber-ware (wooden dishes, &c.) are manufactured in village
t extent; and shipbuilding is carried on along the Dnieper,
and Niemen. Shipping is also an important source of
owing to the traffic on the canal and rivers of the province
560 boats and 1120 rafts with 1,70,000 cwts. of cargo left
s of the Berezina and Pripet; and the traffic on the Dnieper
nen was nearly as great. The industrial arts are almost
undeveloped. There are, however, several distilleries and
s; and woollen stuffs, candles, tobacco and beer are manu
to a limited extent. Corn is exported from the western
, but imported to the same amount into the southern parts,
f export trade is in produce of forest industries, re pre
crossed by two important railways, one of which
with Moscow, and the other Libau and Vi
s of Little Russia; the great highways from aw to
crosses the province in the south, and its pos homesh
ezina is protected by the fortress
s divided into nine districts, of which th
43,500 inhabitants), Bobruisk (30,850), Bor
place where Napoleon I. crossed the Berez
oscow, Igumen (2200), Mozyr (4700), Ne (9000),
8,000), Ryechitsa (4300), and Slutsk (17,200). The pro
well provided with secondary school, but primary educ
especially in the Polyesie, remains very backward. The
ountry now occupied by the province of Minsk was, as far
ical records extend, an abode of Slavonians. Part portion
ch was occupied by the Krivichi became part of the Polotsk
lity and so of "White Russia," the other portion, occu
the Dregovichi and Drevlians, became part of the "Black
; whilst the south western portion of it was occupied by
s or Lithuanians. During the 12th, 13th, and 14th
was divided among several principalities, which were in
ed with the great principality of Lithuania and later were
to Poland. Russia took possession of the country in
In 1812 it was invaded by the army of Napoleon I.
sk, the capital of the above province, is situated
Svisloch, a tributary of the Berezina, at the
n of the Moscow and Warsaw and the Libau
harkoff railways, 165 miles by rail west from
v. It has 13,500 inhabitants, of whom one third
ws of the poorest class: the others are White
ns, Poles, and Tartars (about 700). The manufac
re few and insignificant. Since the introduction of
s the commercial importance of the place, which
y was slight, has begun to increase.
t is mentioned in Russian annals in the 11th century under
e of Myen'sk or Menesk. In 1066 and 1096 it was held
rst by Izyaslav and afterwards by Vladimir. It changed
any times until the 13th century, when it became a Lithu
f. In the 15th century it became part of Poland, but while
t was ravaged by Tartars, and in 1505 by Russians. In the
ature it was taken several times by Swedes and Russians
nnexed it in 1793. Napoleon I. took it in 1812.

STREL. The "minstrels," according to Bishop
"were an order of men in the Middle Ages who
the arts of poetry and music, and sang verses to the
their own composing, who appear to have accom-
their songs with mimicry and action, and to have
ed such various means of diverting as were much
d in those rude times, and supplied the want of more
entertainments." This conception of the "minstrel"
n generally accepted in England ever since Percy
hed his *Reliques of Ancient Poetry*, which he gave to
rld as the products of the genius of these anonymous
r poets and harpers. The name has been fixed in
guage by the usage of romantic poets and novelists;
"last minstrel" and Moore's "minstrel boy" were
els in Percy's sense of the word. The imagination
cinated by this romantic figure, and the laborious
ured antiquary Ritson argued in vain that nobody
Bishop Percy had ever applied the word minstrel to
order of men, that no such order of men ever did
exist in mediaval England, and that the historical l
"minstrels," so-called, were a much less gifted and r
able class, being really instrumental musicians,
retainers or strollers.

The dispute between Ritson and Percy was partly
pute about a word, and partly a dispute about fa
facts; and there can be little doubt that Ritson was su
tially right in both respects. The romantic bisho
ferred to the mediaval English minstrel the social
and brilliant gifts of the Anglo Saxon *gleeman* or *sc*
the French *troubadour* in the flourishing period of Pro
poetry. That the gleemen sang to the harp verses of the
composing, that some of them travelled from court t
as honoured guests, while others were important at
court officials, and all received costly presents, is
attested historical fact. The household bard at He
the poem of *Beowulf*, a man who bore many things in
and found skilfully linked words to express them, w
of King Hrothgar's thanes, the gleeman of the *Tra*
Sonf had visited all the tribal chiefs of Europe, and re
many precious gifts, rings and bracelets of gold,
incidents in these poems may not be historic, bu
furnish indubitable testimony to the social position
gleeman in those days; a successful gleeman was as
honoured as a modern poet laureate, and as richly re
as a fashionable *prima donna*. Further, the strollin
man of a humbler class seems to have been a recog
non combatant: this much we may infer from the
about Alfred and Anlaff having penetrated an e
camp in the disguise of gleemen, whether the story
true or not, for otherwise they would not have
invented. The position of poets and singers in P
from the 11th to the 13th century is still clearer
classification of them by King Alphonso of Castile n
by which time honourable designation were getting
may help to determine the exact position of the
"minstrel." There was first the lowest class, the
who strolled among the common people, singing
songs, playing on instruments, showing feats of sk
strength, exhibiting learned dogs and goats, and so
then the *joglars* or *joculatores*, who played, sang,
conjured, men of very subtle powers of entertainme
performed at the houses of the nobility, and were li
remunerated, then the *trobadors*, or *inventors*, wh
function it was to compose verses, whether or not th
sufficient executive faculty to sing or recite them.

If we compare these distinctions with Percy's de
of the minstrel, we see that his minstrel would have
sponded with the *poeta* who also wrote his own son
recitations. Now in the palmy days of Provenç
there were many professional joglars, such as
Daniel or Peirol, who stood high among the most h
troubadours, and visited on terms of social equali
nobles and princes. But long before English bec
court language the troubadour had disappeared, and
division of function had been developed. In Ch
times the poet of society no longer sang his verses
or recited in person to his patrons with feats of legerd
the *jongleur* (teller of *gests*) discharged the
social duty, diversified with witty stories and th
position of the *poeta* had very much sunk. But
perfectly right in saying that no English poet of an
position was a professional reciter to the harp of v
his own composing. The Provençal joglar, travellin
court to court, combined our modern function
society journalist, entertainer, and musician. Bu
the time when the word "minstrel" came to be ap
him the English joglar was rapidly sinking or had
sunk to the social position of the modern strolling
hawk, travelling showman, or music hall singer.

instrel had had a separate history before it became
mons (as in the *Catholicon Anglicum* of 1483) with
lator, *histrio*, *scurra*, and other names for strolling
mers. Derived from the Low Latin *ministralis*, it
ferally applied to those retainers whose business it
play some musical instrument for the entertainment
he i In Chaucer's *Squire's Tale*, the "minstralles"
the feste Cambuscan's hall dine in state "biforn
the hye bord deliciously," and the "ministrals"
ine, when he rises and withdraws to the orna
chamber

There they swiften[1] in instrument,
That yaf[2] delyt unto hem to heere

en in Chaucer's time there were less portable
n than those of the Low Countries (strolling
n, players on trumpet, clarion, fiddle, lute-,
, bibble-, and other instruments. The rascal were
by the generic name of minstrel, whether because
of them had learnt their art or noble households
they took for a year's board, or because the more
ible of them attached to be in the service of under
ers of powerful nobles, or from comparative ex
e player himself as the "servant" of all those he
All the allusions to minstrelsy in literature from
d time to Spenser point to them as strolling
rs. Some of them may have risen to the keep
t their own companies, and some of them may have
d some of the ballads that now circulate with their
d ample dress; but the poor fellow under the "minstrel"
s so called, was much the same creature that Froissart
ounted it. It was not to every "the boost of the
e that "called them harpers or crowders in a
ve. Yet praised by Henry IV. they appear with
ns, tymbres, et autres instrumens" among the
nt elements of the community.

pressed in Malory's *Morte Darthur*, the word
l is applied to a messenger who goes much nearer
ul of the Provençal *joglar*. When Sir Dinadan
to introduce Sir Mark, he compares a stentorian
nd cave it to Dinot a harper to sing through the
. Tristram, disguised as Tramtrist the minstrel
When Iseult "Of Ireland" had to take leave of the
, the answer was, "Wit you well I have no minstrel
dear but Governayle, and he is hurt in his hand
s sore. And he can no more but a little Mark
him to make merry withal." This was done by Dinot
per to the old romances, and the "tuition of the

Britain at a very early period, there does not appea
any evidence that the mines were worked until co
ably later than the time at which the use of meta
medium of exchange was introduced. It is probable
fore that the metals for exchange were importe
Britain long before the native mines were developed

The metals chiefly used were silver and brass,
were at first simply exchanged by weight for comm
of all kind. As commercial transactions became
numerous and more complicated, this system of pa
grew troublesome, and it was found convenient to
the mass of metal into small parts, which soon to
form of rude coin. But the principle of paym
weight was retained through many centuries, and
perpetuated itself in name only, in the word "pound

Records of attempts to organize the coinage of E
are found as far back as the Anglo-Saxon period, an
known that on the distribution of the Heptarchy the
were regulated by laws framed in the witenagemot
first monarch who appears to have dealt successfull
the organization of the coinage was Athelstan, who
laws for the regulation of the mint, and appointed
whose title and duties are then first recorded. Th
officers connected with the coinage of whom men
found before the time are the "moneyer," who ap
have been alone to provide for the manufacture of th
but it is probable that even then there existed some
who had authority over them. In early Saxon and N
time the number of moneyers was considerable,
being established in almost every important town, a
be expected at a period when communication b
distant places was extremely difficult. They appear
been the officers who actually performed the w
making the coin, the mint-master in later times cont
with them, at high rates, for the work. They were
sible for the purity and perfection of the coins pro
as appears from the fact that it was they who
punished for treason on the case of any deficiency in
or fineness. They had pre-emptive rights in the c
and in modern time (even so late as 1850) claimed
corporate privileges. But it is clear, on the au
of Ruding, that they never were a "corporation" s
from other officers of the mint.[1] The number of
was greatly reduced after the Norman Conques
continued to be considerable until the reign of Ric
when the work of coining for the whole kingdom w
centrated in the mint in the Tower of London. O
provincial mint (Winchester) remained till a later d

No important reorganization of the coinage took
in 1279 under Edward I., the regulations then fra
the manufacture and issue of the coins forming th
of the act still in force. The principal officers under
regulations were master, warden, comptroller, king's
master, king's clerk, and counter. The office of co
was one of great importance at a time when there
a multiplicity of mints, since he had the sole charg
the dies used not only at the mint in the Tower of L
but also in the provinces. He chose the engrave
presented them to the barons of the exchequer in
that they might take the oath of fidelity; he superin
their work, and was generally answerable for the per
of the dies before they were issued for use in the
mint of the country. The office, which was here
ceased to exist when the provincial mints were supp
In its place was instituted the office of clerk of the

[1] Among the special privileges which they undoubtedly enjo
exemption from local taxation, as appears in a writ of He
which commands the mayor of London not to disturb th
exacting tallages contrary to their privileges." Sometimes als
were allowed to them rent free.

unctions were more limited, and were not hereditary
fice was only recently abolished.
e Middle Ages an important duty devolved on the
of the mint was the collection of the seigniorage
was levied on the coining of money, not only for the
of covering the expenses of minting, but also a
of revenue to the crown which the sovereign claimed
e of his prerogative. In former time the collection
seigniorage was entrusted to the warden, who also
tended the manufacture of the coin so as to
he proper relations between the moneyers on the one
nd the state on the other. He does not appear
t, to have had any responsibility with regard to the
and weight of the coins
king's assay master was specially charged with all
relating to the accuracy of the standard. The officer
rank to him was the comptroller, who presented
y to the baron of the exchequer a report of all the
d silver money struck in the kingdom during the
These reports, which were always written upon
ent, constitute the chief mint record. The Lord
xercised a general superintendence and kept an
of all the mint transactions. As the work of the
came more extensive and more complicated other
were added such as the surveyor of the melting,
or of the money presses, and many others.
present arrangements with regard to the officers of
were made in 1870, when several important changes
es in the mint establishment. Up to that time
d been two controlling officers, the master, who
n instances was selected on account of distinguished
e attainments (as in the case of Sir John Herschel
ofessor Graham), and the deputy master and comp
A careful inquiry, however, seems to lead to the
on that the control of the mint might with advantage
entrusted in the hands of a single officer of experience
conduct of public business, it was decided, on the
Professor Graham, to entrust the actual administra
the department to the deputy master, the office
le of master of the mint being held by the
lor of the exchequer for the time being without
At the same time the service of a scientific officer
ened, by the appointment of a chemist of the mint.
ning and die department and the melting depart
ere united under the name of the operative depart
and placed under a single superintendent. The
puty master appointed under the new regulations
Hon. C. W. Fremantle, C.B., to whom the public are
d for a series of *Annual Report* which have given a
l increased interest to the subject of the coinage and
aid to constitute in themselves a mint literature.
actual operations of coining in early times were few
ber and simple in character. The metal forming
y were melted together in the proportion necessary
g them to the required standard, and the alloy thus
d was cast into bars, which were reduced by
ring to the requisite thickness. They were then
h shears into pieces more or less regular in size and
roughly annealed, and finally impressed with the
ed device by a blow with a hammer.
last-named appears to have been the only part of
ess which was performed with any great amount of
The blank piece was placed by the hand upon a die
to a block of wood having a large heavy base to
he oscillation caused by the blow, the die on which
graved the device for the reverse of the coin was
ated upon the upper side of the blank, and held by
of a holder, round which was placed a roll of lead to
the hand of the operator while heavy blows were
with a hammer by an assistant workman. One of the
earliest improvements in coining was the introducti
tool in shape resembling a pair of tongs, the two die
placed one at the extremity of each leg. The neces
necessity of readjusting the dies between successive
of the hammer, and ensured greater accuracy in the
sion. It was long before the system of coining by ha
superseded by the coining press or mill, which, even
its introduction, was only very slowly adopted
attempts were made to introduce machinery for
before it was brought into active use the objection
to its great expense. The mill and screw were
introduced into the mint under Charles II., when
improvements were also made in the preliminary oper
steam power was first applied in 1810, when the s
screw press was introduced. In 1839 Uhlhorn's invent
lever press, which still remains in use.
The subject of the decoration of coins is one being
of time both from an artistic and an historical point o
becomes very important when it is remembered th
the impression of the coin with the authorized
which make it legally current. The artistic merit
degree of the early Greek coins are well known and
that the dies from which the coins were struck must
been engraved with much skill and care. The form
coins before being stamped were at first merely
natural rounded nugget of gold, or of the silver o
known as *electrum*. Such coined nugget of gold
to be found among the hill tribes of India
nugget were afterwards replaced by roughly ha
made like ball bullets, a term which rendered it
impart high relief to the obverse and comparative
relief to the reverse of the coins. The early Britis
had for their prototype the gold "staters" of Ph
Macedon, but the design of this beautifully mo
was so roughly imitated by a succession of Britis
that ultimately the wreath round the head of the
alone survived, and that was scarcely recognizable
It is not only in the early British coins that the m
of classical art may be seen, but a very evident i
of the present day, the most notable instance bei
reverse of the bronze coinage, and the beautiful de
St George and the dragon by Pistrucci, which
as an alternative design for the sovereign. It ha
ascertained that the impressions on the reverse
early Greek coins were produced by the touch
of the anvil or the mint head on which they were
while the obverse was struck with the die. A litt
the device on the reverse of the coin was often
placing the blank piece on small points of metal a
in geometrical form which caused corresponding
tions on the coins when struck with the hammer
beauty and accuracy of design on coins gradually in
as art and mutual kill to competed, and probably culm
at the period of the Renaissance.
Although it has been the custom since the time
Saxons to stamp coins with the head of the r
monarch, it does not appear that any attempt at act
traiture was made in England until the reign of Hen
who, "at the eighteenth or nineteenth year of his
did make a great Portcullis in the form of his co
which his head was now represented in profile, an
a good resemblance of his other pictures."[1] Sim
much care seems to have been taken to stamp th
with a true likeness of the monarch. In most c
head bears a striking resemblance to the portrait
by the great artists of the respective periods, and
indeed, generally designed by artists of eminence
of the Milan coinage of Louis XII. and to tho

[1] See Evans, *Coins of the Ancient Britons*.
[2] See Martin Folkes, *Tables of English Silver and Gold C*

d by Leonardo da Vinci, and similar work is attri
o Benvenuto Cellini
ey each coin silver coins were equal in weight
[illegible] weighing 24 grains or 1 penny
[illegible] was denominated a pound was a
[illegible] or troy silver. The principle
[illegible], not strictly adhered to the coins
[illegible] below the standard of weight. This
[illegible] arisen from the impossibility
[illegible] but Rudding (*Annals of the
[illegible] it to have occurred from design, as the
[illegible] weight was sometimes made a source of profit
[illegible] from the standard weight permitted by law,
[illegible] the remedy, and anciently called the "chere,
[illegible] advantage to the issuer, that the coins
[illegible] considerable diminution, particularly when as
[illegible] happened, they were also clipped or coined
[illegible]. When the coins were called in they
[illegible] by weight and not by tale, so that the pro
[illegible] considerable loss. In later times the great
ments in the method of manufacture made it easy
to for greater accuracy both of weight and impression
ently the remedy permitted by law has been con
y reduced, and the possibility of making a large
of profit by the issue proportionally diminished.
eignorage levied on the coining of money was not
ates, but varied considerably at different times, and
from a deduction made from the bullion coined.
ablished by an Act of Charles II, which provided
person bringing sterling silver or standard gold to
it should receive in exchange an equal weight of
coin, the expense of coining being defrayed by
duty levied upon every commodity of common
The seigniorage [illegible] in the reign
e III, when that part of the Act of Charles II.
elating to the coinage of [illegible] was
d, and another Act was passed [illegible] every
of silver to be coined into [illegible] shillings instead
two, the four shillings to be coined from each pound of
y this depreciation of the [illegible] are [illegible] coined over
nage of the mint to defray the expense of assay
, and manufacture. An Act of William IV
l the seigniorage on the silver coinage to be paid
redit of the Consolidated Fund, and the charge of
t to be brought annually before parliament. Until
nt derived by the latter from the coinage must be
he expense of maintaining the silver coinage at
ge fit for circulation by frequently withdrawing
, and re-issuing the silver coin. A vote of
s annually taken in the mint estimates for the
ge of silver.
[illegible] the work of the mint was performed by
[illegible] master for undertaking the manufacture of
[illegible] gold price, and paying the moneyer
[illegible] of seigniorage under him at a fixed tariff
[illegible] between the crown and the mint
[illegible] master for seigniorage was sometimes
by [illegible] appear to have
[illegible] Edward II., when the master
[illegible] the Exchequer and the [illegible] master of
[illegible] Under this agreement
[illegible] that he [illegible] minute
[illegible] pieces
[illegible] the master of
[illegible] contract was to
[illegible] head-piece of the
[illegible] pound troy
[illegible] silver in the
[illegible] mounted to 3d.
[illegible] every hundred pounds
[illegible] 11, the
[illegible] weight of each
an allowance was secured to the master to cover all
penses of coinage. Although the master of the mint
to be a contractor, the arrangement with the manage
tinued in force up to 1851.

The work of coinage was transferred in 1810 fr
Tower of London, where it had been carried on fo
centuries, to the present Mint on Tower Hill, not fa
the Bank of England. The head of the department,
already been stated, is the chancellor of the exchequ
the time being, who is *ex officio* master of the min
practical direction of the work being placed in the
of a permanent officer, the deputy master, who is resp
for its due performance. From the English mint is s
the coinage to the whole of the British empire, in
the colonies with the exception of Australia; th
and the East Indies are supplied from branch mints
lished at Sydney and Melbourne, and the mints of C
and Bombay. In addition to the gold, silver, and
coins current in the United Kingdom, the Englis
strike gold coin of the value of two dollars fo
foundland, silver coins of the value of fifty, twen
twenty, ten, and five cents respectively for Newfou
and Canada, bronze pence and halfpence of special
for Jersey, and nickel pence, halfpence, and farthi
the West Indies. The number of coins of each s
denomination issued varies considerably in differen
the demand for several denominations of coin ma
determine the supply.

The following table (from official sources) shows the valu
gold and silver coins issued during the ten years 1871
total value of the bronze coinage in the same period is £

	Gold Coinage		Silver Coinage	
	Coins	Total Value	Half Crowns	
		£		
[illegible]	[illegible]	1,617,720	1,261,111	
[illegible]	[illegible]	1,064,240	1,384,068	
[illegible]	1	911,936	1,461,963	274,240
187[illegible]	[illegible]	[illegible] 964	243,264	138,996
1876	11,700	1,091,945	1,676,645	79,200
1877	[illegible]	983,163	914,363	55,836
1878	66,269	1,[illegible],740	2,264,069	184,150
1879	1,545	1,545	3,060	112,662
1880	1,[illegible]	61,[illegible]9	4,[illegible],052	168,107
1881				280,170
	[illegible],721	[illegible],[illegible],[illegible]0	12,479,129	1,291,856

Date	Shillings	Fourpence	Threepence	Twopences	Pence	
	£	£	£	£ s.	£	
1871	41[illegible]	21,[illegible]0	69 6	1,[illegible]96 2	39 12	33
187[illegible]	32[illegible]4	16[illegible],[illegible]0	69 6	5[illegible]44 2	39 12	33
[illegible]	2[illegible],000	16[illegible],000	69 6	[illegible],001 2	39 12	33
[illegible]	2[illegible],[illegible]00	[illegible]	69 6	11,4[illegible] 2	39 12	33
[illegible]	[illegible]49	[illegible],[illegible]5	69 6	[illegible],[illegible]96 2	39 12	33
[illegible]	[illegible],[illegible]00	[illegible],[illegible]77	69 6	[illegible],[illegible]44 2	39 12	33
[illegible]	[illegible],[illegible]00	[illegible],[illegible]00	69 6	[illegible],[illegible]50 2	39 12	33
[illegible]	[illegible],[illegible]46	[illegible],[illegible]60	69 6	[illegible],[illegible]682 2	39 12	33
[illegible]	[illegible],[illegible]51	[illegible],[illegible]42	69 6	[illegible],[illegible]130 2	39 12	33
[illegible]	[illegible]	[illegible],[illegible]00	69 6	[illegible],[illegible]66 2	39 12	33
[illegible]	[illegible]	[illegible],[illegible],[illegible]00	[illegible]	[illegible],[illegible],[illegible]0	390 0	330

The first [illegible] of twenty-shilling piece was iss
by proclamation [illegible] July 1817, superseding the g
[illegible] one-pound piece. Crown pieces of the nominal
[illegible] were first struck in the reign of Henry VI
[illegible] and threepenny pieces are first mentioned in the
Edward VI. while the first of fourpenny-piece was coined
[illegible] the reign of Edward I., the florin or two-shilling-p
[illegible] in 1849. Copper money was first coined by C
[illegible] but does not appear to have been issued until 1672.
[illegible] of bronze in 1860.

The weight and fineness of the various denominations
[illegible] at the Royal Mint [illegible] shown in the first schedule of t
[illegible] 33 Vict. c. 10, 1870:—

In the gold return fractions of pounds sterling are omi
[illegible] The numbers and weights of the fourpences, twopences, a
bronze Maundy coins, are the same for each of the years :—4
pence, 1752 twopences, and 7920 pence.

M I N T

Denomination of Coin	Standard Weight		Least Current Weight		Remedy Allowed	
	Imperial Weight Grains	Metric Weight Grammes	Imperial Weight Grains	Metric Weight Grammes	Standard	Weight per Piece
						Imperial Grains / Metric Grammes
ound	616 37213	39 9410	4[illegible] 50390	39 68934	Pure gold	1 50000 / 0 09719
ound	246 54895	15 9576	244 00000	15 81574	Alloy as mint	0 60000 / 0 03887
old	123 27447	7 9788	122 00000	7 90787	Standard	0 30000 / 0 01944
overeign	61 63723	3 9894	61 00000	3 95393	Pure gold	0 15000 / 0 00972
					Alloy as mint	0 03750 / 0 00243
	46 22792	2 9920				
rown	185 09184	11 9680				
	74 03673	4 7872				
ng						
nce						
ur-penny piece						
penny	21 81818					
ence	10 90909					
					Mint Remedy	2 grains / 0 1296
penny					Copper coin, and	1 0 00 / 0 0648
ny piece					do	0 5 00 / 0 3240

weight and fineness of the coins prescribed by the ordinance to what is provided by the Act 56 George III. Gold coin of the United Kingdom of Great Britain should hold each weight and fineness as were prescribed by the existing mint ordinance, that is to say, that 934 pounds weight troy and twelve ounces troy thereof should be coined into one hundred and thirty four sovereigns and one half sovereign contained in 20 lb weight troy of standard gold, according to the trial of the same of 22 carats fine gold and 2 carats alloy, and the pound weight troy and twelve ounces troy thereof should be coined into two hundred and sixty eight half sovereigns and one half sovereign contained in 20 lb weight troy of standard gold, according to the trial of the same of 22 carats fine gold and 2 carats alloy, and the pound weight troy and twelve ounces troy thereof should be coined into five hundred and thirty six half sovereigns contained in 20 lb weight troy of standard gold, according to the trial of the same of 22 carats fine gold and 2 carats alloy, and the pound weight troy and twelve ounces troy thereof should be coined into one thousand and seventy two quarter sovereigns contained in 20 lb weight troy of standard gold, according to the trial of the same of 22 carats fine gold and 2 carats alloy, and the pound weight troy and twelve ounces troy thereof should be coined into two thousand one hundred and forty four half quarter sovereigns contained in 20 lb weight troy of standard gold, according to the trial of the same of 22 carats fine gold and 2 carats alloy, and the pound weight troy and twelve ounces troy thereof should be coined into four thousand two hundred and eighty eight quarter quarter sovereigns contained in 20 lb weight troy of standard gold, according to the trial of the same of 22 carats fine gold and 2 carats alloy, and the pound weight troy and twelve ounces troy thereof should be coined into eight thousand five hundred and seventy six eighth quarter quarter sovereigns contained in 20 lb weight troy of standard gold, according to the trial of the same of 22 carats fine gold and 2 carats alloy, and the pound weight troy and twelve ounces troy thereof should be coined into seventeen thousand one hundred and fifty two sixteenth quarter quarter sovereigns contained in 20 lb weight troy of standard gold, according to the trial of the same of 22 carats fine gold and 2 carats alloy, and the pound weight troy and twelve ounces troy thereof should be coined into thirty four thousand three hundred and four thirty second quarter quarter sovereigns contained in 20 lb weight troy of standard gold, according to the trial of the same of 22 carats fine gold and 2 carats alloy, and the pound weight troy and twelve ounces troy thereof should be coined into sixty eight thousand six hundred and eight sixty fourth quarter quarter sovereigns contained in 20 lb weight troy of standard gold, according to the trial of the same of 22 carats fine gold and 2 carats alloy, and the pound weight troy and twelve ounces troy thereof should be coined into one hundred and thirty seven thousand two hundred and sixteen one hundred and twenty eighth quarter quarter sovereigns contained in 20 lb weight troy of standard gold, according to the trial of the same of 22 carats fine gold and 2 carats alloy, and the pound weight troy and twelve ounces troy thereof should be coined into two hundred and seventy four thousand four hundred and thirty two two hundred and fifty sixth quarter quarter sovereigns contained in 20 lb weight troy of standard gold, according to the trial of the same of 22 carats fine gold and 2 carats alloy, and the pound weight troy and twelve ounces troy thereof should be coined into five hundred and forty eight thousand eight hundred and sixty four five hundred and twelfth quarter quarter sovereigns contained in 20 lb weight troy of standard gold, according to the trial of the same of 22 carats fine gold and 2 carats alloy, and the pound weight troy and twelve ounces troy thereof should be coined into one million one hundred and seventy seven thousand six hundred and twenty eight one thousand and twenty fourth quarter quarter sovereigns contained in 20 lb weight troy of standard gold, according to the trial of the same of 22 carats fine gold and 2 carats alloy, and the pound weight troy and twelve ounces troy thereof should be coined into two million three hundred and fifty five thousand two hundred and fifty six two thousand and forty eighth quarter quarter sovereigns contained in 20 lb weight troy of standard gold, according to the trial of the same of 22 carats fine gold and 2 carats alloy, and the pound weight troy and twelve ounces troy thereof should be coined into four million seven hundred and ten thousand five hundred and twelve four thousand and ninety sixth quarter quarter sovereigns contained in 20 lb weight troy of standard gold, according to the trial of the same of 22 carats fine gold and 2 carats alloy, and the pound weight troy and twelve ounces troy thereof should be coined into nine million four hundred and twenty one thousand and twenty four eight thousand one hundred and ninety second quarter quarter sovereigns contained in 20 lb weight troy of standard gold, according to the trial of the same of 22 carats fine gold and 2 carats alloy, and the pound weight troy and twelve ounces troy thereof should be coined into eighteen million eight hundred and forty two thousand and forty eight sixteen thousand three hundred and eighty fourth quarter quarter sovereigns contained in 20 lb weight troy of standard gold, according to the trial of the same of 22 carats fine gold and 2 carats alloy, and the pound weight troy and twelve ounces troy thereof should be coined into thirty seven million six hundred and eighty four thousand and ninety six thirty two thousand seven hundred and sixty eighth quarter quarter sovereigns contained in 20 lb weight troy of standard gold, according to the trial of the same of 22 carats fine gold and 2 carats alloy, and the pound weight troy and twelve ounces troy thereof should be coined into seventy five million three hundred and sixty eight thousand one hundred and ninety two sixty five thousand five hundred and thirty sixth quarter quarter sovereigns contained in 20 lb weight troy of standard gold, according to the trial of the same of 22 carats fine gold and 2 carats alloy, and the pound weight troy and twelve ounces troy thereof should be coined into one hundred and fifty million seven hundred and thirty six thousand three hundred and eighty four one hundred and thirty one thousand and seventy second quarter quarter sovereigns contained in 20 lb weight troy of standard gold, according to the trial of the same of 22 carats fine gold and 2 carats alloy, and the pound weight troy and twelve ounces troy thereof should be coined into three hundred and one million four hundred and seventy three thousand seven hundred and sixty eight two hundred and sixty two thousand one hundred and forty fourth quarter quarter sovereigns contained in 20 lb weight troy of standard gold, according to the trial of the same of 22 carats fine gold and 2 carats alloy, and the pound weight troy and twelve ounces troy thereof should be coined into six hundred and two million nine hundred and forty seven thousand five hundred and thirty six five hundred and twenty four thousand two hundred and eighty eighth quarter quarter sovereigns contained in 20 lb weight troy of standard gold, according to the trial of the same of 22 carats fine gold and 2 carats alloy, and the pound weight troy and twelve ounces troy thereof should be coined into one thousand two hundred and five million nine hundred and fifty thousand seven hundred and seventy two one million and forty eighth quarter quarter sovereigns contained in 20 lb weight troy of standard gold, according to the trial of the same of 22 carats fine gold and 2 carats alloy, and the pound weight troy and twelve ounces troy thereof should be coined into two thousand four hundred and eleven million eight hundred and one thousand five hundred and forty two two million and ninety sixth quarter quarter sovereigns contained in 20 lb weight troy of standard gold, according to the trial of the same of 22 carats fine gold and 2 carats alloy, and the pound weight troy and twelve ounces troy thereof should be coined into four thousand eight hundred and twenty three million six hundred and three thousand and eighty four four million one hundred and ninety second quarter quarter sovereigns contained in 20 lb weight troy of standard gold, according to the trial of the same of 22 carats fine gold and 2 carats alloy, and the pound weight troy and twelve ounces troy thereof should be coined into nine thousand six hundred and forty seven million two hundred and seven thousand one hundred and sixty eight eight million and forty eighth quarter quarter sovereigns contained in 20 lb weight troy of standard gold, according to the trial of the same of 22 carats fine gold and 2 carats alloy, and the pound weight troy and twelve ounces troy thereof should be coined into nineteen thousand two hundred and ninety four million four hundred and fourteen thousand three hundred and thirty six sixteen million three hundred and eighty fourth quarter quarter sovereigns contained in 20 lb weight troy of standard gold, according to the trial of the same of 22 carats fine gold and 2 carats alloy, and the pound weight troy and twelve ounces troy thereof should be coined into thirty eight thousand five hundred and eighty eight million eight hundred and twenty eight thousand six hundred and seventy two thirty two million seven hundred and sixty eighth quarter quarter sovereigns contained in 20 lb weight troy of standard gold, according to the trial of the same of 22 carats fine gold and 2 carats alloy, and the pound weight troy and twelve ounces troy thereof should be coined into seventy seven thousand one hundred and seventy seven million six hundred and fifty seven thousand three hundred and forty four sixty five million five hundred and thirty sixth quarter quarter sovereigns contained in 20 lb weight troy of standard gold, according to the trial of the same of 22 carats fine gold and 2 carats alloy, and the pound weight troy and twelve ounces troy thereof should be coined into one hundred and fifty four thousand three hundred and fifteen million three hundred and thirteen thousand four hundred and eighty eight one hundred and thirty one million and seventy second quarter quarter sovereigns contained in 20 lb weight troy of standard gold, according to the trial of the same of 22 carats fine gold and 2 carats alloy, and the pound weight troy and twelve ounces troy thereof should be coined into three hundred and eight thousand six hundred and thirty million six hundred and twenty seven thousand and seventy six two hundred and sixty two million one hundred and forty fourth quarter quarter sovereigns contained in 20 lb weight troy of standard gold, according to the trial of the same of 22 carats fine gold and 2 carats alloy, and the pound weight troy and twelve ounces troy thereof should be coined into six hundred and seventeen thousand two hundred and sixty one million two hundred and fifty five thousand one hundred and fifty two five hundred and twenty four million two hundred and eighty eighth quarter quarter sovereigns contained in 20 lb weight troy of standard gold, according to the trial of the same of 22 carats fine gold and 2 carats alloy, and the pound weight troy and twelve ounces troy thereof should be coined into one thousand two hundred and thirty four million five hundred and twenty three thousand and ninety six one million and forty eighth quarter quarter sovereigns contained in 20 lb weight troy of standard gold, according to the trial of the same of 22 carats fine gold and 2 carats alloy, and the pound weight troy and twelve ounces troy thereof should be coined into two thousand four hundred and sixty nine million and forty seven thousand and forty eight two million and ninety sixth quarter quarter sovereigns contained in 20 lb weight troy of standard gold, according to the trial of the same of 22 carats fine gold and 2 carats alloy, and the pound weight troy and twelve ounces troy thereof should be coined into four thousand nine hundred and thirty eight million and ninety four thousand and ninety six four million and forty eighth quarter quarter sovereigns contained in 20 lb weight troy of standard gold, according to the trial of the same of 22 carats fine gold and 2 carats alloy, and the pound weight troy and twelve ounces troy thereof should be coined into nine thousand eight hundred and seventy seven million and one hundred and eighty four thousand and one hundred and ninety two eight million and ninety sixth quarter quarter sovereigns contained in 20 lb weight troy of standard gold, according to the trial of the same of 22 carats fine gold and 2 carats alloy, and the pound weight troy and twelve ounces troy thereof should be coined into nineteen thousand seven hundred and fifty four million and three hundred and sixty eight thousand and three hundred and eighty four sixteen million and three hundred and eighty fourth quarter quarter sovereigns contained in 20 lb weight troy of standard gold, according to the trial of the same of 22 carats fine gold and 2 carats alloy, and the pound weight troy and twelve ounces troy thereof should be coined into thirty nine thousand five hundred and eight million and seven hundred and thirty six thousand and seven hundred and sixty eight thirty two million and seven hundred and sixty eighth quarter quarter sovereigns contained in 20 lb weight troy of standard gold, according to the trial of the same of 22 carats fine gold and 2 carats alloy, and the pound weight troy and twelve ounces troy thereof should be coined into seventy nine thousand and seventeen million and three hundred and fifteen thousand and four hundred and eighty eight sixty five million and five hundred and thirty sixth quarter quarter sovereigns contained in 20 lb weight troy of standard gold, according to the trial of the same of 22 carats fine gold and 2 carats alloy, and the pound weight troy and twelve ounces troy thereof should be coined into one hundred and fifty eight million and sixty two thousand and seventy six two hundred and sixty two million and one hundred and forty fourth quarter quarter sovereigns contained in 20 lb weight troy of standard gold, according to the trial of the same of 22 carats fine gold and 2 carats alloy, and the pound weight troy and twelve ounces troy thereof should be coined into six hundred and twenty four million and six hundred and thirty thousand and seven hundred and sixty eight two hundred and sixty two million and one hundred and forty fourth quarter quarter sovereigns contained in 20 lb weight troy of standard gold, according to the trial of the same of 22 carats fine gold and 2 carats alloy, and the pound weight troy and twelve ounces troy thereof should be coined into one thousand two hundred and forty nine million and two hundred and sixty one thousand and one hundred and fifty two five hundred and twenty four million two hundred and eighty eighth quarter quarter sovereigns contained in 20 lb weight troy of standard gold, according to the trial of the same of 22 carats fine gold and 2 carats alloy, and the pound weight troy and twelve ounces troy thereof should be coined into two thousand four hundred and eighty

ad to be the weight of coin which could be manu
d in a day when the operations of coining were
ned by the head. The journey weight of gold is
troy, equal to 701 sovereigns or 1402 half-
ons. The journey weight of silver is 60 lb
from each journey weight a coin is taken and
of its pyx or chest for the annual trial. Thus
the trial of the gold mark company under
the crown in the presence of the queen's
or who administers the oath to the jury and
proceedings. The coin selected for trial
compared with pieces cut from trial plates of standard
which are in the keeping of the warden of the
the pieces being arrayed against the coin-
examination. If the coin are found to be of the
fineness and weight, within certain limits, a verdict
effect is drawn up by the jurors and presented to
a jury.

on account of the impossibility of ensuring an abso
exact admixture of metals in coinage, it has been
ecessary at all times to allow to the mint master
n margin, or "remedy" within which coins may
weight and fineness from the fixed standard and
considered of the current standard. The remedy
es for English gold coin is now fixed at 2 parts
000. The great importance of maintaining the
d of fineness for gold will be evident when it
hat the variation of $\frac{1}{10}$ of a millionth or thousandth
above or below the standard causes a gain or loss
00 in every million sterling. Gold coin would
hin the remedy of fineness permitted by law if
unt of precious metal contained in them varied
116 to 918·6 parts in 1000, and, although this
cannot be considered to be more than would
ecessarily and unavoidably occur even from the exact
d, still, in the case of gold, but a very small part of
medy of fineness is actually used, the coin seldom
below 916·3 parts of gold in 1000 or rising above
while the mean composition of each million of
ined from the mint is often of the precise legal
d, 916·66. The remedy of fineness for silver coin
appears to have been always greater than that for
n, it is 4 parts per 1000. The remedy of weight
l is 1·6 per 1000 parts, that for silver 1·17, and
bronze 2·0. Extreme care is taken to prevent the
om the mint of any coin that exceed these permitted
ns in weight and fineness, each piece being weighed
dy, and all that are found to be above or below the
d being returned to the melting-pot.

the real value of the gold coin at the same n
inal value, it is of the first importance that gold
hall not be below the standard weight should not be
to circulate, otherwise bullion or base coin might be
e profitable to counterfeit. After a certain
of wear coin ceases to pass current from hand to hand
ceases to be legally current. By the Coinage
ment Act 1870 a remedy of 1/2 grain for every sovereign or half-sovereign
was allowed to him in payment which is
the case with the person tendering it bearing
, but, as experience proved that this regard of the
ion, the law was practically without effect. The
awal of light coin from circulation was formerly
lished solely by the Bank of England, the mint
ions making provision for the receipt of gold tendered
ange only in the form of coin. The bank undertook
buy the light gold from the public at the rate of
. 6½d. an ounce, a price which, when compared with
t value of £3 17s. 10½d., meant a loss of no less
l an ounce on the seller. This loss was occasioned
by the circumstance that the bank, being obliged before sending the light gold to the mint for recoi
nage, assay, and cast it into bars, found it neces
deduct the sum of 2½d. an ounce from the rate of £
9d. an ounce at which it was allowed by statute to p
gold for coinage, in order to cover the expense o
operations and the loss incident to them. The loss
in price, added to that from deficient weight, occ
constant disregard of the law requiring all light coi
cut or defaced, and consequently a large amount
gold continued to be circulated. After the passing
Coinage Act in 1870, accordingly, fresh regulation
made, by which the mint authorities undertook to
light gold coin for recoinage, returning to the impor
full mint value of £3, 17s. 10½d. an ounce, thus reduc
loss to that arising from deficiency of weight only.
Bank of England was enabled by these regulations
its price for light gold to the rate of £3, 17s. 9d., th
rate at which it is bound to purchase ingots of st
gold, greater inducements were offered to the public
to light gold for recoinage, and its withdrawa
circulation was in consequence greatly facilitated.
evident, however, that, as the deficiency in weigh
entail some loss on the holders of light gold coin, th
be disposed to keep it in circulation as long as po
consequently only a small proportion of the ligh
received by bankers finds its way to the Bank of E
and thence to the mint for recoinage. The result o
careful experiments made by the late Mr Stanley
and published by him in the *Journal of the Statistical*
(vol. xxxi. p. 126), showed that a sovereign beco
light to be legally uncurrent at the end of eighteen
The last state measure taken for the withdrawal o
gold coin from circulation was the issue of a roy
proclamation in 1842 calling attention to the law
regulations relating to light gold coin, and inst
those persons whose duty it was to enforce them
that they were carried out. From the beginning o
1842 to the end of March 1845 £14,000,000 i
gold coin was withdrawn from circulation and re
This amount was estimated to represent 95 per cent
whole of the light gold then in circulation. In o
facilitate this withdrawal the Treasury had in Jun
entered into arrangements with the Bank of Engl
which the bank was enabled to purchase light g
on behalf of the Government, at the full mint value of £
10½d. an ounce. Light coin, however, continue
out into the bank for some time after it had reve
at original rate of payment for light gold, viz., £3, 17
an ounce. The expense to the state of this with
including the expenses of recoinage, was £67,816.
important withdrawal of worn gold coin has occurre
that time, it is evident that a large amount of ligh
must be at the present time in circulation, and th
loss on weight must be considerably greater than
the coins withdrawn in 1842, the oldest of which w
more than twenty-five years old, the first issue having
place in 1817. It has been proved by experiment t
average loss of weight in worn sovereigns and half-sov
now in circulation is about 5d. in each sovereign, a
the deficiency in fineness of a large proportion of t
amount to about £100 per million. This deficienc
from the trial plate of 1829, which determined the st
of a portion of the coins still in circulation, being
below the legal standard. Taking the gold circula
£100,000,000, of which at least 50 per cent. is ligh
estimated that the amount to be recoined cannot
than £50,000,000, on which the loss from defici
gold, both in weight and fineness, must be reckoned a
£650,000, independent of the expenses of recoinage

In the case of the silver coinage, the loss consequen

wal and recoinage of silver money is now covered
seigniorage arising from the difference between the
l the nominal value of the coins. Before the adop-
gold as the sole standard of value, the conditions
ng the withdrawal and recoinage of silver were much
e as they were for gold. In the period between the reign
rles II. and the accession of William III. the
on of the silver coinage became so unsatisfactory as
nd the attention of parliament. A recommendation
t the suggestion of Sir Isaac Newton for a recoinage
r was at first strenuously opposed, but was finally
l. In the course of the discussion the question of
the standard of weight and fineness arose, and this
ut change would probably have been made but for
resentations of Locke, who warmly took up the
n and convinced the Government of the desirability
serving the established standard. In the great
ge of silver, the loss arising from clipped and defaced
s borne by the public, the money being raised by
of a special tax on glass windows. The silver
l at this time amounted to £7,000,000, and the
sed to cover loss and the expenses of coinage to
,000. The work of this recoinage was so great that
ouncers of the mint in London were found to be
l to the pressure put upon them, and therefore
ere either revived or established for the first time
ew of the large provincial towns. In addition to
n furnaces were erected behind the Treasury at
all to melt down the old pieces. By these means
oration of the silver coinage was completed within
r. The new silver coins then issued were the first
had milled edges, the milling having been introduced
r to prevent clipping.

ode in which the silver currency is distributed throughout
dom is explained by the late Mr George Forbes, cashier of
k of England, as follows:

bankers in the Kingdom have a banker who is by agreement in
Every London banker has an account with the Bank of
l. In the Bank of England there is a department devoted
sale and receipt of silver coin. If in a district there is a
y of silver currency, the bankers of the district run the first
t out. They at once write to their London agent, who
their account with the Bank of England and obtains what
required, which they send to the country bankers. On the
nd, if there is a surplus of silver in a district it accumulates
ollers of the local bankers who send it up to their London
and they send it into the Bank of England. If there is a
demand for silver currency, the stock which the Bank of
l endeavours to keep on hand becomes unduly diminished.
mediate notice of the fact is conveyed to the mint authorities,
ceed with all convenient speed to coin a supply of florins,
s, sixpences, or of all of these coins, as the nature of the
may require.

l bullion for coinage is supplied to the mint almost
y by the Bank of England, the bank being bound
to purchase at the rate of £3, 17s. 9d. an ounce
old bullion of the legal standard which the public
ring for sale. Private individuals are permitted to
ullion to the mint, and to receive back the full
t (at £3, 17s. 10½d. an ounce) converted into coin,
any charge for loss or manufacture; but, as they are
to considerable delay, all "importations" of bullion
converted into coin in the order in which they are
t to the mint, the public practically prefer to sell
ullion to the bank, and receive its value without
In order to be accepted by the bank, the bullion
e cast into ingots and assayed, a guarantee being
by certain recognized assayers that the gold is of a
standard fineness. This is known as the "trade
." When the bank requires gold to be struck, due
is sent to the deputy master, and on a fixed day
llion is conveyed to the mint and delivered into his
y. It arrives in the form of ingots, each weighing
about 200 ounces, the aggregate value of each consignment being about £14,000. When the ingots arrive at the mint a small sample is taken from each and assayed, the result being sent to the authorities of the bank in order that it may be compared with that of the bank assay. If the bank authorities find that the two assays agree, within certain limits, as to weight and fineness, the ingots are immediately sent to the operative department of the mint to be converted into coin. The mint assayers use the basis for calculating the amount of copper, the alloy metal, that must be melted with the gold in order to produce the standard prescribed by law. The case of silver is somewhat different, the bullion being purchased by the bank department at its market value, which varies from year to year. During the ten years ending 1881 the average price of silver bullion sank gradually from 60½d. to 52d. per ounce. The silver bullion arrives at the mint in the form of bars, each of which weighs about 1000 ounces, the value of each bar or set of ingots varying considerably. The ingots, both of gold and silver, are weighed on a balance capable of turning with 1 grain when loaded with 1200 ounces.

The operations of coining have undergone some important changes with the introduction of new machinery and the increased extent of the Royal Mint, since the reconstruction of the operative department in 1881.[1] The plan (fig. 1) shows the present arrangement of the operative department.

The operations employed in the manufacture of gold and silver coin are as follow. (Incidental operations are printed in smaller type.)

I. Assaying the bullion.

II. Melting the metal.

(*a*) Addition of the exact amount of copper necessary to the prescribed alloy, by pouring the metal into moulds so as to form bars, and cleaning these bars to remove rough edges and hollow ends, (*b*) recovery of the metal from crucibles and "sweepings."

III. Assaying portions of metal cut from certain bars to ascertain whether sufficient accuracy has been attained in the standard fineness.

IV. Rolling the bars into strips or "fillets."

Annealing the fillets in some cases.

V. Adjusting the fillets by a final rolling and in some cases by the use of the drawbench.

Testing the fillets to ascertain whether they are sufficiently accurate for the coins.

VI. Cutting out discs or blanks from the fillets.

Adjusting the blanks to standard weight in one mint by hand.

VII. Edge rolling the blanks to produce a raised rim, and annealing the blanks and in some cases "blanching" or "pickling" them in dilute acid.

VIII. Coining, or stamping the devices on the blanks by means of engraved steel dies.

Milling the edges of the blanks or in some cases impressing the inscription, or ornament upon them.

IX. Weighing each coin, usually by the aid of automatic machinery.

X. Weighing and weighing pieces taken from the finished coin before it is issued to the public.

The foregoing list will make it clear that the operations of coining consist chiefly in the mechanical production of accurately adjusted disks of metal the purity of

[1] The coins are now annealed in the manner already described, and are washed in Sprengel's Acid Mixture and Gorse.

[2] In order to provide a stock of silver coin about the time of the accession of the present sovereign, when the want of the mint, there was a great demand for coin, and the stock of bronze coin was nearly exhausted, the Act 44 Vict. c. 2 was passed in 1881. The governor of the Bank of England had pointed out that the stock of gold coin held by the bank was also very small, and that no inconvenience would arise if the bank were relieved from coining sovereigns and half-sovereigns for a period of six months or a year or even more.'

as to be guaranteed, but in the formation of an
nposed of [illegible] and base metals in definite pro
The correctness of the "standard fineness" of the
ter [illegible] must be absolutely ascertained; the
[illegible] exceed thereto in manufacture against a
[illegible] and finally the correctness must be
[illegible] been converted into coin.

[illegible] are weighed on entering the mint,
a charge [illegible] stage in the manufacture of
[illegible] coins are also weighed in bulk before
[illegible] to the public.

[illegible] incidental to the coinage of bronze and
[illegible] from the [illegible] described in relation to gold in some
[illegible] detail only, and the weight and composition
bronze coins [illegible] not so carefully guarded as in the
[illegible] gold and

Subjoined are the details of the operations involved in the conversion of bullion into coin at the British mint.

After being assayed and weighed in the manner already described the bullion is taken to the melting house, where the details of treatment for silver and gold respectively differ somewhat. (The subsequent operations are nearly identical for both metals.) The silver melting house (see fig. 1) contains eight furnaces, of the kind shown at A in fig. 2, the part of the furnace containing the crucible being below the hole B, B. Crucibles of cast iron were formerly employed, but these were replaced in 1853 by wrought iron pots, which have since 1870 been in turn abandoned in favour of crucibles made of a mixture of clay and graphite, each crucible being capable of containing about 3000 oz. Such crucibles are very generally adopted throughout the Indian and Continental mints, but the form and dimensions given to them vary. The fuel employed in England is coke, about 75 lb of which are required to melt 3000 oz. of standard silver. Sufficient draught is afforded by the flue C and by a chimney about 35 feet high which communicates with it. The silver and copper are melted together

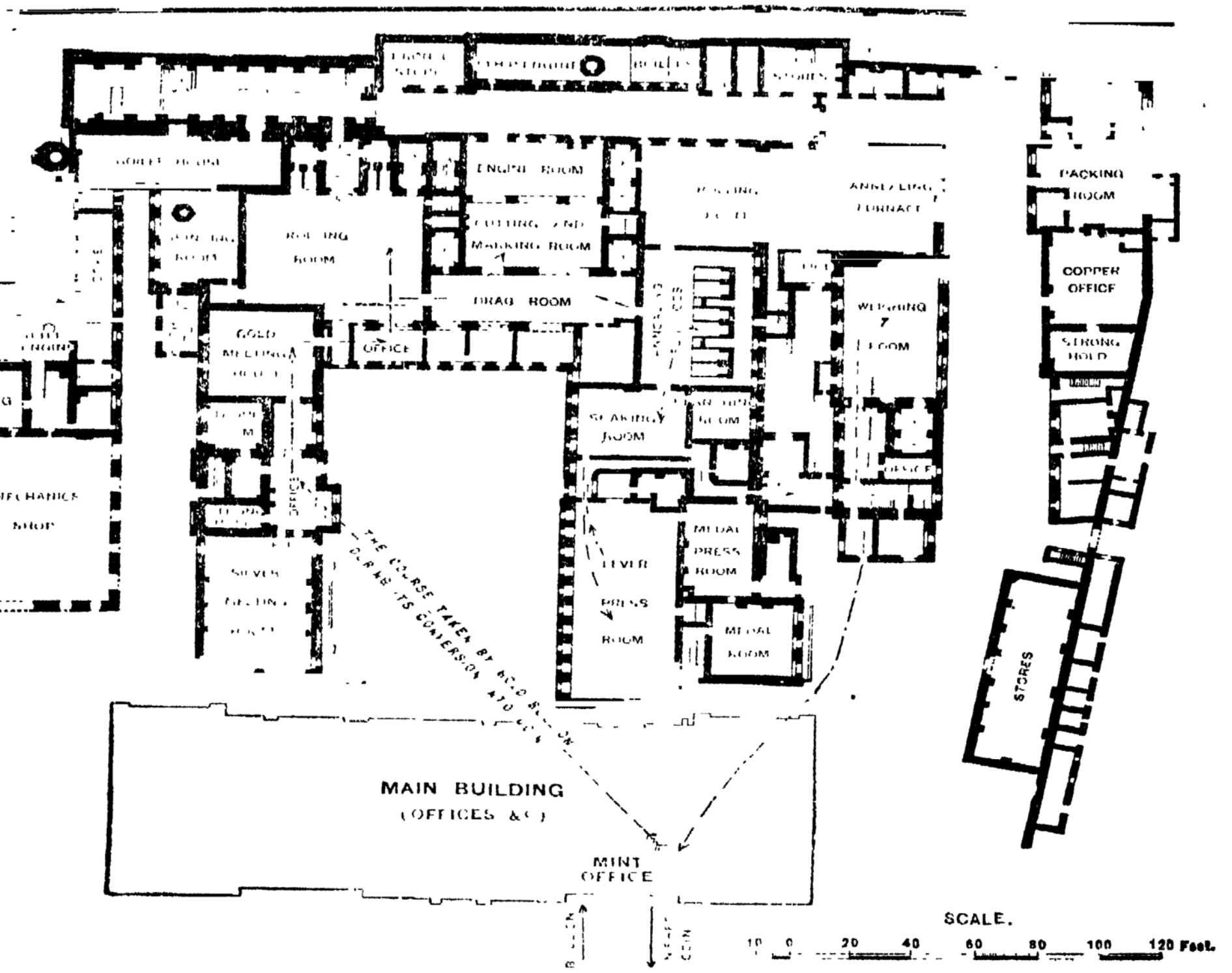


Fig. 1.—Royal Mint, Tower Hill, London. Plan showing the Operative Department as rearranged in 1881–82.

[illegible] poured into moulds it is stirred with an [illegible] end. The surface of the molten metal is [illegible] charcoal to prevent oxidation of the copper [illegible] ot is then removed from the furnace [illegible] tongs W and placed in a cradle M [illegible] by means of a handle D. By the interven- [illegible] G, H, and K acting on a rack the [illegible] the fulcrum formed by a spindle, [illegible] may be poured into the moulds [illegible] running on rail Q, Q. The moulds [illegible] enough to enable bars to [illegible] inches long. The width of the bars according to [illegible] from ¼ to ⅝ inches. [illegible] metal has [illegible] moulds it is removed and [illegible] trimmed by the aid of a revolving circular file, then [illegible] cut off and returned to the melting pot. Portions of [illegible] then cut from each of the ends and sent to the assay [illegible]. The bars are weighed before they pass to the subsequent operations of coinage, in order that the amount of metal remaining in the crucibles or carried into the flue may be ascertained. [illegible] is melted in a similar way, but the crucibles are smaller and contain only 1200 oz. Their contents are poured by hand into moulds, one end of the tongs by which the crucible is grasped being supported by a chain and suspended from the roof. In many Continental mints it is very generally the practice to leave the crucible containing the precious metals in the furnace and to pour the contents into the moulds by the aid of small ladles of wrought iron lined with clay.

It has been pointed out in GOLD (vol. x. p. 751) that minute quantities of certain metals render standard gold extremely brittle and unfit for coinage. If either the gold bullion or the copper used as an alloying metal should be impure, brittle bars will be the result. Should this prove to be the case, the bars are re-

[illegible] A new form of furnace devised by M. A. Piat of Paris has recently been introduced. In these furnaces the portion which contains the crucible may be detached from the flue, so as to admit of the molten metal being poured into moulds without removing the crucible from the incandescent fuel. Four of such furnaces have been fitted up in the gold melting-house, but have not as yet been used for gold melting, in the melting of silver and bronze, however, they are known to effect considerable economy in labour, fuel, and crucibles.

melted and chlorine gas is passed through the molten mass in the manner described in GOLD, vol. x. p. 750.

The engine-room (shown in fig. 1) contains three 60 horse-power vertical condensing engines, which are provided with Corliss valves, and are specially devised for meeting the constantly varying strain to which they are subjected by the machinery, the whole of which they are capable of driving. The central engine acts directly on either or both of the rolling rooms placed on each side of the engine-house. There is, however, an additional 20 horse-power compound beam engine usually employed, in connexion with the pumps of a deep artesian well.

Into one or other of these rooms the bars which have been cast in the melting-house are brought, and are rolled into strips the thickness of which depends on the kind of coins to be produced. Gold is rolled in one room and silver or bronze in the other; the details of manipulation involved in the conversion of gold or bronze bars into coin, however, do not differ materially, and coining of sovereigns will therefore be taken as typical.

Each room contains six pairs of rolls, the diameter of which varies from 10 to 14 inches. Smaller diameters are employed in most European mints, but on the other hand the use of very large rolls of the largest diameter has often been suggested, and there appears to be good ground for the belief that the rigidity of such rolls would enable strips or fillets of more uniform thickness to be

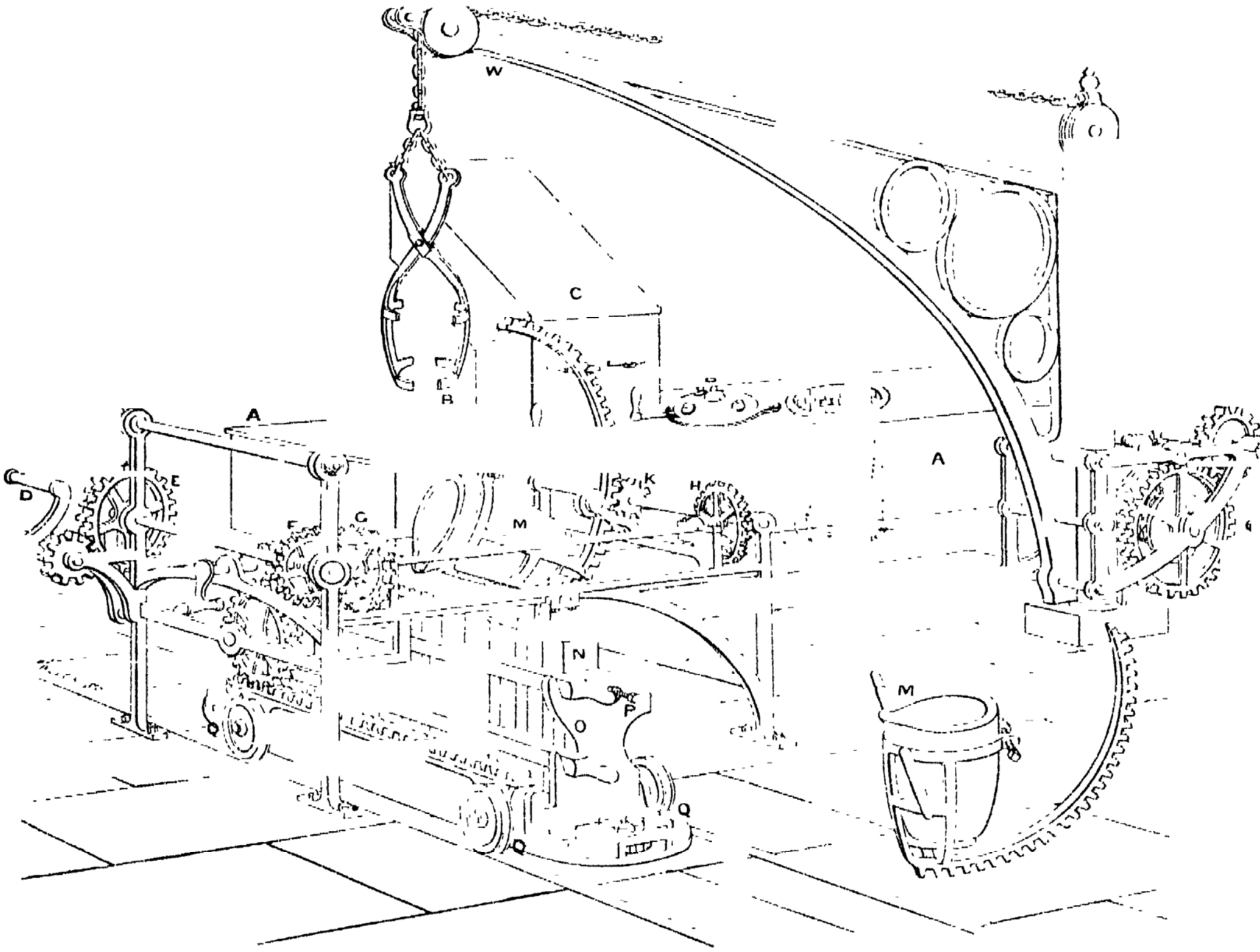


FIG. 2.—Furnace Apparatus.

produced than is the case at present. The iron frame CC (fig. 3) is firmly bolted to the stone D, which rests on a solid foundation EE. This frame supports the two rolls A, B, the lower of which B revolves, but is not, like the upper, capable of adjustment in a vertical plane. The upper roll is centred in bearings, and may be raised or lowered by means of screws connected with toothed wheels F, F, which are turned by a handle G, both wheels being moved simultaneously by worms on the rod H. The bearings of the upper roll are connected by vertical rods with weights below the level of the floor;

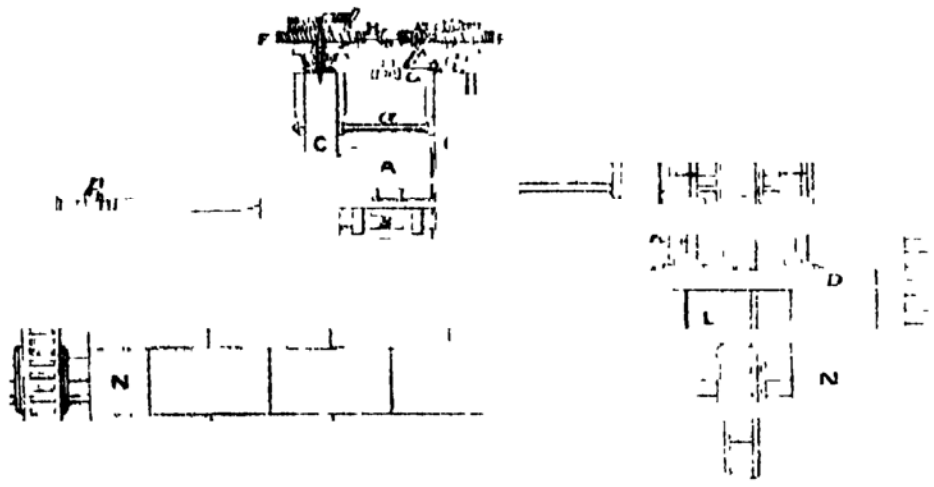


FIG. 3.—Rolls.

and, as it moves with the screws it can thus be readily adjusted to lie exactly parallel with the lower roll, at a distance from it to admit the bar which is to be reduced to a strip. The rolls are turned by the shaft NN, the main wheel and the gearing K, L, O, P. The collets by which the upper roll is connected with the gearing by the shaft I are not rigid, therefore with the shaft Q of the lower roll, but admit of the adjustment of the roll. The portion of the roll used to determine the guide a little wider than the bar. The rolls throughout the department are driven at the rate of about 52 revolutions per minute. The iron frame CC is braced by rods [illegible] and beams the driving gear are shown at [illegible].

The metal [illegible] sovereign bars, the standard weight of which is [illegible] ounces, are annealed in batches of about [illegible] in order to be passed through the rolls under precisely the same condition of adjustment. The bars are only [illegible] with a few repeated passes through the rolls, but are [illegible] reduced by [illegible] on the first stage of the [illegible]

[illegible] are [illegible] shown in the [illegible] are [illegible] the rolls are [illegible] by the pair of [illegible] down roll [illegible] which the fillets are first treated. The upper [illegible] also revolves. The necessary [illegible] is given to the [illegible] introduced, by slightly turning the upper roll by means of a [illegible] lever.

…s, while in the lat… …ives the reduction in the thickness at each …sage through the r… …s from 1/64th of an inch and finally …or two" passes are given to the bar by simply pass… …them through the rolls without altering the adjustment. The …ness of the blanks is then ascertained whether they are of the accurate …kness or not. …

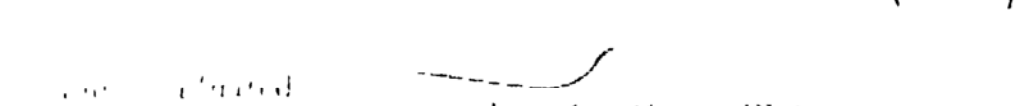


Fig. 4. Gauge Plate.

…ident that the weight of the fan… …depends upon …ness of the fillet; and to show how accurately the rolling …s performed it may be pointed out that, in the case of the …sovereign, a variation of 1/64th of an inch above or below the …thickness, or a range of 1/64th of an inch, throws the …of" remedy.

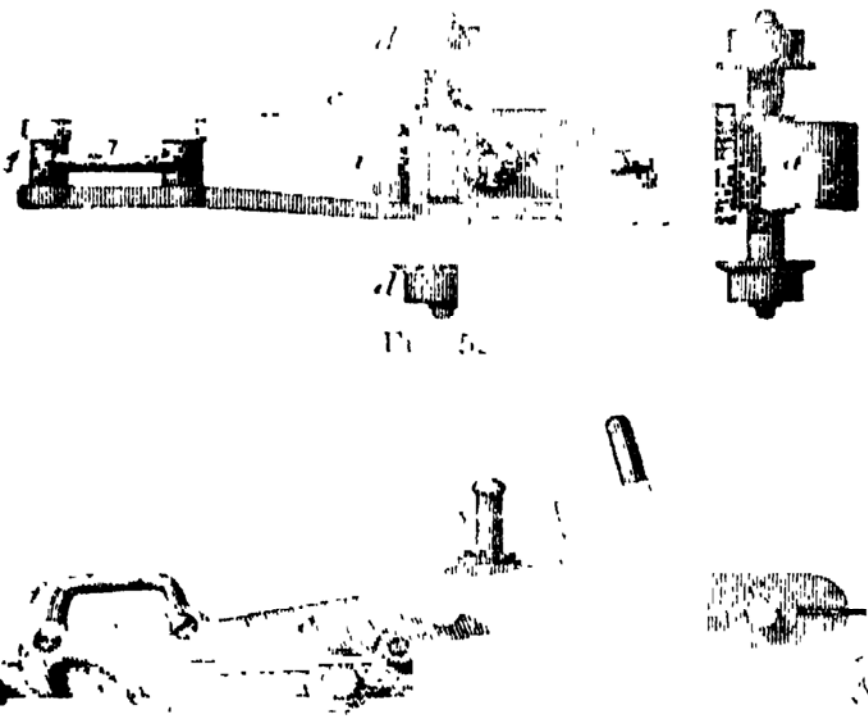
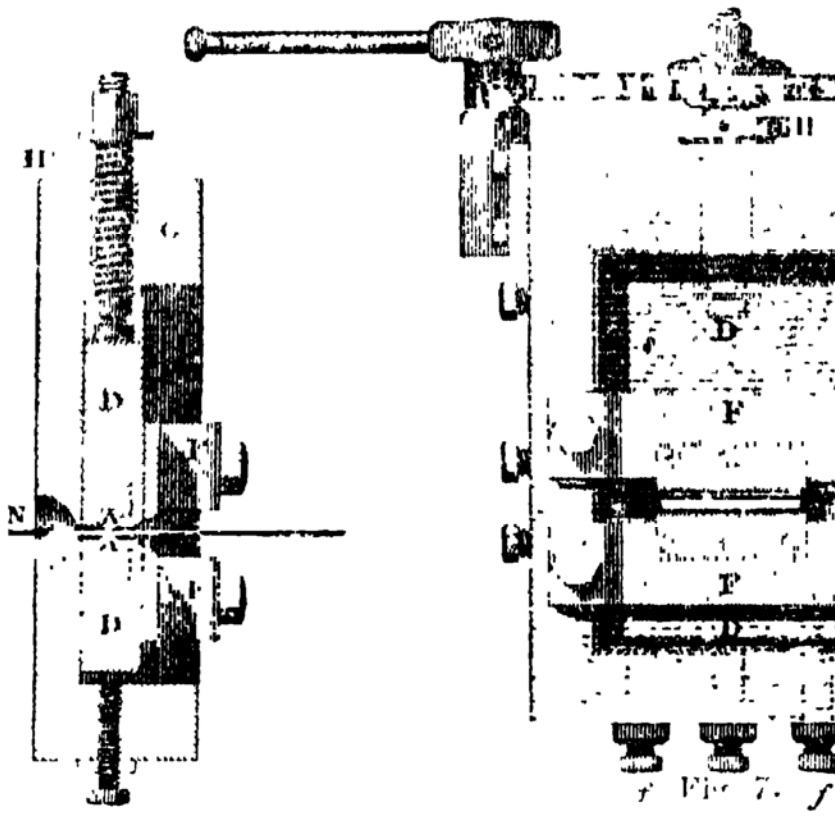


Fig. 5.

Fig. 6.

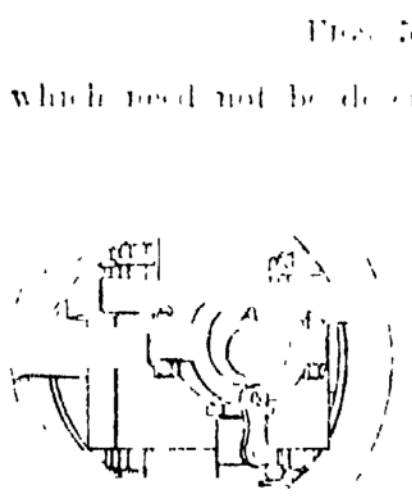
The repeated passage through the rolls is attended by a conside… …able increase of hardness in the metal, and it is therefore in som… …cases necessary to anneal the fillets repeatedly during the rollin… In the case of fillets for sovereigns the annealing may be entire… …dispensed with if the original thickness of the bars does not exce… …ths of an inch. Fillets for half-sovereigns have only to be anneal… …once. In some European mints the fillets are annealed frequently… …in one mint the operation is performed after each passage throug… …the rolls. The furnace used for the purpose is generally so arrange… …as to permit the flame to play over the fillets, which are sometim… …freely exposed to the action, but are more often enclosed in cast… …tubes. Muffle furnaces are frequently used. The furnace used … …the Royal Mint is a simple form of reverberatory furnace. Th… …final rolling is given by a pair of finishing rolls capable of mo… …accurate adjustment than the "breaking down" rolls.

The fillets of gold or silver are in some cases, though not alway… …submitted to an appliance known as the drag bench, shown … …figs. 5, 6, 7. It is designed to equalize the thickness of the fillets b… …drawing them between steel cylinders. The ends of the fillets a…



Figs. 5, 6, 7.—Drag Bench.

…flattened in a little appliance, which need not be described.



…central feature of the …hine now used in the …consists of two small …cylinders A A, which …not revolve, and are …in position in the …D, D by clamp pieces …s, tightened against them. …portions of metal may …justed by the aid of …the …ing …and by small ad… …screws f, f. The …of the machine con… …the steel cylinders, …ed by a cut of a …

…and f are operated by …handle f. The …on the wheel …drawing of the … conducted is to ov… …flattened end is introd… …ed between the steel …nders, and is then pas… …the jaws a. The jaws …on the pairs c, and while …fillet is being dragged …ugh the cylinders the …of the wheels d, d tends …ase the grip of the …by acting on their inclined ends …

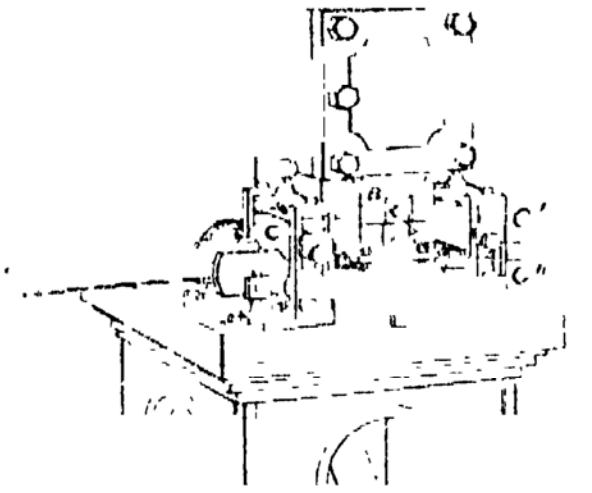


Fig. 8. Cutting Machine.

…directly the strain on the …

The cutters employed in the mint until quite recently were … …complicated construction, but these have been replaced by a simp… …machine (fig. 8) which, by the revolution of an excentric A, caus… …two short steel cylinders, mounted on a block of iron B suitab… …guided, to enter two holes firmly fixed in a plate on the bed of th… …machine. When the fillet FF is … …interposed between the short cylin… …ders and the holes, the former force… …disk of metal through the holes, …the fillet being advanced at each …stroke of the machine by small gripping rolls C, C', C'' actuated by … …ratchet wheel E, driven from the shaft which bears the excentric … …The disks pass down the tube G to a receptacle placed on the floo… …In the case of very large silver coins, only one disk is cut in th… …width of the fillet, and in some few mints disks for gold coin a… …also cut in this way, but it is far more usual to cut two disks … …the width of the fillet, the position of the cutters being so arrange… …as to remove blanks in the manner shown in fig. 9. In cuttin… …disks for bronze coin extreme precision is not necessary, and it h…

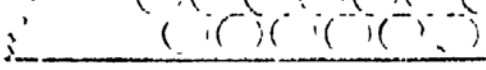


Fig. 9.

…fore been found possible to obtain five at each stroke of th… …machine.

will be evident that the rough classification of the fillets rding to their thickness, to which reference has already been e, renders it easy to compensate for slight irregularities in thick- caused by rolling, by employing cutters of a slightly larger eter than the standard size for fillets which are too thin.

he fillets after the removal of the disks present the perforated arance shown in fig. 9. The residual metal, called "scissel," h amounts to from 25 to 30 per cent of the metal operated upon, turned to the melting house in bundles weighing 180 oz. It be mentioned here that all attempts to cut disks or blanks for age from the ends of rods or cylinders, and thus to avoid the uction of scissel, have hitherto failed.

he next operation to which the blanks are submitted varies in rent mints. In some, each blank is weighed by hand or by matic machinery, and each blank that is too heavy is adjusted r to an exact weight or to within the remedy prescribed by

On the Continent it is very generally the practice to adjust ks by the aid of a file, or by a machine that removes a fine ing of metal from the surface of the blank. In mints where hanical adjustment is adopted there is a tendency to produce o heavy" blanks in the rolling and cutting departments, as it is ossible to adjust blanks which are too light.[1]

In the London mint finished coin alone is weighed, so that t blanks after leaving the cutting room pass directly to an edge-rollin machine, which thickens the edge of each blank so as to form a ri intended to protect the impression on the finished coin. T operation of edge-rolling is called "marking," and the method conducting it varies considerably in different mints.

In the Royal Mint the blanks are made to pass in quick succe sion, at the rate of six hundred a minute, between a circular groo in the face of a revolving steel disk and a groove in a fixed blo placed parallel to the face of the revolving disk. The groove the block exactly corresponds to that on the disk; and, as t distance between the block and the disk is slightly less th the diameter of the blank submitted to the operation, the result that before the blank escapes from the machine its edge has be thickened. The operation may be varied by admitting the blan between a groove in the periphery of a revolving wheel and a groo in a segmented block, placed at a distance from the wheel rath less than the diameter of the blank. The wheel and block may either vertical or horizontal.

In some cases the edges of the blanks, at the same time that th are thickened, receive the impression of a legend, or inscription, an ornamental device. When this is the case the blank is roll

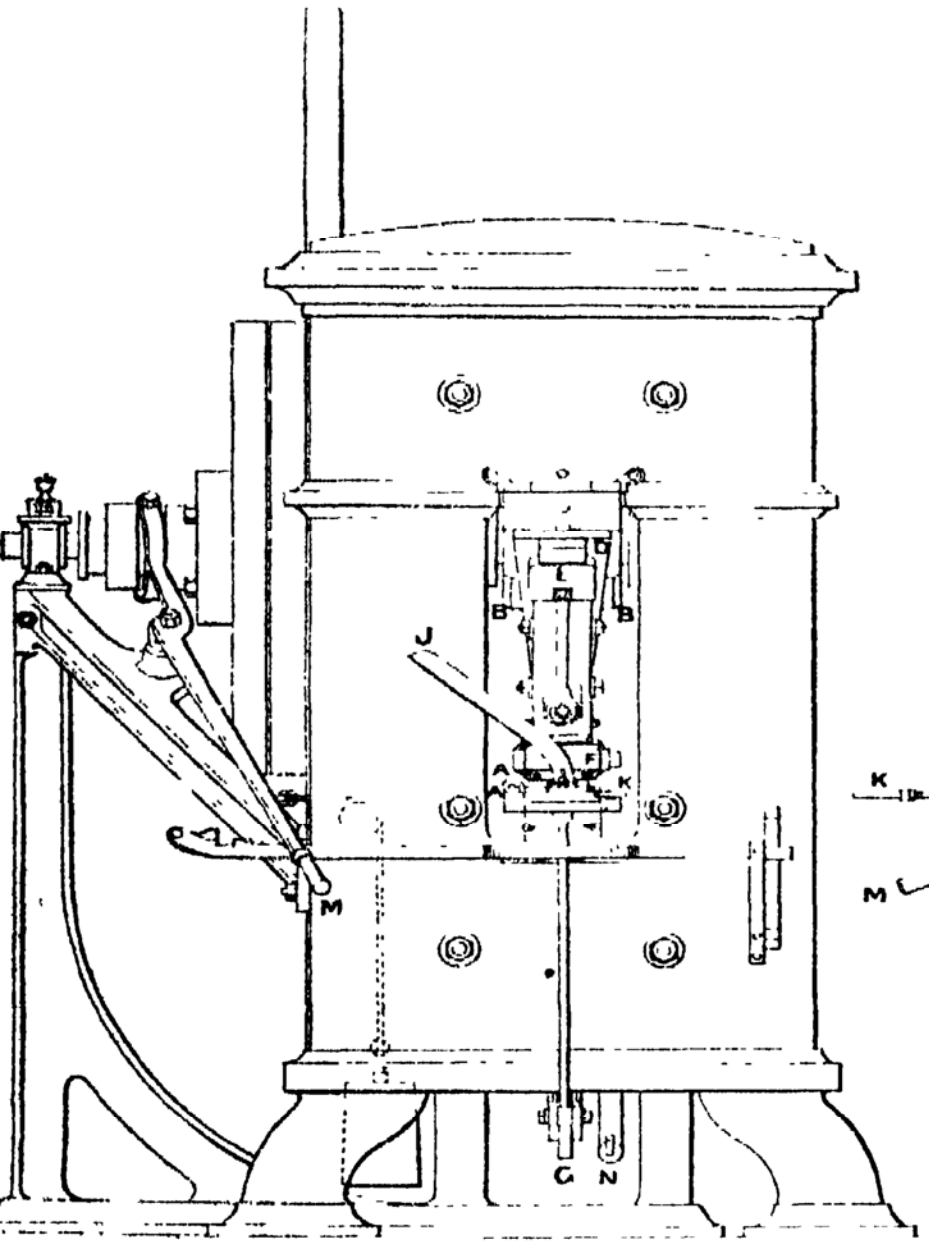


Fig. 10.

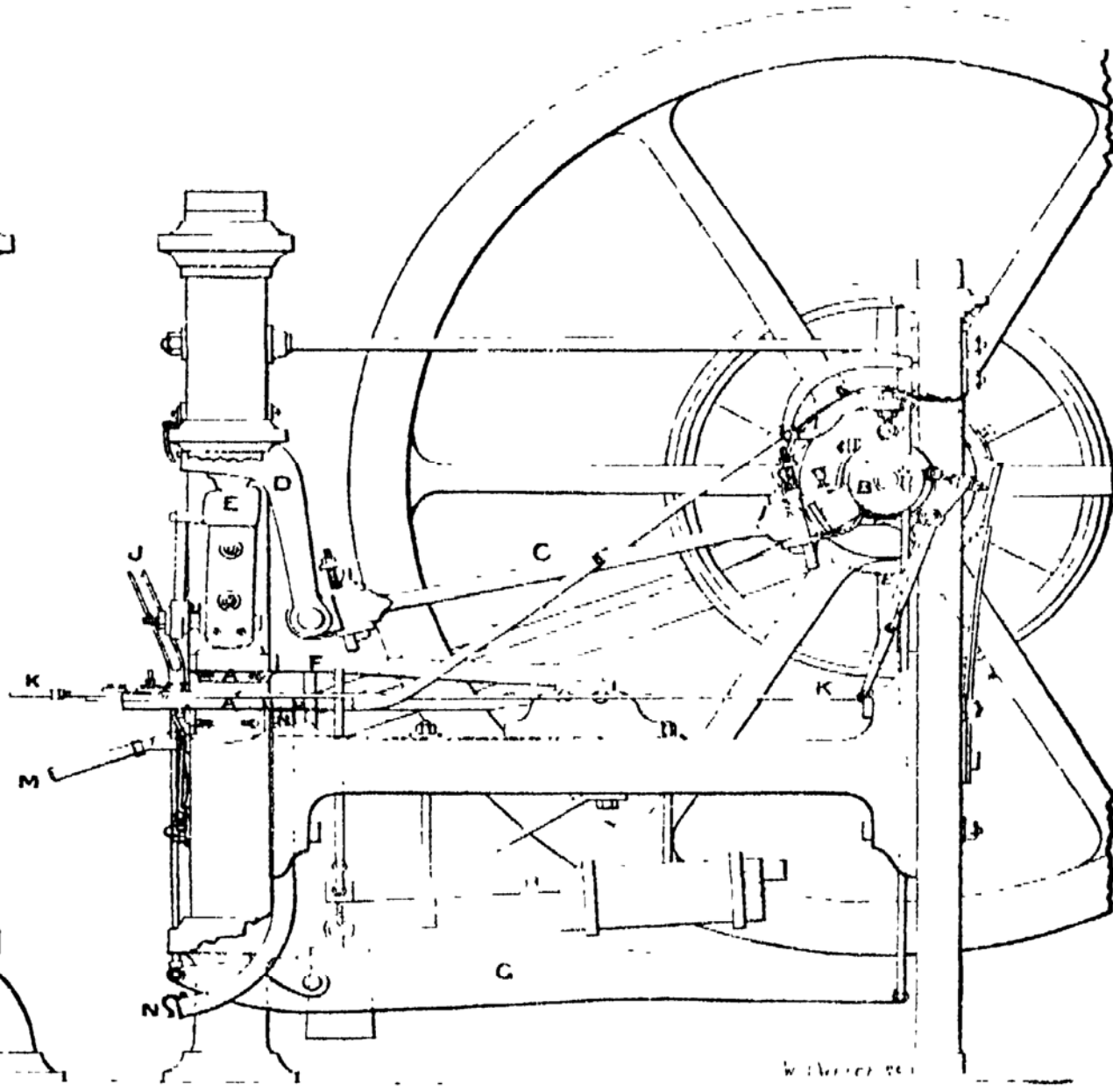


Fig. 11.

een two planes, one of which is fixed and bears
e the other has a reciprocating motion imparted to it, or the
of the blank receives the impression, which may be either raised or sunk, from a collar surrounding the blank in the coining press, will be afterwards explained.

Before passing to the coining press the blanks either of gold silver are annealed. In many mints the object of the heating not only to soften the blanks before they receive the impression, b also to produce a film of oxide of copper on their surface. This attained in various ways. In England gold blanks are placed cylindrical crucibles of plumbago and covered with a layer of ch coal heated in a reverberatory furnace, and when the blanks re cherry red they are cooled by plunging them in water. T thin film of oxide of copper thus formed on the surface of the g or silver blanks is readily soluble in dilute sulphuric acid, and t removal of a small portion of the alloying metal in this way co stitutes "blanching" or "pickling" the coin. The method conducting the operation varies somewhat in different mint mainly, however, in the strength of the acid used, which varies fr 3 to 5 of the hydrometer of Baumé. The solution is sometim heated to 96° to 98° C., while in other cases the blanks are int duced into the solution while at a red heat. The latter method however, objectionable, as a dense layer of pure metal is found at t surface of the blank which is apt to protect the underlying oxide copper from the action of the acid. The blanks are afterwa washed in pure water and dried either in sawdust or in copp vessels heated by steam jackets. The object of the process is

[1] A description of a machine used for the adjustment of blanks will be found in *Dingler's Polytechnisches Journal* (1882, ccxlv. 61, pl. 6), and some years ago J. M. Napier devised for the Indian mints a beautiful machine which first obtains how much it is necessary to cut from each blank in order to reduce it to standard weight, and then removes the necessary amount of metal and more. The initial cost of such machinery, however, is considerable. In 1849 Mereck, director of the mint in Paris, endeavoured to substitute a chemical or mechanical treatment by submitting the heavy gold blanks to aqua regia which it was anticipated would bring them within the prescribed limits of accuracy. The results were not satisfactory, and the attempt was abandoned. In 1870 the present chemist of the mint, Professor W. Chandler Roberts, showed that gold alloyed with copper might be removed from heavy blanks with singular regularity by means of a suitable solvent aided by a battery. The blanks are arranged in a frame of wood and submitted to the action of a solution of cyanide of potassium, the heavy blanks forming the dissolving pole of the battery. The process was not used in the London mint, as it became evident that it could not favourably replace the present system, under which finished coins alone are weighed and the manufacture of good coin only is paid for. It was, however, introduced into the Bombay mint in 1870 by the late Mr L. G. Hines, who increased its usefulness by transferring the metal dissolved from the heavy blanks to blanks which are too light, the latter being by this means raised to the prescribed weight. The process has now fairly taken its place as an ordinary operation of coining, and its importance to the mints where it is used may be judged from the fact that in the Indian mints no less than 1300 tons of silver are converted into coin in one year (1879), so that the saving effected by its use must be considerable.

improve the appearance of the finished coin by removing all traces of impurity from the surface of the blank. It has, however, been abandoned in the British mint except in the case of some of the smaller silver coins, mainly because the soft superficial layer of metal wears away with undue rapidity. Certain precautions suggested in 1869 by Mr Hill, the superintendent of the operative department, for avoiding oxidation or tarnishing of the metal during coinage rendered the abolition of the process possible.

The blanks receive the impression which constitutes them coins from one of the dies. Each is placed in the lower of two dies, and the upper brought forcibly down upon it. The lateral escape of the metal prevented by a collar which surrounds the blank while being struck. This collar may be either plain or of it the latter is the case any device or ornament it be imparted to the edge of the blank.

The presses used in various mints may be divided into three the screw press worked by atmospheric pressure, the eccentric press, and the lever press. The first of these (see *Engineering*, 8th ed., vol. xvii. p. 92) has now been abandoned. In the eccentric press the power is applied to a shaft bearing an eccentric which acts by means of a connecting rod upon a vertical shaft bearing the die which has brought down on the blank. This form of press is used in the mint at Constantinople where the atmospheric screw press is also still retained. Of the third type, the lever press, there are two modifications, devised respectively by Thonnelier and by Uhlhorn. The details of the Uhlhorn press have been improved by Messrs R. Heaton & Sons of Birmingham, and, their superiority to the old vacuum screw press having been demonstrated by careful experiment, they have been finally adopted in the newly arranged mint which contains fourteen of them. This press is shown in figs. 10 and 11. It is driven from below the floor of the press-room by bands which pass over fast and loose pulleys on the same shaft that bears the fly wheel. The loose pulley, however, is only used when it is necessary to stop the machine entirely, as the fly wheel is permitted to revolve without imparting motion to the shaft. A lever M, worked from the front of the machine, does cause the fly wheel to be connected with the driving wheel by means of two pins. The dies are placed in the front part of the machine, fig. 10. The lower one is firmly fixed to the bed, while the upper is held at A by the upper of two jaws F and A', or levers, the fulcra of which are so close together as almost to coincide, the lower jaw A' bearing the collar which encircles the blank while it is being converted into a coin, the upper jaw F, V, governed by the weighted lever H shown below the bed of the machine, has a tendency to rise a sufficient distance to admit the blank between the upper and lower dies. A crank B on the shaft bearing the fly wheel is connected by a rod C with the bent lever D, and this bent lever, acting through the toggle joint and a piece of metal E connected with the jaw that bears the

Fig. 12.

upper and lower of the two lower jaw to be depressed on the lower die, to next blank in position 60 to 120 a minute blanks to be converted advance of each blank the "driver on" by the backward and forward movement of which is also regulated by an eccentric on the crank shaft. The details of this part of the machine are shown in plan, fig. 12.

and thus squeezes the blank between the V-cam on the crank shaft acting on the shown below the bed of the machine causes the collar which surrounded the blank to leave the finished coin freely resting once it is driven down the shoot N by the Coins are produced at rates varying from a minute giving the best results. The coins are placed on the slide J, and the coin is regulated by the rod called

The last operation before the finished coin is returned to the mint office for issue to the public is the weighing each gold or silver piece separately. This is effected in the American and in most Continental mints by hand, but in England automatic balances of construction are employed. They were originally dev separating worn pieces from those of current weight, but they employed to distinguish between "light," "heavy," and pieces, the latter alone being permitted to pass into circula the newly arranged department thirty such machines are Each is driven from overhead shafting by means of gut li driving pulleys derive their motion from a small atm engine, which is found to give more satisfactory results tha be the case if the steam-engine were employed directly balance is worked by a cone pulley A (fig. 13) by a passing round it from the loose pulleys B, the necess sion being imparted to the line by means of a spring tension of the line is, however, but slight, for if the the balance is arrested by accident the cord slides over pulley A without turning it. It will be obvious that t the cone pulley enables the machine to be driven with degrees of speed. The toothed wheel D is mounted on the which bears the driving pulley A, but it acts only thr intervention of a friction wheel, which is so lightly screwe the driving wheel that it would cease to act if the machin be accidentally detained. The wheel D sets in motion th E, E', E''. The cam E, acting on the curved extremity of the frame G, causes the lever H to bring forward one of a serie arranged in the hopper I until it rests on the plate J of th beam, of which beam a portion is shown in an enlarged above the balance, while the plate that receives the coin is al in a separate drawing to the left of the machine. Anothe then comes into play, and enables the forceps, shown at L, the rod M to which the balance plate J is attached. The serves to keep the rod steady while the coin is being place plate J. A rod shown at N is then raised by the cam O, extremity of the rod being kept steady by a pin sliding in the bottom plate of the balance and its upper end by a p works into the central support of the balance beam. At of this rod N, and at right angles to it, there is a metallic the ends of which pass through stirrups in the pendants from the opposite ends of the beam. The elevation of this tal rod by the cam O simultaneously releases both ends of t and the coin placed on the beam plate has then, for the f a direct influence on the beam. If the coin is "too li counterpoise R in the cage at the end of the rod P will coin, and the revolution of the machine then causes part o K to permit a spring to close the forceps L and to hold the M firm. An indicating finger T then falls, and by me horizontal lever UU', which fits into one of three inverted the bottom of the shoot V, determines over which of thr W, W', W'' in the bottom plate of the balance this shoot sh In the meantime the advance of the slide H brings the n forward, and displaces the coin which has hitherto oce beam plate J, forcing the coin down the shoot V, and thence the orifice W into a receptacle external to the balance, de the reception of "light coin." If this next piece should heavy" it will not only raise the counterpoise R but will al a little wire S, which would otherwise remain undistu support. This little wire represents the "working rem the particular denomination of coin in question, which, f is less by $\frac{1}{100}$th of a grain than the remedy permitted by l undue weight of the "heavy coin" will depress the right balance beam and its pendant M to the lowest possible p the indicating finger T will, in this case, determine tha UU' shall occupy the lowest step of the shoot V, which w quently stand over the orifice W'' in the bottom plate of th which communicates with the receptacle for the "heavy and the heavy coin on the beam plate will be driven shoot by the next coin in succession. If the coin which brought forward by the slide H should be a "good" one it is within the working "remedy," its action will be a It may be slightly heavier than the counterpoise, but not su heavy to lift both the counterpoise and the remedy w balance beam consequently remains approximately horizo the indicating finger T will cause the rod UU' to strike t step of the shoot V, which will then stand over the central in the bed plate which communicates with a receptacle for coins, into which the coin will find its way, as soon as it from the beam plate by the next coin of the series. I evident that this excellent appliance both weighs and cla coin. About twenty-three coins are passed through it in

In order to show the importance of extreme accuracy in it may be pointed out that, although by the Coinage Act of "remedy" or allowed variation above or below the standa of a sovereign is only $\frac{1}{4}$th of a grain, yet in a million s sovereigns the difference between the least and the greate the law allows would be no less than £3244.

The manufacture of coin is not the only work performed in the Royal Mint. All medals issued

and navy, as well as those given by the Royal and the university of London and some others, uck in the mint, and their preparation forms a rable part of the work of the die department. 874 the clasps and bars for the medals have also anufactured in the mint, whence they have been completely mounted. Another operation, not with the coinage, which is performed in the mint is the assay of the "diet" or metal scraped from t and silver plate manufactured at Sheffield and Birmi under the direction of the warden of the stan wrought plate for those towns. By Act of Parlia is directed that this shall be brought once in each the mint to be assayed by the "king's assay m under the supervision of an officer appointed by th of the Treasury.

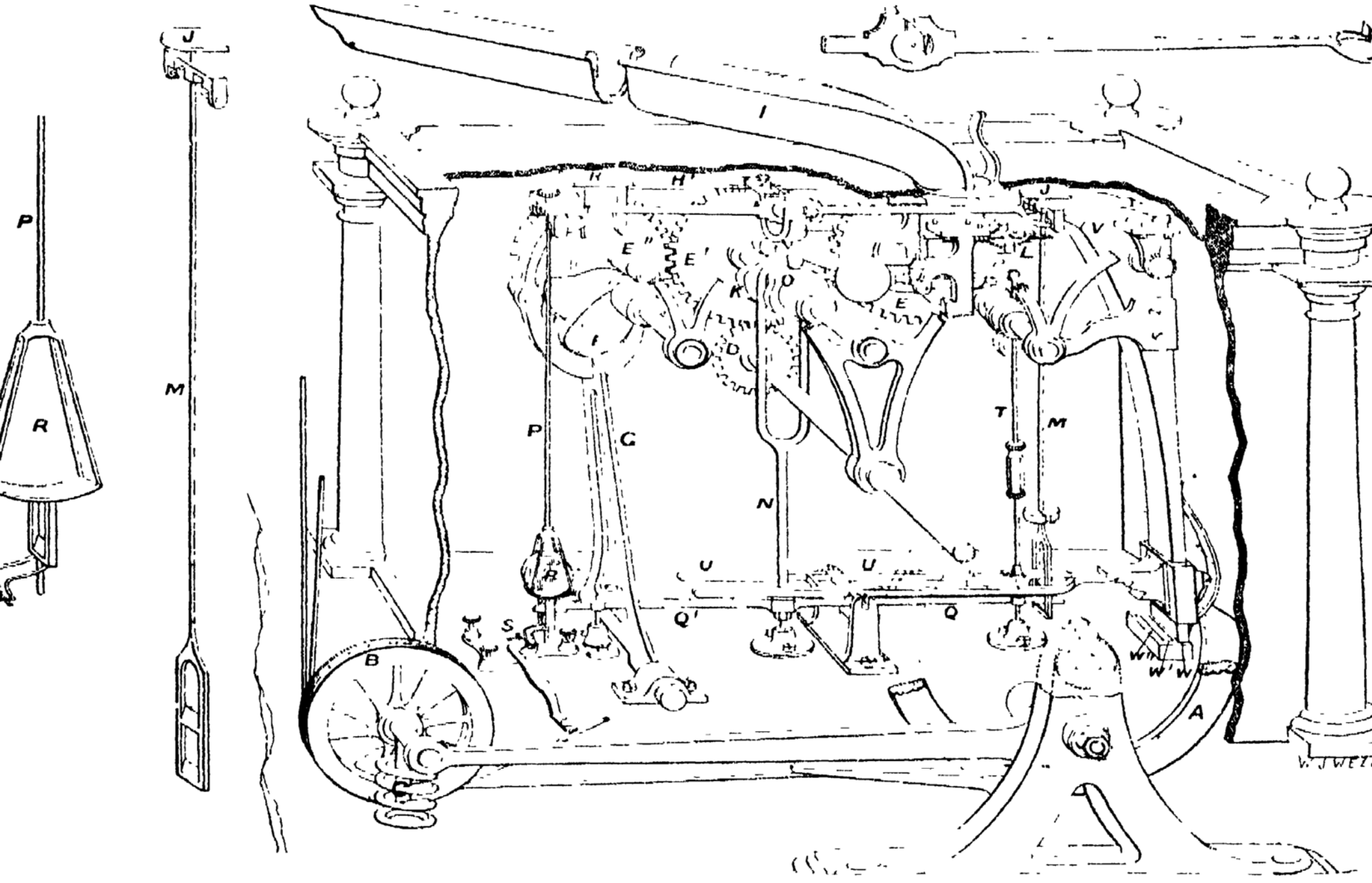


FIG. 13.—Automatic Balance.

gold coin in circulation in Great Britain is esti- at £100,000,000. It may be well to add the ng table, which gives the value of the gold and coinages of four of the most important foreign es, in two recent years :

	1880.		1881	
	Gold.	Silver	Gold	Silver
States	£12,461,655	£5,481,941	£19,370,178	£5,587,840
ny	1,332,430		326,837	
a	493,605	1,674,712	486,999	1,805,731
.....			83,646	259,910
	£14,287,690	£7,156,653	£20,266,660	£7,653,484

value of the gold coinage of the American mints the fiscal year ending June 1882 amounted to 3,447·50, being greater than that of any previous their history. (W. C. R.—R. A. H.)

T, botanically *Mentha*, a genus of labiate plants, sing about twenty species of perennial herbs, widely ted throughout the temperate and sub-tropical s of the globe. All the species are furnished with stems, opposite, aromatic leaves, and creeping roots. wers are arranged in axillary cymes, which either parate whorls or are crowded together into a terminal The corolla is usually small, and of a pale purple or pinkish colour; it has four nearly equal lobes, and two long and two short stamens. Great diffic experienced by botanists in discriminating the sp this genus by reason of the occurrence of a large of intermediate forms, nearly three hundred of whi been named and described. Many of these variet permanent in consequence of being propagated by s

In Britain nine of the recognized species are i ous. *Mentha viridis*, L., or Spearmint, grows in meadows, and is the species commonly used for c purposes; it is distinguished by its smooth, sessile and lax tapering flower-spikes. *Mentha sylvestris* Horsemint, chiefly differs from the above in its habit and hairy leaves, which are silky beneath, an denser flower spikes. This plant is supposed to be t of Scripture, as it is extensively cultivated in the E is much used in cookery: it was one of the bitte with which the paschal lamb was eaten. *M. rotu* resembles the last in size and habit, but is readily guished by its rounded wrinkled leaves, which are beneath, and by its lanceolate bracts. The last two usually grow on damp waste ground near roadside *aquatica*, or Capitate Mint, grows in ditches and side of streams, and is easily recognized by its r flower-spikes and stalked hairy leaves. *M. Pipe* Peppermint, has stalked smooth leaves and an obtuse terminal spike of flowers; it is extensively

or its volatile oil. *M. pratensis* belongs to a group
ts which, unlike the foregoing, have the flowers
ed in axillary whorls and never in terminal spikes;
rwise bears some resemblance in foliage and habit
viridis. *M. sativa*, the Whorled Hairy Mint, grows
mp road-sides and *M. arvensis* in cornfields: they
tinguished from *M. pratensis* by their hairy stalked
which in *M. arvensis* are all equally large, but in
ter are much smaller toward the apex of the stem.
Pulegium, commonly known as Pennyroyal, more rarely
mint, has small oval obtuse leaves and flowers in
whorls, and is remarkable for its creeping habit
cular odour. It differs from all the mints above
ed in the throat of the calyx being closed with hairs.
t with in damp places on grassy commons, and forms
known domestic remedy for female disorders.
he plants of the genus *Mentha* abound in a volatile
ich is contained in small receptacles having the
ance of resinous dots in the leaves and stems. The
f the oil is similar in several species, but is not dis-
, the same odour occurring in varieties of distinct
while plants which cannot be distinguished by any
al character possess the same odour. Thus the
nint flavour is found in *M. Piperita*, in *M. incana*,
Chinese and Japanese varieties of *M. arvensis*. Other
f the last named species growing in Ceylon and Java
e flavour of the common garden mint, *M. crispa*,
e same odour is found to a greater or less degree
sylvestris, *M. rotundifolia*, and *M. canadensis*. A
ot scent is met with in a variety of *M. aquatica* and
s of other species. Most of the mints may be found
som in August.
name mint is also applied to plants of other genera,
la punctata being called Horsemint, *Pycnanthemum*
um, Mountain Mint, and *Nepeta Cataria*, Catmint.

TO, Sir Gilbert Elliot, First Earl of (1751
was descended from an old border family, the
of Minto, and was born at Edinburgh, April 23,
His father, Sir Gilbert Elliot, was a member of the
stration of Pitt and Grenville, and is spoken of by
Walpole as "one of the ablest men in the House of
ons." Young Elliot was educated by a private tutor,
hom at the age of twelve he went to Paris, where
Hume, who was then secretary of the embassy,
ook, from friendship to his father, the special charge
rintending his studies. After spending the winters
5 and 1767 at Edinburgh University, Elliot entered
. On quitting the university he became a member
oln's Inn, and was in 1771 called to the bar. He
parliament in 1776, the year of his father's death,
eh he gave a general support to Lord North's
tration, he from the beginning occupied an inde-
t position, and in 1782 supported the address of the
on to carry on an offensive war with America. From
me he became a declared follower of Fox and
with the latter of whom he gradually came to be
ns of the closest intimacy. He was created Baron Minto
7, and after filling several diplomatic posts with great
became in 1807 governor-general of India. The
ter and events of his rule in India are described
xii. p. 805). He was created Earl of Minto and
nt Melgund in 1813. He returned to England in
and died on June 21 of that year.

Life and Letters of Sir Gilbert Elliot, first Earl of Minto,
1 to 1806, 1874, and *Life and Letters*, 1807–14, 1880. See
RABEAU.

UCIUS FELIX, Marcus, one of the earliest, if not
liest, of the Latin apologists for Christianity. Of
sonal history nothing is known, and even the date
h he wrote can be only approximately ascertained.
Jerome (*De Vir. Ill.*, 58) speaks of him as "
insignis causidicus," but in this he is probabl
improving on the expression of Lactantius (*Inst. Di*
who speaks of him as "non ignobilis inter causidico
He is now exclusively known by his *Octavius*, a d
on Christianity between the pagan Cæcilius Natal
the Christian Octavius Januarius, a provincial s
the friend and fellow-student of the author. The
pleasantly and graphically laid on the beach at Ost
holiday afternoon, and the discussion is represe
arising out of the homage paid by Cæcilius, in pas
the image of Serapis. His arguments for paganism
proceed partly upon agnostic grounds, partly up
inexpediency of disturbing long-established religious
partly upon the known want of culture in Christia
alleged indecency of their worship, and the i
absurdity of their doctrines, are taken up seria
Octavius, with the result that the assailant is con
postponing, however, the discussion of some things
sary for perfect instruction to a future occasion. T
of the dialogue, modelled on the *De Natura Deor*
De Divinatione of Cicero, shows much care and abili
its style is on the whole both vigorous and elega
times not exempt from something of the affectation
age. If the doctrines of the Divine unity, the resur
and future rewards and punishments be left out of a
the work has less the character of an exposi
Christianity than of a philosophical and ethical
against the absurdities of crass polytheism. Chri
and the other metaphysics of distinctively C
theology are entirely passed over, and the ca
Scriptures are not quoted, hardly even alluded to.

The *Octavius* is admittedly earlier than Cyprian's *De*
Vanitate, which borrows from it; how much earlier can
mined only by settling the relation in which it stands to Ter
Apologeticum. The argument for the priority of Minu
been most exhaustively set forth by Ebert ("Tertullians
niss zu Minucius Felix" in vol. v. of the philologico-h
series in *Abhandl. d. Königl. Sachs. Gesellsch. der Wissen*
1868), who has been followed by Teuffel (*Röm. Lit.*, sec. 36
Celsus' Wahres Wort, 1873), Kuhn, and other scholar
opposite view is ably maintained by Professor Salmon ("M
Felix" in Smith's *Dict. Christ. Biogr.*, 1882). The *Octa*
first printed (Rome, 1543) as the eighth book of Arnobi
Gentes, Baldinus (Heidelberg, 1560) first assigned it to it
author. There have been numerous subsequent editions,
being that of Halm in the *Corp. Scriptor. Eccl. Lat.* (Vienn
See Kuhn's monograph, *Der Octavius des Minucius Felix* (

MINUET (Fr. *Menuet*, from [*pas*] *menus*), a very
ful kind of dance, consisting of a coupee, a high st
a balance. Its invention is universally ascribed
inhabitants of Poitou. The melody begins with th
beat, and contains three crotchets in a bar. The m
made up of two strains, which, from being repea
called *reposes*, each consisting of eight or more ba
very rarely of an odd number. Walther speaks of a
in Lully's opera of *Roland*, each strain of which c
ten bars, the sectional number being five,—a circum
which renders it very difficult to be danced; but
system of phrasing was remarkably irregular.
instrumental composers have introduced into the
phonies and quartetts, &c., minuets of rapid mo
and tuneful character, followed by supplementary
(called trios) in a different style. Some of these c
tions bear but very slight resemblance to the older
and many of them begin with the third beat in t
The finest minuets we possess are those in Handel's
and Mozart's *Don Giovanni*.

MIRABEAU, Honoré Gabriel Riqueti, Com
(1749–1791), one of the greatest statesmen and

[1] This name occurs in six inscriptions of the years 211–217
Constantine (Cirta), North Africa (*C. I. L.*, vol. viii.).

has ever produced, was born at Bignon, near
rs, on March 9, 1749. M. de Loménie has shown
e family of Riquet or Riqueti came originally from the
own of Digne, that they won wealth and municipal
s as merchants at Marseilles, and that in 1570 Jean
i bought the chateau and estate of Mirabeau, which
to that time belonged to the great Provençal family
as, and took the title of esquire a few years later.
5 Honoré Riqueti obtained the title of Marquis de
au, and his son Jean Antoine brought honour to it.
ved with distinction through all the later campaigns
reign of Louis XIV., and especially distinguished
in 1705 at the battle of Cassano, where he was so
y wounded in the neck that he had ever after to wear
stock; yet he never rose above the rank of colonel,
to his eccentric habit of speaking unpleasant truths
superiors. On retiring from the service he married
ise de Castellane, a remarkable woman who long
d him, and he left at his death, in 1737, three sons
or, Marquis de Mirabeau (see next article), Jean
e, Bailli de Mirabeau, and Comte Louis Alexandre de
au. The great Mirabeau was the elder surviving
the marquis. When but three years old he had
lent attack of confluent small pox which left his
r ever disfigured, and contributed not a little to
his father's dislike to him. His early education
onducted by Lachabeaussière, father of the better
man of letters, after which, being like his father
randfather destined for the army, then the only
ion open to young men of family, he was entered
nsion militaire at Paris, kept by Abbé Choquart
s school, which had Lagrange for its professor of
natics, we have an amusing account in the life of
Elliot, first earl of Minto, who with his brother
afterwards British minister at Berlin, there made
quaintance of Mirabeau, an acquaintance which
ipened into friendship, and to which Mirabeau in
fe owed his introduction into good English society.
ving this school in 1767 he received a commission
cavalry regiment of the Marquis de Lambert, which
ndfather had commanded years before. He at once
love making, and in spite of his ugliness succeeded
ning the heart of the lady to whom his colonel was
d, which led to such scandal that his father obtained
e de cachet, and the young scapegrace was imprisoned
isle of Rhé. The love affairs of Mirabeau form
a history by themselves, and a well known history,
to the celebrity of the letters to Sophie; and the
our of the marquis in perpetually imprisoning his
equally well known, and as widely blamed. Yet it
e asserted that until the more durable and more
ble connexion with Madame de Nehra these love
es were the most disgraceful blemishes in a life
ise of a far higher moral character than has been
nly supposed. As to the marquis, his use of let
het is perfectly defensible on the theory of the exist
f lettres de cachet at all. They were meant to be
(see LETTRES DE CACHET) by heads of families for
rrection of their families, and Mirabeau, if any son,
deserved such correction. Further, they did have
ect of sobering the culprit, and the more creditable
f his life did not begin till he left Vincennes.
eau, it may be remarked at once, was not a states-
f the Alcibiades type, and he did not develop his
qualities of mind and character until his youthful
es were over. These will be passed over as rapidly
sible, for it was not till 1781 that the qualities which
him great began to appear.

being released from his first imprisonment, the young
who had always intended to continue his military career, obtained leave to accompany as a volunte
French expedition which was to effect the reduc
Corsica. The conquest was one of sheer mu
strength, for the whole population was on the
Paoli, and Mirabeau, perceiving the value of public o
is said to have written a treatise on the oppressi
Genoese had formerly exercised over the island, wh
Government was ready to publish had not the Marq
Mirabeau thought fit to destroy it because of its dive
from his own philosophical and economical views.
services in Corsica Mirabeau was made a capt
dragoons, though not in any particular regiment, and
return his father endeavoured to make use of the
ability he had shown for the advancement of hi
economical theories. He tried to keep on good term
his father, though he could not advocate all his idea
even went so far in 1772 as to marry a rich hei
daughter of the Marquis de Marignane, whose allia
father had procured for him. He did not live
with her, and in 1774 was ordered into semi exile
country, at his father's request, where he wrote his
extant work, the *Essai sur le Despotisme*. His viole
position now led him to quarrel with a country gen
who had insulted his sister, and his semi exile was c
by lettre de cachet into imprisonment in the Chatea
In 1775 he was removed to the castle of Joux, to
however, he was not very closely confined, havi
leave to visit in the town of Pontarlier. Here
Marie Thérèse de Monnier, his Sophie as he calle
married woman, for whom he conceived a violent
Of his behaviour nothing too strong can be said:
introduced into the house as a friend, and betra
trust by inducing Madame de Monnier to fall in lo
him, and all his excuses about overwhelming passi
make his conduct more despicable. The affair ende
escaping to Switzerland, where Sophie joined him
then went to Holland, where he lived by hack-work
booksellers; meanwhile Mirabeau had been conden
death at Pontarlier for *rapt et vol*, of which he was c
not guilty, as Sophie had followed him of her own
and in May 1777 he was seized by French poli
imprisoned by a lettre de cachet in the castle of Vin
remained three years and
release ends the first and most disgraceful period of
During his imprisonment he seems to have learnt to
his passions from their very exhibition, for the ea
of his confinement is marked by the indecent let
Sophie (first published in 1793), and the obscene
Biblion and *Ma Conversion*, while to the later
belongs his first political work of any value, the
de Cachet. The *Essai sur le Despotisme* was an o
but at times eloquent declamation, showing in its
tions a wide miscellaneous knowledge of history,
Lettres de Cachet exhibits a more accurate knowl
French constitutional history skilfully applied
attempt to show that an existing actual grievance
only philosophically unjust but constitutionally illeg
show, though still in rather a diffuse and decla
form, that application of wide historical knowledge
philosophical perception, and genuine eloquence
practical purpose which was the great character
Mirabeau, both as a political thinker and a statesman.

With his release from Vincennes begins the second
of Mirabeau's life. He found that his Sophie was a
ized version of a rather common and ill educated
and she speedily consoled herself with the affecti
young officer, after whose death she committed
Mirabeau first set to work to get the sentence of de
hanging over him reversed, and by his eloquence
succeeded but got M. de Monnier condemned in the

ole law proceedings. From Pontarlier he went to
here he claimed the court's order that his wife should
to him She naturally objected, but his eloquence
brave won in court, even against Portalis, the leader
Aix bar, had he not in his excitement accused his
respectability on which the court pronounced a decree
in favour He then with his usual impetuosity inter-
in the suit pending between his father and mother
the parlement of Paris, and so violently attacked
his powers that he had to leave France and again go
and and try to live by literary work. About this
from his connexion with Madame de Nehra, which
to the crowning years of toil and brought out the
best of his character. She was the daughter of
n Haren, a Dutch statesman and political writer,
a woman of a far higher type than Sophie, more
d, more refined, and more capable of appreciating
his good points and helping him to control his
s. With her the lion became a lamb, and his life
engthened by the love of his *petite horde*, Madame
ra, her baby son, afterwards Lucas de Montigny,
little dog Chico. After a period of work in
d he took himself to England, where his treatise on
le Cachet had been much admired, and where he
n admitted into the best Whig literary and political
of London, through his old schoolfellow Gilbert Elliot,
d now inherited his father's baronetcy and estates,
come a leading Whig member of parliament. Sir
introduced him freely, but of all his English friends
em to have been so intimate with him as Lord Lans-
and Mr (afterwards Sir Samuel) Romilly. The
became particularly attached to him, and really
ood his character; and it is strange that his remarks
Mirabeau in the fragment of autobiography which
and Mirabeau's letters to him, should have been
d by French writers. Romilly was introduced to
im by Dumont, and readily undertook to translate
nsiderations on the Order of Cincinnatus. Romilly
thus of him in his autobiography:

count was difficult enough to please, he was sufficiently
d with the beauties of the original. He went over every
he translation with me, observed on every passage in which
was not done to the thought or the force of the expression
d made many useful criticisms. During the occupation
occasion to see one another often, and became very intr
nd, as he had read much, had seen a great deal of the world,
inted with all the most distinguished persons who at that
formed either the royal court or the republic of letters in
had a great knowledge of French and Italian literature, and
d very good taste, his conversation was extremely interest
not a little instructive. I had such frequent opportunities
g him at this time, and afterwards at a much more import
od of his life, that I think his character was well known
I doubt whether it has been so well known to the world,
re entertained that great injustice has been done him. This,
a true reporting, when one considers that, from the first
he set out upon the career of an author, he had been
how numerous or how powerful might be the
he should provoke. His vanity was certainly excessive;
have no doubt that in his public conduct as well as in his
s, he was deeply conscious good that his ambition was of
ble kind and that he proposed to himself the noblest ends;
s, however, like many of his countrymen, who were active in
anitous Revolution which afterwards took place, not suffi
scrupulous about the morality by which those ends were to be
blished. He indeed in a certain degree professed this; and more
nce I have heard him say that there were occasions upon
'la petite morale était comme de la grande.' It is not sur
that with such maxims on the one hand in his mouth, unguarded
expressions, and careless of his reputation he should have
l room for the circulation of many stories to his disadvan
Violent, impetuous, conscious of the superiority of his
, and the declared enemy and denouncer of every species of
and oppression, he could not fail to shock the prejudices,
se the interests, to excite the jealousy, and to wound the
f many descriptions of persons. A mode of refuting his
open to the basest and vilest of mankind, was to represent
him as a monster of vice and profligacy. A scandal once
foot is strengthened and propagated by many, who have no
against the object of it. They delight to talk of what is ext
nary; and what more extraordinary than a person so admira
his talents and so contemptible for his conduct, professing
writings principles so excellent and in all the offices of publ
private life putting in practice those which are so detestab
indeed possessed demonstrative evidence of the falsehood of
the anecdotes which by men of high character were related
prejudice." *Life of Sir S. Romilly*, vol. i. p. 58.

This luminous judgment, the best that is extant
character of Mirabeau, deserved to be quoted at leng
must be noted that it was written by a man of ac
ledged purity of life, who admired Mirabeau in earl
not when he was a statesman, but when he was
struggling literary man. This close association
Romilly, and his friends Baynes, Trail, and Wilson
credit to Mirabeau, and must have helped that
revolution against his passions which was passing
him. He was a warm friend, and first made R
acquainted with Lord Lansdowne, and tried to get
seat in parliament. Lord Lansdowne was himse
extraordinary man, and the first of the new Whigs
well feel sympathy with the statesman of the
Revolution. The *Considerations sur l'ordre de Cinci*
which Romilly translated was the only important
Mirabeau wrote in the year 1785, and it is a good
men of his method. He had read a pamphlet publis
America attacking the proposed order, which was t
a bond of association between the officers who had
in the American War of Independence against En
the arguments struck him as true and valuable,
rearranged them in his own fashion, and rewrote th
his own oratorical style. He soon found such wo
sufficiently remunerative to keep his "petite hor
comfort, and then turned his thoughts to employmen
the French foreign office either in writing or in dipl
He first sent Madame de Nehra to Paris to make his
with the authorities, in which she was completely succ
and then returned himself, hoping to get emplo
through an old literary collaborateur of his, Duriva
was at this time director of the finances of the depa
of foreign affairs. One of the functions of this offic
to subsidize political pamphleteers, and Mirabea
hoped to be so employed, but he ruined his chance
series of financial works. On his return to Paris
become acquainted with Clavières, a Genevese exil
was minister of finance during the Revolution, an
now introduced him to a banker named Panchaud.
them he heard plenty of abuse of stock-jobbing, and
their ideas he began to regard stock jobbing, or agio
the source of all evil, and to attack in his usual vel
style the Banque de St Charles and the Compag
Eaux. This was at least disinterested on his pa
while his supporters were poor, the bankers he a
were rich, and would gladly have bought his silenc
Mirabeau, though ever ready to take money for w
wrote, never sold his opinions, or wrote what he
really believe. The very eloquence of his style res
the enthusiastic conviction that he himself was rig
those who differed from him were stupidly and
wrong. This last pamphlet brought him into a
versy with Beaumarchais, who certainly did not
best of it, but it lost him any chance of literary
ment from Government. However, his ability w
great to be neglected by a great minister such as
Vergennes undoubtedly was, and after a preliminar
in the early spring of 1786 he was despatched i
1786 on a secret mission to the court of Prussi
which he returned in January 1787, and of which
a full account in his *Histoire Secrète de la Cour de*

onths he spent at Berlin were important ones in the of Prussia, for in them Frederick the Great died. ters just mentioned show clearly what Mirabeau did at he saw, and equally clearly how unfit he was to plomatist; for, with all his knowledge of men and luence over them, he thought (and showed he t) too much of himself ever to be able to surprise cret thoughts and intentions. He certainly failed ciliate the new king Frederick William; and thus Mirabeau's one attempt at diplomacy. During his he had made the acquaintance of a Major Manvillon, he found possessed of a great number of facts and s with regard to Prussia, these he made use of in work on Prussia published in 1788, a Romilly show that he could write more than a fugitive et. But, though his *Monarchie Prussienne* gave general reputation for historical learning, he had in ne year lost a chance of political employment. He ered himself as a candidate for the office of secretary Assembly of Notables which the king had just con and to bring his name before the public published financial work, the *Dénonciation de l'agiotage*, ed to the king and notables, which abounded in olent diatribes that he not only lost his election, but iged to retire to Tongres; and he further injured his ts by publishing the reports he had sent in during ret mission at Berlin. But 1789 was at hand; the general was summoned; Mirabeau's period of pre was over, and he was at last to have that oppor- of showing his great qualities both as statesman tor on a worthy arena.

hearing of the king's determination to summon ates-general, Mirabeau started for Provence, and to assist at the preliminary conference of the e of his district. They rejected him; he appealed *iers état*, and was returned both for Aix and for les. He elected to sit for the former city, and was at the opening of the states-general on May 4, From this time the record of Mirabeau's life forms t history of the first two years of the Constituent ly, for at every important crisis his voice is to be though his advice was not always followed. It is ble here to detail minutely the history of these two l years; it will be rather advisable to try and the manner in which Mirabeau regarded passing and then show how his policy justifies our analysis.

Mirabeau possessed at the same time great logical ess and most passionate enthusiasm; he was there th a statesman and an orator, and the interest of two years of his life lies mainly in the gradual but victory of the statesmanlike and practical over the ve and oratorical qualities. From the beginning au recognized that government exists in order that k of the population may pursue their daily work in nd quiet, and that for a Government to be successful be strong. In this practical view of [illegible]d of a executive lies one of Mirabeau's greatest titles to the f statesman. At the same time he thoroughly com ded that for a Government to be strong it must be nony with the wishes of the majority of the people, at the political system of Louis XIV. was now fall- lack of this. He had carefully studied the English ution in England under the guidance of such men d Lansdowne, Sir Gilbert Elliot, and Romilly, and ated it with the wise approval of its powers of ex which characterized the new Whigs, and not with nd admiration of Burke. He understood the key- f the practical success of the English constitution he irresponsibility of the king, the solidarity of the ers, and the selection of the executive from among the majority of the representatives of the country; hoped to establish in France a system similar in pr but without any slavish imitation of the details English constitution.

In the first stage of the history of the states Mirabeau's part was very great. He was soon rec as a leader, to the chagrin of Mounier, because he knew his own mind, and was prompt at emergencie him is to be attributed the successful consolidation National Assembly, its continuance in spite of De Br the carpenters, and the address to the king for th drawal of the troops assembled by De Broglie. W taking of the Bastille had assured the success Revolution, he was the one man who warned the As of the futility of passing fine sounding decrees a necessity for acting. He declared that the famous of August 4 was but peo immense theoretical liberty while not assuring th practical freedom, and overthrowing the old regime ould be constituted. Still more did his foresight when he attacked the dilatory behav the Assembly, which led to the catastrophes of the 5 6th October. He implored the Assembly to strike the iron was hot, and at once solve in a practical the difficult problems presented by the aboliti feudalism. But the Assembly consisted of men in enced in practical politics, who dreamed of drawing ideal constitution precluded by a declaration of ri imitation of the Americans; and for two mont Assembly discussed in what words the declaration be expressed, while the country was in a state of a declaring old laws and customs abolished and hav new ones to obey or follow, disowning the old a trative system and having no new one yet institute Paris was starving and turbulent, and the queen friends planning a counter revolution. The result two months' theorizing was the march of the wo Versailles, and the transfer of the king to Paris. M now saw clearly that his eloquence would not enab to guide the Assembly by himself, and that he must fore try to get some support. He wished to esta strong ministry, which should be responsible English ministry, but to an assembly chosen to re the people of France better than the English H Commons then represented England. He first tho becoming a minister at a very early date, it we may a story contained in *Mémoires* of the D d'Abrantes, to the effect that in May 1789 the quee to bribe him, but that he refused to be bribed to and expressed his wish to be a minister. The indig with which the queen repelled the idea may hav the cause of his thinking of the Duc d'Orleans as a constitutional king, because his title would of neces parliamentary. But the weakness of Orleans w palpable, and in a famous remark Mirabeau expre utter contempt for him. He also attempted to f alliance with Lafayette, but the general was as v as obstinate as Mirabeau himself, and had his own about a new French constitution. Mirabeau trie time, too, to act with Necker, and obtained the sa the Assembly to Necker's financial scheme, not bec was good, but because, as he said, "no other pl before them, and something must be done."

Hitherto weight has been laid on the practical Mirabeau's political genius; his ideas with regard Revolution after the 5th and 6th October must examined, and this can be done at length, thanks publication of Mirabeau's correspondence with La M study of which is indispensable for any correct kn of the history of the Revolution between 1789 an

mte de la Marck was a Flemish lord of the house of
erg, who had been proprietary colonel of a regiment
he was a close friend of the
and had been elected a member of the states-
. His acquaintance with Mirabeau, commenced in
ipened during the following year into a friendship,
La Marck hoped to turn to the advantage of the
After the events of the 5th and 6th of October he
Mirabeau as to what measures the king ought to
d Mirabeau, delighted at the opportunity, drew up
uable state-paper, which was presented to the king
reau, afterwards Louis XVIII. The whole of this
should be read to get an adequate idea of Mira-
ems for politics; here it must be merely sum

ain position is that the king is not free in Paris he must
leave Paris and appeal to France. "Paris n'en veut que
les provinces demandent des lois." But where must the
"Se retirer à Metz ou sur toute autre frontière serait
la guerre à la nation et abdiquer le trône. Un roi qui est là
le son peuple fait point devant son peuple;
pour juge et de principe. He must
ds the interior of France to a provincial capital, best
Tours, and there he must appeal to the people and summon
onvention. It would be time to appeal to the noblesse, as
advised: "un coups de nobles n'est point une armée,
combattre." When this great convention met, the
st show himself ready to reconcile that great changes have
e, that feudalism and absolutism have for ever disappeared,
a new relation between king and people has arisen which
loyally observed on both sides for the future. "Il est
Lafleurs, qu'il faut une grande révolution pour sauver le
que la nation a des droits, qu'elle est en chemin de les
tous, et qu'il faut non seulement les rétablir, mais les con-
To establish this new constitutional position between
people would not be difficult, because "l'indivisibilité du
e et du peuple est dans le cœur de tous les Français; il
lle existe dans l'action et le pouvoir."

was Mirabeau's programme, which he never
d from, but which was far too statesmanlike to be
ood by the poor king, and far too positive as to the
condition of the monarchy to be palatable to the
Mirabeau followed up his *Mémoire* by a scheme
at ministry to contain all men of mark,—Necker
e minister, "to render him as powerless as he is
le, and yet preserve his popularity for the king,"
rchbishop of Bordeaux, the Duc de Liancourt, the Duc
Rochefoucauld, La Marck, Talleyrand bishop of
at the finances, Mirabeau without portfolio, Target
of Paris, Lafayette generalissimo to reform the
Ségur (foreign affairs), Mounier, and Chapelier. This
got noised abroad, and was ruined by a decree of
mbly of November 7, 1789, that no member of the
ly could become a minister; this decree destroyed
nce of that necessary harmony between the ministry
majority of the representatives of the nation exist-
England, and so at once overthrew Mirabeau's present
and any chance of the permanence of the constitution
being devised. The queen utterly refused to take
au's council, and La Marck left Paris. However,
il 1790 he was suddenly recalled by the Comte de
Argenteau, the Austrian ambassador at Paris, and
een's most trusted political adviser, and from this
Mirabeau's death he became the medium of almost
communications between the latter and the queen.
eau at first attempted again to make an alliance with
tte by a letter in which he says, "Les Barnave, les
t, les Lameth ne vont intérieurement plus de leur active
n; on singe longtemps l'adresse, non pas la force."
was useless to appeal to Lafayette; he was not a
man himself, and did not appreciate "la force" in
From the month of May 1790 to his death in
791 Mirabeau remained in close and suspected but
tually proved connexion with the court, and drew
up many admirable state-papers for it. In return the
paid his debts; but it ought never to be said that h
bribed, for the gold of the court never made him s
from his political principles—never, for instance, mad
a royalist. He regarded himself as a minister, thou
unavowed one, and believed himself worthy of his
Undoubtedly his character would have been more adm
if he had acted without court assistance, but it mu
remembered that his services deserved some reward
that by remaining at Paris as a politician he had
unable to realize his paternal inheritance. Before h
fluence on foreign policy is discussed, his behavio
several important points must be noticed. On the
question of he took a practical view, and
that the royal power was already sufficiently weak
declared for the king's absolute veto, and against
compromise of the suspensive veto. He knew fro
English experiences that such a veto would be hardl
used unless the king felt the people were on his s
which case it would be a useful check on represent
of the people, and also that if it was used unjust
he power of the purse possessed by the represent
and the very constitutional organization of the
would, as in England in 1688, bring about a blo
revolution, and a change in the person entrusted wi
royal dignity. He saw also that much of the inefli
of the Assembly arose from the inexperience of the me
and their incurable verbosity; so, to establish some
of rules, he got his friend Romilly to draw up a d
account of the rules and customs of the English Ho
Commons, which he translated into French, but whi
Assembly, puffed up by a belief in its own merits, u
to use. On the great subject of peace and war he sup
the king's authority, and with some success. Wh
the good of an executive which had no power? Le
responsible to the representatives of the nation
means; but if the representatives absorbed all exe
power by perpetual interference, there would be six h
kings of France instead of one, which would hardl
change for the better. Again Mirabeau almost alone
Assembly understood the position of the army u
limited monarchy. Contrary to the theorists, he he
the soldier ceased to be a citizen when he became a s
he must submit to be deprived of his liberty to thi
act, and must recognize that a soldier's first d
obedience. With such sentiments, it is no wonde
he approved of Bouillé's vigorous conduct at Nancy,
was the more to his credit as Bouillé was the one
the court influences opposed to him. Lastly, in mat
finance he showed his wisdom: he attacked N
"caisse d'escompte," which was to have the whole
of the taxes, as absorbing the Assembly's power
purse; and he heartily approved of the system of ass
but with the important reservation that they sho
be issued to the extent of more than one-half the v
the land to be sold. This restriction was not ob
and it was solely the enormous over-issue of assigna
caused their great depreciation in value.

Of Mirabeau's attitude with regard to foreign a
is necessary to speak in more detail. He held it to
that the French people should conduct their Revolu
they would, and that no foreign nation had any r
interfere with them, so long as they kept themselves
to their own affairs. But he knew also that neighb
nations looked with unquiet eyes on the progress of
in France, that they feared the influence of the Rev
on their own peoples, and that foreign monarch
being prayed by the French emigrés to interfere on
of the French monarchy. To prevent this interfer
rather to give no pretext for it, was his guiding tho

policy. He had been elected a member of the plomatique of the Assembly in July 1790, and s reporter at once, and in this capacity he was revent the Assembly from doing much harm in foreign affairs. He had long known Montmorin, n secretary, and, as matters became more strained complications with the princes and counts of the e entered into daily communication with the advised him on every point, and, while dictating defended it in the Assembly. Thus in the partiance of the foreign office, for the few months irabeau's death, a harmony was established he minister and the Assembly through Mirabeau, cked for a time the threatened approach of foreign on, and maintained the honour of France abroad. 's exertions in this respect are not the smallest e name of statesman; and how great a work he t proved by the confusion which ensued in this t of affairs upon his death.

leed in the beginning of 1791 his death was very l he knew it to be so. The wild excesses of his l their terrible punishment had weakened his nstitution, and his parliamentary labours consework. So surely did he feel its approach that before the end he sent all his papers over to his sh friend and schoolfellow Sir Gilbert Elliot, who under seal until claimed by Mirabeau's executors. his illness was evidently gaining on him, to his f, because he knew how much depended on his felt that he alone could yet save France from the of her monarch and the present reforms, and foreign interference, which would as surely bring astrophes unparalleled in the history of the world. ife hung the future course of the Revolution. re that science could afford was given by his l physician, the famous chemist Cabanis, to whose on his last illness and death the reader may refer. le, whose faith in him revived in spite of all s, when they heard that he was on his death-bed, street in which he lay quiet, but medical care, g solicitude of friends, and the respect of all the uld not save his life. His vanity appears in its ntic proportions in his last utterances during his ut many of them have something grand in their his last reported expression, when he looked upon -"If he is not God, he is at least His cousin-

When he could speak no more he wrote with hand the one word "dormir," and on April 2, died.

irabeau died, it has been said, the last hope of the mon with Marie Antoinette supreme at court, can it be said that ever have been any real hope for the monarchy? Had she ss like her imperious mother, Louis would have made a nal monarch, but her will was as strong as Mirabeau's he Bourbon monarchy had to meet its fate. The subsets of the Revolution justified Mirabeau's prognostications mémoire of October 15, 1789. The royal family fled e German frontier, and from that moment there sank deep arts of the people not only of Paris, but of the provinces, n that the king and queen were traitors to France, which bly to their execution. The noblesse and the foreign and he queen relied proved but a source of weakness. The Mirabeau had said, was no army which could fight, and emy of the emigrés could do nothing against revolutionary arms. The intervention of foreign and only sealed the and forwarded the progress of the Revolution, not in a natural development, but to the terrible resource of the error. With regard to the Assembly too, and its constirabeau had shown his foresight. The constitution of llent as it was on paper, and well adapted to an ideal not deal adequately with the great problems of the time and by its ridiculous weakening of the executive was a modern state. Surely if events ever proved a man's agacity, the history of the French Revolution proved .

A few words must be added on Mirabeau's manner of work and his character.

No man ever so thoroughly used other men's work, and yet made it all seem his own. "Je prends mon bien ou je le trouve" is as true of him as of Molière. His first literary work, except the bombastic but eloquent *Essai sur le Despotisme*, was a translation of Watson's *Philip II.*, accomplished in Holland with the help of Durival; his *Considérations sur l'ordre de Cincinnatus* was based on an American pamphlet, and the notes to it were contributed by Target, while his financial writings were all suggested by the Genevese exile Clavières. During the Revolution he received yet more help; men were proud to labour for him, and did not murmur because he absorbed all the credit and fame. Dumont, Clavières, Duroveray, Pellenc, Lamourette, and Reybaz were but a few of the most distinguished of his collaborators. Dumont was a Genevese exile, and an old friend of Romilly's, who willingly prepared for him those famous addresses which Mirabeau used to make the Assembly pass by sudden burst of eloquent declamation; Clavières and Duroveray helped him in finance, and not only worked out his figures, but even wrote his financial discourses. Pellenc was his secretary, and wrote the speeches on the goods of the clergy and the right of making peace, and even the Abbé Lamourette wrote the speeches on the civil constitution of the clergy. Reybaz, whose personality has only been revealed within these last ten years, not only wrote for him his famous speeches on the assignats, the organization of the national guard, &c., which Mirabeau read word for word at the tribune, but even the posthumous speech on succession to estates of intestates, which Talleyrand read in the Assembly as the last work of his dead friend. Yet neither the gold of the court nor another man's conviction would make Mirabeau say what he did not himself believe, or do what he did not himself think right. He took other men's labour as his due, and impressed their words, of which he had suggested the underlying ideas, with the stamp of his own individuality; his collaborators themselves did not complain, they were but too glad to be of help in the great work of controlling and forwarding the French Revolution through its greatest thinker and orator. True is that remark of Goethe's to Eckermann, after reading Dumont's *Souvenirs*. "At last the wonderful Mirabeau becomes natural to us, while at the same time the hero loses nothing of his greatness. Some French journalists think differently. . . . The French look upon Mirabeau as their Hercules, and they are perfectly right. But they forget that even the Colossus consists of individual parts, and that the Hercules of antiquity is a collective being, a gigantic personification of deeds done by himself and by others."

There was something gigantic about all Mirabeau's thoughts and deeds. The excesses of his youth were beyond all bounds, and severely were they punished, his vanity was immense, but never spoilt his judgment: his talents were enormous, but could yet make use of those of others. As a statesman his wisdom is indubitable, but by no means universally recognized in his own country. Lovers of the *ancien régime* abuse its most formidable and logical opponent, believers in the Constituent Assembly cannot be expected to care for the most redoubtable adversary of their favourite theorists, while admirers of the republic of every description agree in calling him from his connexion with the court the traitor Mirabeau. As an orator more justice has been done him: his eloquence has been likened to that of both Bossuet and Vergniaud, but it had neither the polish of the old 17th-century bishop nor the flashes of genius of the young Girondin. It was rather parliamentary oratory in which he excelled, and his true compeers are rather Burke and Fox than any French speakers. Personally he had that which is the truest mark of nobility of mind, a power of attracting love, and winning faithful friends. "I always loved him," writes Sir Gilbert Elliot to his brother Hugh; and Romilly, who was not given to lavish praise, says, "I have no doubt that in his public conduct, as in his writings, he was desirous of doing good, that his ambition was of the noblest kind, and that he proposed to himself the noblest ends." What more favourable judgment could be passed on an ambitious man! What finer epitaph could a statesman desire?

The best edition of Mirabeau's works is that published by Bla[illegible] of in 1822, in 10 vols., which has been his *Diverses Oratoires*, from this [illegible]tion, however, many of the best [illegible] works, and the *Monarchie Prus*[illegible] in 4 vols., 1788, are to be found. For the life consult *Mirabeau. Mémoires sa et privés*, 8 vols., 1834 and, what is of most importance, *Mémoire littéraires et politiques de Mirabeau écrits par lui-même, par* [illegible] *et publiés* [illegible] which was issued by M. Lucas de Montigny in 8 vols., Paris 1841. See also Dumont, *Souvenirs sur Mirabeau*, 1832; Duval, *Souvenirs sur Mirabeau*, 1848; Victor Hugo, *Etude sur Mirabeau*, 1834; *Mirabeau's Jugendleben*, Breslau, 1839; Schmidt-Weissenfels, *Mirabeau und seine Zeit*, Leipsic, 1834; *Mirabeau, a Life History*, London, 1848. The publication of the *Correspondance entre Mirabeau et le Comte de la Marck* by Ad. Bacourt, 3 vols., 1851, marks an epoch in our exact knowledge of Mirabeau and his career. The most useful modern books are Louis de Loménie, *Les Mirabeau*, 1878, which, however, chiefly treats of his father and [illegible] *Collaborateurs* [illegible] of Reybaz throwing intimate light on Mirabeau's mode of work; and, lastly, H. Reynald, *Mirabeau et la Constituante*, 1875. On his eloquence and the share his collaborators had in his speeches, see Aulard, *L'Assemblée Constituante* 1882. For his death see the curious brochure of his physician Cabanis, *Journal de la maladie et de la mort de Mirabeau*, Paris, 1791. (H. M. S.)

ABEAU, Victor Riqueti, Marquis de (1715 himself a distinguished author and political economist more famous as the father of the great Mirabeau, n at Pertuis near the old chateau de Mirabeau on 1, 1715. He was brought up very sternly by his and in 1729 joined the army. He took keenly to camg but never rose above the rank of captain, owing unable to get leave at court to buy a regiment. came into the family property on his father's and spent some pleasant years till 1743 in literary ip with his dear friend, Vauvenargues, and de Pompignan, which might have continued had suddenly determined to marry—not for money, but ed estates. The lady whose property he fancied was ne Vieuxe, daughter of a M. de Vassan, a brigadier in y, and widow of the Marquis de Saulveboeuf, whom ed without previously seeing her on April 21, 1743. garrison at Bordeaux, Mirabeau had made the tance of Montesquieu, which may have made him thoughts to political speculations; anyhow it was leisure after returning from the army that he wrote

st work, his *Testament Politique* (1747), which led for the prosperity of France a return of the noblesse to their old position in the Middle Ages. ork, written under the influence of the feudal ideas sed upon him by his father, was followed in 1750 book on the *Utilité des Etats Provinciaux*, full of wise considerations for local self-government, which blished anonymously, and had the honour of being ted to Monte-squieu himself. In 1756 Mirabeau his first appearance as a political economist by blication of his *Ami des Hommes ou traité de ulation*. This work has been often attributed to luence, and in part even to the pen, of Quesnay, the of the economical school of the physiocrats, but ally written before the marquis had made the tance of the physician of Madame de Pompadour. 0 he published his *Théorie de l'Impôt*, in which he d with all the vehemence of his son the farmers of the taxes, who got him imprisoned for eight Vincennes, and then exiled to his country estate at . At Bignon the school of the physiocrats was established, and the marquis surrounded himself evotees, and eventually in 1765 bought the *Journal riculture, du commerce, et des finances*, which became gan of the school. He was distinctly recogd a leader of political thinkers by Prince Leopold

scany, afterwards emperor, and by Gustavus III den, who in 1772 sent him the grand cross of er of Vasa. But the period of his happy literary over, and his name was to be mixed up in scandalous lawsuit. Naturally his marriage ot been happy; he had separated from his wife utual consent in 1762, and had, he believed, d her family in the provinces by a lettre de cachet, n 1772 she suddenly appeared in Paris, and soon commenced proceedings for a separation. The poor is did not know what to do; his sons were a great e to him, and it was one of his own daughters who ncouraged in vain to take this step. Yet he was mined to keep the case quiet if possible for the sake of me de Pailly, a Savoy lady whom he had loved since But his wife would not let him rest; her plea was d in 1777, but she renewed her suit, and, though reat Mirabeau had pleaded his father's case, was sue- l in 1781, when a decree of separation was proed. This trial had quite broken the health of the us, as well as his fortune, he sold his estate at n, and hired a house at Argenteuil, where he lived y till his death on July 11, 1789.

For the whole family of Mirabeau, the one book to refe Louis de Loménie's *Les Mirabeau*, 2 vols., 1878, and it is gre be regretted that the talented author did not live to treat th of the great Mirabeau and his brother. See also Lucas d tigny's *Mémoires de Mirabeau*, and, for the marquis's econ views, De la Vergne's *Économistes français du 18me siècle*.

MIRAGE. See Light, vol. xiv. p. 600.

MIRAMON, Miguel, a Mexican soldier of I extraction, was born in the city of Mexico, Septemb 1832, and shot along with the emperor Maximil Queretaro, June 19, 1867. While still a student he l to defend the military academy at Chapultepec again forces of the United States; and, entering the army in he rapidly came to the front during the civil wars th turbed the country. It was largely due to Miramon's su of the ecclesiastical party against Alvarez and Com that Zuloaga was raised to the presidency; and in 18 was called to succeed him in that office. Decisively however, by the Liberals, he fled the country in 186 spent some time in Europe earnestly advocating f intervention in Mexican affairs; and when he retur was as a partisan of Maximilian. His ability as a was best shown by his double defence of Puebla in

MIRANDA, Francisco (1754–1816), was b Santa Fe in New Granada in 1754. He entered the and served against the English in the American Independence. The success of that war inspire with a hope of being the Washington of his own co and a belief that the independence of Spanish A would increase its material prosperity. With these he began to scheme a revolution, but his schemes we covered and he had only just time to escape to the States. Thence he went to England, where he was duced to Pitt, but chiefly lived with the leading m of the opposition—Fox, Sheridan, and Romilly. F no help in his revolutionary schemes, he travelled g greater part of Europe, notably through Austr Turkey, till he arrived at the court of Russia, he was warmly received, but from which he was dis though with rich presents, at the demand of the S ambassador, backed up by the envoy of France. Th of the dispute between England and Spain about Sound in 1790 recalled him to England, where a good deal of Pitt, who had determined to ma of him to "insurge" the Spanish colonies, but the p arrangement of the dispute again destroyed his hop April 1792 he went to Paris, with introductions to and the leading Girondists, hoping that men who wer ing so hard for their own freedom might help his c men in South America. France had too much to fighting for its own freedom to help others; but Mi friends sent him to the front with the rank of of brigade. He distinguished himself under Dum was intrusted in February 1793 with the conduct siege of Maestricht, and commanded the left wing French army at the disastrous battle of Neerv Although he had given notice of Dumouriez's pr treachery, he was put on his trial for treason on M He was unanimously acquitted, but was soon again into prison, and not released till after the 9th The He again mingled in politics, and was sentenced deported after the struggle of Vendémiaire. Yet he e and continued in Paris till the *coup d'état* of Fr caused him finally to take refuge in England. H found Pitt and Dundas once more ready to listen and the latter sent a special minute to Colonel the governor of Trinidad, to assist General M schemes in every possible way; but, as neither would or could give him substantial help, he went United States, where President Adams gave him fai but nothing more. Once more he returned to E

dington might have done something for him but gnature of the peace of Amiens in 1802. At the ough in no way amnestied, he returned to Paris, promptly expelled by the First Consul, who was r to be on good terms with the court of Spain. nted in further efforts to get assistance from and the United States, he decided to make an on his own responsibility and at his own expense. two American citizens, Colonel Smith and Mr equipped a small ship, the "Leander," in 1806, the help of the English admiral Sir A Cochrane nding near Caracas, and proclaimed the Colombian He had some success, and would have had more a false report of peace between France and caused the English admiral to withdraw his At last in 1810 came his opportunity, the n Spain which brought about the Peninsular divided the authorities in Spanish America some declared for Joseph Bonaparte, others for d VII., while others again held to Charles IV. moment Miranda again landed, and had no difficulty g a large party together who declared a republic Venezuela and New Granada or Colombia But 's desire that all the South American colonies should a federal republic be formed, awoke the selfish l pride of individual provincial administrations, weakened the cause, which further was believed to ul to heaven owing to a great earthquake on 6, 1812. The count of Monte Verde, the Bourbon , had little difficulty in defeating the disunited Miranda, and on July 26 the general capitulated ition that he should be deported to the United The condition was not observed; Miranda was om dungeon to dungeon, and died in 1816 at Cadiz. re allusions to Miranda's early life in nearly all memoirs of but they are not generally very accurate For his trial see t Roux, *Histoire Parlementaire*, xxvii. 26 ,0 For his see Biggs, *History of Miranda's Attempt in South America*, 1809; and Veggasi, *Revolucion de la Colombia*.

ANDOLA. See Pico.

KHOND (1433 1498). Mohammed bin Khâwand Mahmúd, commonly called Mirkhwand or Mirk more familiar to Europeans under the name of nd, was born in 1433, the son of a very pious and man who, although belonging to an old Bokhara of Sayyids or direct descendants of the Prophet, d died in Balkh. From his early youth he applied to historical studies and literature in general. In where he spent the greater part of his life, he gained our of that famous patron of letters, Mir 'Alíshír 40), who served his old school fellow the reigning Husain (who as the last of the Timúrides in Persia the throne of Herát in 1468), first as keeper seal, afterwards as governor of Jurján. At the of this distinguished statesman and writer nd began about 1474, in the quiet convent of yah, which his patron had founded in Herát as a f retreat for literary men of merit, his great work on al history, the largest ever written in Persian, and present day an inexhaustible mine of information Eastern and Western scholars. It is named *-ussafá ji sírat-ulanbiái walmuluk walkhulafá* or *of Purity on the Biography of Prophets, Kings, and*. That the author has made no attempt at a critical ation of historical traditions can scarcely be called a fault of his, since almost all Oriental writers are deficient in sound criticism; more censurable is his flowery and often bombastic style, but in spite of this drawback, and although, in our own age, the discovery of older works on Asiatic history has diminished to some extent the value of Mirkhond's *Rauzat*, it still maintains its high position as one of the most marvellous achievements in literature from the pen of one man, and often elucidates, by valuable text corrections, various readings, and important additions, those sources which have lately come to light. It comprises seven large volumes and a geographical appendix, but internal evidence proves beyond doubt that the seventh volume, the history of the sultan Husain (1438 1505), together with a short account of some later events down to 1523, cannot have been written by Mirkhond himself, who died in 1498. He may have compiled the preface, but the main portion of this volume is probably the work of his *grandson*, the equally renowned historian Khwandamir (1475 1534), to whom also a part of the appendix must be ascribed.

The following is a summary of the contents of the other six volumes. Vol i. Preface on the usefulness of historical studies, history of the creation, the patriarchs, prophets, and rulers of Israel down to Christ, and the Persian kings from the mythical times of the Peshdadian to the Arab conquest and the death of the last Sasanian Yazdajird III. in 30 A.H. (651 A.D.). Vol. ii. Mohammed, Abúbekr, 'Omar, 'Othmán, and 'Alí. Vol. iii. The twelve imams, and the Omayyad and Abbasid caliphs down to 656 A.H. (1258 A.D.). Vol. iv. The minor dynasties contemporary with and subsequent to the 'Abbasids, down to 778 A.H. (1376 A.D.), the date of the overthrow of the Kurt dynasty by Timur. Vol. v. The Moghuls down to Timur's time. Vol. vi. Timúr and his successors down to Sultan Husain's accession in 873 A.H. (1468 A.D.). The best accounts of Mirkhond's life are De Sacy's "Notice sur Mirkhond" in his *Mémoires sur diverses antiquités de la Perse*, Paris, 1793; Jourdain's "Notice de l'histoire universelle de Mirkhond" in the *Notices et Extraits*, vol. ix., Paris, 1812 (together with a translation of the preface, the history of the Ismailians, the conclusion of the sixth volume, and a portion of the appendix); Eliot, *History of India*, vol. iv. p. 127 *sq.*; Morley, *Descriptive Catalogue*, London, 1854, p. 30 *sq.*; Rieu, *Cat. of Persian MSS. of the Brit. Mus.*, vol. i., London, 1879, p. 87 *sq.* Mirkhond's patron Mir Alí-shír, to whom the Rauzat is dedicated, died three years after him (1501).

Besides the lithographed editions of the whole work in folio, Bombay, 1853, and Teheran, 1853-56, and a Turkish version Constantinople, 1842, the following portions of Mirkhond's history have been published by European Orientalists: *Vie de Kaid, roi de Perse*, by D. Shea, London, 1832 (Oriental Translation Fund); *L'Histoire de la dynastie Samanides*, by [illegible] (on the above mentioned *Mémoires*), *Histoire des Samanides de la Perse* by Jaubert, Paris, 1813, *Historia patriarcharum regum Persarum*, Pers. and Lat. by Jenisch, Vienna, 1782, *Mirchondi historia Taheridarum*, Pers. and Lat., by Mitscherlich, Gottingen, 1811 2d ed., Berlin, 1819; *Historia Samanidarum*, Pers. and Lat., by Wilken, Gottingen, 1808, *Histoire des Samanides*, Turkish text by Defremery, Paris, 1845; *Historia Ghaznevidarum*, Pers. and Lat., by Wilken, Berlin, 1832, *Geschichte der Sultane aus dem Geschlechte Ilech*, Turkish and German, by Wilken, Berlin, 1835, followed by Erdmann's *Erzählungen und Denkmäler*, Kazan, 1850; *Historia Seldschukidarum*, ed. Vullers, Giessen, 1837, and a German translation by the same; *Histoire des Sultans du Kharezm*, in Persian, by Defremery, Paris, 1842, *History of the Atabeks of Syria and Persia*, in Persian, by W. Morley, London, 1848, *Historia Gharidarum*, Pers. and Lat., by Mitscherlich, Lond. and Gott., 1817; *Histoire des Sultans Ghourides*, translated into French by Defremery, Paris, 1844; *Life of Djenghiz Khan*, in Persian, by Jaubert, Paris, 1824 (see also extracts from the same 4th volume in French translation by Langlès in vol. vi. of *Notices et Extraits*, Paris, 1799, p. 192 *sq.*, and by Hammer in *Sur les ori. des Russes*, St Petersburg, 1825, p. 59 *sq.*). "Timur's Expedition against Tuktamish Khan," Persian and French, by Charmoy, in *Mémoires de l'Acad. Imper. de St Petersbourg*, 1836, pp. 270-321 and 441-474. (H. F.)

MIROPOLIE, a town of Russia, situated in the government of Kursk, district of Sudja, 83 miles south-west of Kursk and 25 miles from the Sumy railway station. It is supposed to have been founded in the 17th century, when it was fortified against the raids of Tartars. The fertility of the soil led to the settlement of large villages close by the fort, and the 10,800 inhabitants of this town are still engaged mostly in agriculture. There is also an extensive manufacture of boots.

MIRROR. It is only since the early part of the 16th century that mirrors have become articles of household furniture and decoration. Previous to that time—from the 12th to the end of the 15th century—pocket mirrors or small hand mirrors carried at the girdle were indispensable adjuncts to ladies' toilets. The pocket mirrors consisted of small circular plaques of polished metal fixed in a shallow circular box, covered with a lid. Mirror cases were chiefly made of ivory, carved with relief representations of love

Alíshír not only excelled as poet both in Chaghatái, in s epopees gained him the foremost rank among the classic n that language, and in Persian, but composed an excellent n or biography of contemporary Persian poets.

estic scenes, hunting, and games, and sometimes
tions of popular poetry or romance. Gold and
enamels, ebony, and other costly materials were
used for mirror cases, on which were lavished the
decorative efforts of art workmanship and costly
g. The mirrors worn at the girdle had no cover,
re furnished with a short handle. In 625 Pope
e IV sent Queen Ethelberga of Northumbria a
of a silver mirror; and there is ample evidence
early Anglo-Saxon times mirrors were well known
and. It is a remarkable fact that on many of the
d tones of Scotland, belonging probably to the
, or 9th century, representations of mirrors, mirror
d comb occur.

method of backing glass with thin sheets of metal
ors was well known in the Middle Ages at a time
ed and silver mirrors were almost exclusively
d. Vincent de Beauvais, writing about 1250, says
mirror of glass and lead is the best of all "quia
propter transparentiam melius recipit radios." It
n that small convex mirrors were commonly made
hern Germany before the beginning of the 16th
and these continued to be in demand under the
f bull's-eyes (*Ochsen Augen*) till comparatively
times. They were made by blowing small globes
into which while still hot was passed through
e a mixture of tin, antimony, and resin or tar.
he globe was entirely coated with the metallic com-
nd cooled it was cut into convex lenses, which of
ormed small but well defined images. It appears
ention was drawn to the method of making mirrors
e as early as 1317, in which year a "Magister de
a," who knew how to work glass for mirrors, broke
ement had made to m ce Venetians,
m their hands a large quan of mixed alum and
which they could find no u e.

s, however, in Venice that the making of glass
on a commercial scale was first developed; and
ceptre ing republic enjoyed a rich and much prized
ly of the manufacture for about a century and a
n 1507 two inhabitants of Murano, representing
y possessed the secret of making perfect mirror
a knowledge hitherto confined to one German glass-
obtained an exclusive privilege of manufacturing
for a period of twenty years. In 1564 the mirror-
of Venice, who enjoyed peculiar privileges, formed
ves into a corporation. The product of the
glass-houses quickly supplanted the mirrors of
l metal, and a large and lucrative trade in Venetian
irrors sprang up. They were made from blown
s of glass which were slit, flattened on a stone,
y polished, the edges frequently bevelled, and the
silvered by an amalgam. The glass was remarkably
d uniform, the "silvering" bright, and the sheets
e of considerable dimensions. In the inventory
effects made on the death of the great French
Colbert enumerated a Venetian mirror 16 by
es, in a silver frame, valued at 8016 livres, while
e by Raphael was put down at 3000 livres.

manufacture of glass mirrors, with the aid of Italian
en, was practised in England by Sir Robert Mansel
n the 17th century and about 1670 the duke of
gham was conducting a glass-work at Lambeth
lint glass was made for looking-glasses. These old
mirrors, with bevelled edges in the Venetian
, are still well known.

Venetians guarded with the utmost jealousy the
of their varied manufactures, and gave most excep-
rivileges to those engaged in such industries. By
tatutes any glassmaker carrying his art into a foreign state was ordered to return on the pain imprisonment of his nearest relatives, and should disobey the command emissaries were delegated to s the contumacious subject. In face of such a stat Colbert attempted in 1664, through the French ambassa in Venice, to get Venetian artists transported to France develop the two great industries of mirror-making a point lace working. The ambassador, the bishop Béziers, pointed out that to attempt to send the requi artists was to court the risk of being thrown into Adriatic, and he further showed that Venice was selling France mirrors to the value of 100,000 crowns and lace three or four time it value. Notwithstanding th circumstances owever, twenty Venetian glass-mir makers were sent to France in 1665, and the manufact was begun under the fostering care of Colbert in Faubourg St Antoine, Paris. But previous to this the of blowing glass for mirrors had been actually practised Tour la Ville, near Cherbourg, by Richard Lucas, Sieur Nehou, in 1653 and by the subsequent combination skill of both establishments French mirrors soon excel in quality those of Venice. The art received a new impu in France on the introduction of the making of plate gl which was discovered in 1691. The St Gobain Gl Company attribute the discovery to Louis Lucas of Neh and over the door of the chapel of St Gobain they h placed an inscription in memory of "Louis Lucas qui venta in 1691 le methode de couler les glaces et install manufacture en 1695 dans le château de Saint Gobain."

Manufacture. The term "silvering," as applied to the for tion of a metallic coating on glass for giving it the properties mirror, was till quite recently a misnomer, seeing that till ab 1840 no silver was used in the process. Now, however, a la proportion of mirrors are made by depositing on the glass a coa of pure silver, and the old amalgamation process is comparati little used.

The process of amalgamation consists in applying a thin amalg of tin and mercury to the surface of glass, which is done o perfectly flat and horizontal slab of stone bedded in a heavy, i bound wooden frame, with a gutter running round the outer e surface of this table, which must be perfectly smooth leve spread a sheet of thin tin foil, somewhat larger than the g *to be operated on, and after all folds and creases have been e* ely removed. oking and beating with a cove wooden rubber, the process of "quickening" the foil is commen A small quantity of mercury is rubbed lightly and quickly over whole surface, and the scum of dust, impure tin, and mercur taken off. Mercury is then poured upon the quickened foil, u there it sufficient to float the glass to be silvered (al the edg at one of the sides having been cle har to mercury, the glass (scrupulously cle multaneously with the above operations) is slid from that side surface of the mercury. Weights are placed over the su until the greater part of the amalgamated mercury is pressed *the table is then tilted diagonally, by means of dumb-screws,* all superfluous mercury finds its way to the gutter. The g is left twenty four hour under weights; it is then turned silvered side up, and removed to a drainer with inclining shel where by degrees, as it dries and hardens, it is brought vertical p tion, which in the case of large sheets may not arrived at in less than a month. This process yields excel results, pr luces a brilliant silver-white metallic lustre whic only to alteration by exposure to high temperatures, o contact with damp surfaces, but the mercurial vapours to wh the workmen are exposed give rise to the most distressing and f affections.

In 1835 Baron Liebig observed that, on heating aldehyde w an ammoniacal solution of nitrate of silver, in a glass vesse brilliant deposit of metallic silver was formed on the surface of glass. To this observation is due the modern process of silve sil- In practice the process was introduced about 1840; ar is now carried on, with several modifications, in two distinct w called the hot and the cold process respectively. In the for method there is employed a horizontal double-bottomed met table, which is heated with steam to from 35° to 40° C. The g to be silvered is cleaned thoroughly with wet whiting, then was with distilled water, and prepared for the silver with a sensiti solution of tin, which is well rinsed off immediately before removal to the silvering table. The table being raised to proper temperature, the glass is laid, and the silvering solutio

ce poured over it, before the heat of the table has time to dry y part of the surface of the glass. The solution used is prepared follows:—in half a litre of distilled water 100 grammes of trate of silver are dissolved; to this there is added of liquid mmonia (sp. gr. 0·880) 62 grammes; the mixture is filtered, and de up to 8 litres with distilled water, and 7·5 grammes of tartaric d dissolved in 30 grammes of water are mixed with the solution. bout 2·5 litres are poured over the glass for each superficial metre be silvered. The metal immediately begins to deposit on the ass, which is maintained at about 40° C. (104° F.), and in little ore than half an hour a continuous coating of silver is formed e silvered surface is then cleaned by very cautiously wiping with very soft chamois rubber, and treated a second time with a ution like the first, but containing a double quantity of tartaric d. This solution is applied in two portions, and thereafter the ass is once more carefully cleared of all unattached silver and fuse and removed to a side room for backing up.

In silvering by the cold process advantage is taken of the power inverted sugar to reduce the nitrate of silver. This process l en adopted for the silvering of mirrors for astronomical telescopes, tably for Leverrier's great telescope in the Paris Observatory. For linary mirror silvering the following is the process recommended H. E. Benrath. Two solutions are prepared, the first of which ntains the silver salt, and the second the sugar preparation. For e silver solution 800 grammes of nitrate of silver and 1200 grammes nitrate of ammonium are dissolved in 10 litres of water, and 1·3 los of pure caustic soda in 10 litres of water, and of each of these utions 1 litre is added to 8 litres of water, which is allowed to t till the sediment forms and then decanted. The second solution—inverted sugar—is prepared by dissolving 150 grammes of loaf gar with 15 grammes of vinegar in 0·5 litre of water, and boiling e solution for half an hour. After cooling it is made up with water 4200 cubic centimetres. The silvering is done on horizontal bles in a well-lighted and moderately heated apartment, and the ass is cleaned with scrupulous care. For each square centimetre glass operated on 15 cubic centimetres of the silver solution ove described are measured out, and from 7 to 10 per cent. of e solution of inverted sugar is added, both being quickly stirred together and poured rapidly and evenly over the glass. The reduction immediately begins, and the solution exhibits tints passing through se, violet, and black, till in about seven minutes it again becomes ansparent and the deposit of metal is complete. This first deposit extremely thin, and allows the transmission of bluish rays. he exhausted solution with floating and unattached dust like annules of silver is carefully wiped off, the silvered surface washed th distilled water and again treated with the mixed solutions to the tent of half the quantity used in the first application. The finished rface is wiped and washed in the most thorough manner,—for e least trace of caustic soda left would destroy the mirror. The rther processes are the same in both methods of silvering.

The deposit of silver on glass is not so adherent and unalterable under the influence of sunlight and sulphurous fumes as e tin-mercury amalgam, and moreover real silvered glass has a ghtly yellowish tinge. These defects have been overcome by a ocess introduced by M. Lenoir, which consists of brushing over e silvered surface with a dilute solution of cyanide of mercury, hich instantaneously forming a kind of amalgam renders the deposit once much whiter and more firmly adherent than before. To otect the thin metallic film from mechanical injury and the emical action of gases and vapours, it is coated with shellac copal varnish, over which when dry are applied two coatings of d-lead paint.

Platinum Mirrors.—A cheap process of preparing mirror glass is some extent prosecuted in France, whereby a thin but very dherent deposit of platinum is formed on the glass. A solution of loride of platinum with a proportion of litharge and borate of ad dissolved in essential oil of spike is applied with a brush to ell-cleaned glass, which is then placed on edge in a muffle furnace, d the platinum is thus burned in, forming an exceedingly thin t brilliant metallic backing having a somewhat grey lustre. It used only for the lids of cheap boxes, toys, ornamental letters, &c.

Magic Mirrors.—Hand mirrors of metal are still in common use Oriental countries, and especially in Japan and China they continue to be the prevalent form of looking-glass. In the former untry indeed bronze mirrors are articles of the greatest importance the generally meagre furnishing of houses, and besides possessing religious significance. They have been known and used from e most remote period, mention of them being found in Chinese terature of the 9th century. The (reputed) first made Japanese irror, preserved at Isé, is an object of the highest veneration in apan, and an ancient mirror, connected with which is a tradition the effect that is was given by the sun-goddess at the foundation the empire, is a principal article of the Japanese regalia. The irrors of Japan vary in form and size, but in general they consist of thin disks, from 3 to 12 inches in diameter, of speculum etal with handles cast in one piece. The polished face of the irror is slightly convex in form, so that a reflected image is seen proportionately reduced in size; the back of the disk is occupied with characteristic Japanese ornamentation and inscriptions in bold relief, and its rim is also raised to the back. Much attention has been attracted to these mirrors by a singular physical peculiarity which in a few cases they are found to possess. These are known as magic mirrors from the fact that when a strong beam of light is reflected from their smooth and polished surface, and thrown on a white screen, an image of the raised ornaments and characters on the back of the mirror is formed with more or less distinctness in the disk of light on the screen. This peculiarity has at no time been specially observed by the Japanese, but in China it attracted attention as early as the 11th century, and mirrors possessed of this property sell among the Chinese at ten or even twenty times the price sought for the ordinary non-sensitive example. The true explanation of the magic mirror was first suggested by the French physicist Person, who observed that the reflecting surface of the mirrors was not uniformly convex, the portions opposite relief surfaces being plane. Therefore, as he says, "the rays reflected from the convex portion diverge and give but a feebly illuminated image, while, on the contrary, the rays reflected from the plane portions of the mirror preserve their parallelism, and appear on the screen as an image by reason of their contrast with the feebler illumination of the rest of the disk." That such differences of plane in the mirror surface arise is an accidental circumstance due to the way in which it is prepared, a process explained by Professors Ayrton and Perry, by whom ample details of the history, process of manufacture, and composition of Oriental mirrors have been published. A preliminary operation in polishing the surface consists of scoring the cast disk in every direction with a sharp tool. The thicker portions with relief ornament offer more resistance to the pressure of the tool than the thin flat portions, which tend to yield and form at first a concave surface, but this by the reaction of its elasticity rises afterwards and forms a slightly convex surface, while the more rigid thick portions are comparatively little affected. This irregularity of surface is inconspicuous in ordinary light, and does not visibly distort images; but when the mirror reflects a bright light on a screen the unequal radiation renders the minute differences of surface obvious. The ingenious theory of Person has been established by experiments communicated by M. Govi to the academy of Turin in 1861-65, and more recently by investigations of MM. Bertin and Dubosq. See *Annales de Chimie et de Physique* (5th ser., vol. xx.). (J. PA.)

Ancient Mirrors.

The mirror of classical antiquity (κάτοπτρον, speculum) was a thin disk of bronze slightly convex on one side and polished, usually provided with a handle, sometimes mounted on a stand in the form of a female figure (see Costume, vol. vi. p. 453, fig. 1), sometimes fixed inside a circular bronze case. The common size is that of an ordinary hand mirror. Examples large enough to take in the whole figure appear to have been rare. Mirrors of glass are mentioned, and though none of them have been found their existence need not be questioned altogether, since the process of silvering occasionally employed on bronze mirrors suggests that an analogous process may have been applied to glass. But the very large number of mirrors still existing from antiquity shows that bronze was the regular material employed. The alloy known as speculum, producing a very hard metal with great reflecting power, is comparatively seldom met with. Silver mirrors are mentioned, but none have as yet been found.

The principal feature of ancient mirrors, especially those of Etruria, is the design incised on the back (see Etruria, vol. viii. p. 633). While two thousand incised specimens are all that are as yet known from Greece, the number found in Etruria must be nearly a thousand. As a rule the subjects incised are taken from Greek mythology and legend, the names of the persons represented being frequently added in Etruscan letters and orthography. In most cases the style of drawing, the types of the figures, and the manner of composing the groups are true to the characteristics of Greek art. Some may have been imported from Greece; but the greater number appear to have been more or less faithfully imitated from such designs as occurred on the almost innumerable painted Greek vases which the Etruscans obtained from Greece. Even where distinctly Etruscan figures are introduced, such as the heroes Ælius and Celius Vibenna on a mirror in the British Museum, Greek models are followed. The characteristics of Greek art here referred to date from a little before 400 B.C., and continue for some time after. In this period would fall the majority of the Etruscan mirrors, and to this period also belong the Greek incised mirrors, among which may be mentioned for their beauty one representing Leucas and Corinthus, inscribed with their names engraved, *Monuments Grecs*, 1873, pl. 5, published by the Association pour l'encouragement des Études Grecques, and another in the British Museum (*Gazette Arch.*, ii. pl. 27), on the back of which is a figure of Eros which has been silvered over. With this last-mentioned mirror was found the bronze case used to contain it,

back of which is a group of Aphrodite and Eros in repoussée. found in Crete. But most of the Greek mirrors and mirror- having artistic designs are from Corinth. One bears the name artist, Ἀπολλόδωρος ἐποίει (engraved, *Arch. Zeitung*, 1862, pl. g. 1).

haic art (about 300 B.C.) is represented by a mirror in the Museum from Sunium in Attica. The mirror itself is quite but the handle composed of a draped female figure, above head float two cupids. From Etruria there is a comparatively number with archaic incised designs. It may be concluded that ory of mirror enriched with incised designs was not freely in- before 400 B.C. in Etruria and never to any extent in Greece. centre of incised mirrors was the Latian town of Praeneste rnae, and it is of interest in regard to some of the mirrors there that they have inscriptions in early Latin. Artistically ave a purely Greek character. Plain mirrors are found Greek and Roman civilization spread and it may be seen pecimen found in Cornwall, now in the British Museum, e Celtic population of England had adopted the form and es of the mirror from their conquerors. This specimen is ed with a Celtic pattern incised. The shape of the handle tomatic originality. Mirrors were used in Greece, perhaps for divination, as appears, for example, from Pausanias (vii. the method being to let the mirror down into a well by of a string till it reached close to the surface of the water it was pulled up after a little it was expected to show the the sick person on whose behalf the ceremony was performed. as at Patras.

ome recent publications on ancient mirrors are Gerhard, *Etruskische Spiegel*, 1–65, 1 vols. containing 419 plates, for the Greek mirrors; Myloris, Καταστροφή, Athens, 1876 and Dumont, *Bulletin de Correspondance Hellénique*, 1877, see also Friederichs, *Kleinere Kunst und Industrie im Alterthum*, Dressel, ed. p. 15 *sq.*, and Marquardt and Mommsen, *Handbuch der römischen Alterthümer*, vii. pt. 2, p. 670. (A. S. M.)

RZÁPUR, a district in the North Western Provinces dia, lying between 23° 51′ 30″ and 25° 31′ N. lat., etween 82° 9′ 15″ and 83° 0′ 36″ E. long., is bounded N. by Jaunpur and Benares, on the E. by Shahabad ohardagá, on the S. by Sarguja state, and on the W. lahabad and Rewah state, and has an area of 5217 miles. It is crossed from east to west by the ya and Kámur ranges. A central jungly plateau ts these, and separates the valley of the Ganges that of the Son.

population in 1872 was 1,015,203 (male, 520,196, females, 7), of whom 949,641 were Hindus, 64,869 Mohammedans, 0 Christians. The non-Asiatic population numbered 623. hree towns had a population exceeding 5000. Mirzapur, , Chunar, 10,151, and Ahraura, 9091. Out of a Govern- d area of 3048 square miles, 1333 are cultivated, 497 ble waste, and 1218 uncultivable. The part of Mirzapur he north of the Vindhyas is very highly cultivated and peopled, but the rest of the district consists largely of and forests, with a very sparse population. Local manu- comprise carpets of a superior description, brass ware, and . The East Indian Railway traverses the district, above the ank of the Ganges, for a distance of 32 miles. The climate ally warmer and dryer than that of districts farther north st. The mean annual rainfall is 42·7 inches.

RZÁPUR, chief town and administrative headquarters above district, is situated on the south bank Ganges, 56 miles below Allahabád (25° 9′ 13″ N. 82° 38′ 10″ E. long.). The population in 1872 was 4, of whom 55,917 were Hindus and 11,053 Mo- medans. Up to quite recent years Mirzapur was rket in upper India for grain and cotton; but s commercial importance has rapidly decreased, g to the establishment of through railway communica- with Bombay *viâ* Jabalpur, and the rise of Cawnpore e position of a mercantile centre. The river front, with stone *ghat* or flight of stairs, and exhibiting erous mosques, Hindu temples, and dwelling houses of wealthier merchants, with highly decorated façades and carved balconies and door frames, is handsome; but terior of the town is mainly composed of mud huts. manufacture of shellac gives employment to about four and persons; brass ware and carpets are also made. imports consist of grain, sugar, cloth, metals, fruit, s, tobacco, lac, salt, and cotton; the same articles, manufactured lac-dye, shellac, and *ghi*, are exported.

MISDEMEANOUR. "The word misdemeanour," sa Russell (*On Crimes*, vol. i. chap. iv.), "is applied to all the crimes and offences for which the law has not provided particular name." Stephen, in his *Digest of the Crimi Law*, adopts the following mode of distinguishing betwe misdemeanour and other crimes. "Every crime is eith treason, felony, or misdemeanour. Every crime whi amounts to treason or felony is so denominated in the defi tions of crimes hereinafter contained. All crimes not denominated are misdemeanours." It is customary to spe of misdemeanour as implying a less degree of crime th felony (see FELONY). "Misdemeanours," observes Russ in the passage already cited, "have been sometimes term *misprisions*, indeed the word misprision, in its larger sen is used to signify every considerable misdemeanour wh has not a certain name given to it in the law, and it is s that a misprision is contained in every felony whatsoev so that the offender may be prosecuted for misprision at t option of the crown. Misprision, in a more restricted se (or negative misprision), is the concealment of an offen Positive misprisions are contempts or misdemeanours o public character, *e.g.*, maladministration of high offici contempt of the sovereign or magistrates, &c. The r as to punishment, when no express provision has been ma by law, is that "every person convicted of a misdemeano is liable to fine and imprisonment without hard labo (both or either), and to be put under recognizances to ke the peace and be of good behaviour at the discretion the court" (Stephen's *Digest*, art. 22). By 28 & 29 V c. 67 prisoners convicted of misdemeanour and sentenc to hard labour shall be divided into two divisions, one which shall be called the first division, and when a pers convicted of misdemeanour is sentenced to imprisonme without hard labour the court may order him to be treat as a first-class misdemeanant, who shall not be deem a "criminal prisoner" within the meaning of that A The Prison Act, 1877 (§§ 10, 41), requires prisoners c victed of sedition or seditious libel, or attached for conten of court, to be treated as misdemeanants of the first cla

In New York and some other States of the Americ Union the legislature has defined felony as any cri which is or may be punishable with death or imprisonme in a State prison, all other crimes being misdemeanours.

MISHNAH. The *Mishnah*, in the most familiar ap cation of the name, is the great collection of legal decisio by the ancient rabbis which forms in each Talmud the te on which the *Gemara* rests, and so is the fundamen document of the oral law of the Jews. The quest "What is Mishnah?" was asked, however, as early as latter part of the 1st or the early part of the 2d centu though in a somewhat different sense and for a somew different purpose.[1] It will be answered in the course this article in all its bearings.

I. *Name.* Rabbinic tradition has fixed the point *Mishnah* (מִשְׁנָה) by giving its *status constructus* *Mishnath*. Although the word *Mishnah* is not found the Bible, it is no doubt a classical Hebrew term, sig fying something closely akin to *Mishneh* (which te occurs more than once there), as may be seen on compar *Mikveh* with *Mikveh*, *Miknah* with *Mikneh*, *Ma'alah* w *Ma'aleh*, and *Mar'ah* with *Mar'eh*, each two of which a however they may vary in practical application, questionably synonymous terms. The practical sign cations of *Mishnah* are seven in number:—(1) rep tion, *i.e.*, tradition:[2] as such it is the equivalent of

[1] See T. B., *Kiddushin*, 49*a*.

[2] The root *Shanah* (שָׁנָה), from which *Mishnah* is immediately rived, is not merely, as is often thought, to *learn*, to *teach*, but *repeat*; and it is in reality this last meaning which underlies the former.

σεις of Epiphanius,[1] the *traditiones et* δευτερώσεις ome,[2] the δευτέρωσις of Justinian,[3] and the שניה "the second to the law") of the *Arukh*[4]; (2) re- from memory, in contradistinction to reading from ;[5] (3) study: as such it is the equivalent of *h* in the former part of its third signification; (4) tion: as such it is the equivalent of *Midrash* in ter part of its third signification;[6] (5) system, view, line of study and instruction: as such it is al with the Talmudical *Shittah*;[7] (6) a paragraph *Mishnah*: it is invariably employed in this sense in bylonian Talmud, and is identical with the word *ah*, used for the same purpose, in the Palestinian l; and (7) the collection of the decisions of the "oral law," *i.e.*, the *Mishnah* in the concrete sense. ord *Mishnah* has three different plurals: (1) the nal *Mishnayoth* for signification (7), formed on alogy of *Mikraoth* (not, as some think, on that of *oth* or *Midrashoth*); (2) the correct, though que- *Mishniyyoth* for signification (6), formed on the of *Parshayyoth* from *Parashah* (or *Parshah*), not k of that of *Ma'asiyyoth* from *Ma'aseh*, (3), the nat inelegant, but correct, *Meshnoth*,[8] which also for signification (6). Significations (1), (2), (3), d (5) have, however inconsistent it may appear one takes into consideration their respective equi , n. plural whatever. So much for the Hebrew *h*. The Aramaic *Mathntha* will be spoken of

Contents and Nature. -The *Mishnah* consists chiefly *Halakhah*;[9] there is, comparatively speaking, little *h*[10] to be found in it. It is not, however, as many either a commentary on the Halakhic portions of the ench, or on the ordinances of the *Sopherim*, or on ogether. It rather presupposes the knowledge of, spect for, both the Mosaic and the Sopheric laws, only discusses, and finally decides on, the best mode anner of executing these. The discussions and al decisions to be found in the *Mishnah* owe their ce principally to deep meditation on these two of laws, notably on the former, by the rabbis of s ages, but chiefly by those who lived fifty years and one hundred and fifty years after the rise of anity, the names of whom it faithfully gives, along eir respective discussions and decisions. There are y cases to be found in the *Mishnah* which would ly come under the denomination of an *Halakhah le mis-Sinai*, *i.e.*, an explanation (of a law) as directly given by God to Moses, and in uninterrupted suc received from him by the rabbis. Several cases under this name in the *Mishnah* are not *bona fide* c for the test of such an *Halakhah* is that it must have been contested by any one.[12]

3. *Method.* A *Mishnah*, if genuine, never begi a passage of the Pentateuch, and even compar seldom brings direct proof from or gives referenc When there is any exception to this rule it will be on close examination, either that such a paragraph l to a very early age (that of the *Sopherim*), or that be found in another work of the "oral law," and is copied in the *Mishnah*, or, what is more likely, t independent, it belongs to a very late age, or, finall the proof or the reference thus given is only a later tion. One example of the true method of the *Mishna* perhaps, better illustrate the foregoing statement sheet full of theorizing on the subject, and this one e will the more surely suffice because of its mixed (and Sopheric) character. It is the very first paragr the whole *Mishnah*, and runs thus: "From what ti the day) does (may, should) one read the *Shema* taking upon oneself the yoke of the heavenly kng in the evening?"[13] The *Mishnah* does not begin: n duty bound to read the *Shema* in the evening, l it is written (Deut. vi. 7), "And when thou lie-t For, in the first place, the law to read the *Shema* e and morning is not unquestionably Mosaic, as the "And thou shalt talk of them, &c.," do not re this passage of the law particularly, but rather words of the Pentateuch in general;[14] and, secondl needless to say that one is in duty bound to rec *Shema* twice a day, since every Jew readily acknow this duty and executes it, although it is not Mosaic. duty of reading the *Shema*, the grounds on whi duty rests, and how it is best fulfilled, are ful ably discussed, developed, and finally settled i part of the Talmud called *Gemara*,[15] - the busi which it is to discuss the words of the *Mishnah* show the sources of the tradition, and eventually t sage in the Pentateuch (it on such the case rest which the respective disputants had derived their vie

4. *Purpose.* Although it is a book containing Ha decisions, the *Mishnah* was never intended, as many to enable the reader thereof to decide from it immed This mistake is old[16] and widely spread, but a n nevertheless. The purpose of the *Mishnah* was simply to exhibit the development of the "oral and the view taken of the development by the ra various times. For this reason one finds side b with the opinions of the majority those also minority, which latter are very carefully given why, since these opinion of the minority can h decisional effect! The *Mishnah* itself (*'Eduyyoth*,

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[1] *Mens.*, xv. (*κατὰ γραμματέων*), *in fine*. Epiphanius was a native tine, even if he was not, as some think, of Jewish parentage. lestinian writer on Jewish and semi-Jewish matters he must l a more than superficial knowledge of the Jewish traditions *shnah*, &c.). And indeed, to judge from the account he gives arious Jewish traditions (although the text of this account is ly corrupt in every way), he was pretty well informed. For us that the Jews have four kinds of traditions — such as are to Moses (by which he no doubt means the *Halakhah le mis-Sinai*); such as are ascribed to the sons of Asmonæus ch he means the *Tiḳḳanoth*, &c., of the *Bath Dina shel Hasha-* see T. B., *'Abodah Zarah*, 36*b*); such as are ascribed to R (the great teacher and martyr); and such as are ascribed to n, &c. (Rabbi Yehudah Hannasi).

[2] *Isaiam*, cap. viii. 11-15.

[3] . cxlvi. (Περὶ Ἑβραίων) *κεφ. ά, in medio.*

[4] cle משנה (first definition).

[5] trast *Shanah* (שָׁנָה) with *Ḳaro* (קָרָא).

[6] article MIDRASH, p. 285.

[7] Schiller-Szinessy, *Catalogue of Hebrew MSS. in the amoridge ity Library*, ii. p. 94.

[8] MS. Add. 464 (University Library, Cambridge), leaf 283*b*.

[9] s word, derived from the root *halakh* (הָלַךְ), to go, is synony- ith *Minhag* (custom, practice) and *Mishpat* (rule), &c.

[10] r the meaning of this term and the Agadic parts which are t d in the *Mishnah*, see MIDRASH.

[11] See R. Asher b. Yehiel (Harosh), *Hilkhoth Mikwaoth* c. 1 after this Rabbi's commentary on *Niddah*, in the printed of the Bab. Talmud, i. 1.

[12] "There are, however, at least sixteen such *bona fide* cases to in the works of the 'oral law.'"

[13] See T. B., *Berakhoth*, on Deut. xi. 19.

[14] *Gemara*, or *Gemara*, signifies concretely discussion on settlement of the contents of the *Mishnah*, from *gemar* (גְּמַר), deeply, to come to a final result; which last signification is, often, to be found also in the Hebrew root *gamar* (גָּמַר).

[15] T. B., *Baba Mezi'a*, 33*a*, and Rashi, *in loco*.

[16] See T. B., *Sotah*, 22*a*.

[17] The word עדיות is variously pointed, — *'Adayoth*, *'Edayoth* in the text, *'Eduyyoth*, which last, if the name come to because of the testimony of the witnesses on which this *M* chiefly rests, would be the only correct one. But it ough remarked that the Babylonian teachers must have spelled it (best things), since its equivalent is given by them as *Be Beḥarotho*). See T. B., *Berakhoth*, 27*a* and elsewhere.

vers this question: it is that the teacher or the judge ter ages may be thus enabled, if he have good grounds taking a view different from that of the majority as n hundreds of years before, to reverse the old decision, orming, on the strength of the example before him, others who agree with him (or without them, if one vote was wanted to reverse the majority) a fresh ority. Thus the Jewish "oral law" can never become ied like the laws of the Medes and Persians.

Language. The *Mishnah* is, on the whole, written almost pure Hebrew; and even the originally non rew word (Aramaic, Greek, Latin, &c.) are so skilfully Hebraized that they are a most creditable testimony he linguistic powers both of many of the disputants tioned in it, whose very words are in most cases given, of the editor[1] or editors who revised them.

Date and Authorship.—R. Yehudah Hannasi (the e), the reputed author (in reality only the principal best among the editors) of the *Mishnah*, was born the year 140 of the Christian era. His name was ll Yehudah b. Shime'on b. Gamliel b. Shime'on b. liel[2] b. Shime'on b. Hillel. On account of his holy g he was surnamed Rabbenu Hakkadosh, and on nt of his great learning and authority he was called ly "Rabbi" ("My Teacher" *par excellence*). Rabbi and ime, however, are no *terminus a quo* for the composi of the *Mishnah*. For, not to speak of many isolated *niyyoth* which can be brought home to R. Meir, to R. bah, to Hillel,[3] to Yose b. Yo'ezer,[4] and to others, even e earlier *Sopherim*,[5] we find that R. Yose b. Halaphta he 1st century already quotes the beginning and end of a whole Mishnic treatise (*Kelim*[6]), and that in the century (or very early in the 2d) another treatise isting of early testimonies ('*Eduyyoth*[7]) was put into r. Moreover, although the phrases *Mishnath R. er b. Ya'akob*[8] and *Mishnath R. 'Akibah*[9] do simply ty the systems, styles, and views of these two ent teachers, there can be little doubt that they and rs besides them, presided over colleges in which the le Halakhic matter was systematically treated and larly gone through. Nor are Rabbi and his time for composition of the *Mishnah* a *terminus ad quem*, for the *nah* was not brought to a close till a very long time wards. Not only did R. Hiyya Rabbah, R. Hosha'yah bah, and Shime'on bar Kappara redact *Mishnayoth*,[10] in the *Mishnah* before us notices are actually found h reach to the end of the 3d century, if not even later. statement that Rabbi was the first to write down the

h Hebrew spoken in the house of the principal editor of the was so correct that rabbis actually learnt the meaning of common words of the Bible from the handmaidens of this house. B. *Bezah Hasshanah*, 26*b*. As for Rabbi himself, he was not a true Hebrew scholar, but a fine Greek scholar also. He was reported in T. B., *Sotah*, 49*b*, he is reported to have exclaimed, in the very one speak in Palestine 'Suri'a'? Let him speak Hebrew or Greek." In using the word 'Suri' for "Surith" he, in fact, makes a punning allusion to the mixed (cut-up) acter of the language, corrupted from Hebrew, Chaldee, Persian, k, and Latin.

This was the opinion of St Paul.

In addition to the above-known Aramaic *Mishnayoth* are those which instinctly so called, as opposed to Biblical, see *Mishnah Kadmonith*, iv. nd contrast with them the language and style of the *Mishnah* in al, and that of the *Boraitha* in particular.

Mishnah Eduyyoth, viii. 7.

See *Mishnah Ma'aser Sheni*, v. 7, *Sotah*, v. 1, 2; *Ne'ilim*, xii. 7, &c.; though it cannot be said that these passages preserve exching of the *Sopherim* in the strictest purity.

See *Mishnah Kelim*, *ut supra*.

See T. B., *Berakhoth*, 28*b*. "It was handed down orally (תנא) that *nayoth* was on that day (when Eleazar b. Azaryah was installed esident) gone through," *i.e.*, recited.

T. B., *Yebamoth*, 19*b*.

Mishnah Sanhedrin, iii. 4.

See *Koheleth Rabbah* on ii. 8 *in medio*.

Mishnah is untrue, because the thing is impossible. the two Talmuds, of which that of Babylonia w finished before the 6th century (if then), know, cer nothing of the writing down of the *Mishnah*. C contrary, their language throughout presupposes the *nah* in their time to have been what its name indic repetition, *i.e.*, a thing acquired by continual reci because, like the other works of the "oral law" (*shebba'al peh*), it was to be, and was, handed down o As for the difficulty of keeping in memory such pendous and vast work as the *Mishnah*, it is som forgotten in this controversy that memory was ai a great variety of mnemotechnic means, such as nu and names of teachers, and by the existence of other of the "oral law," which, although they also we written down, could be easily kept in memory b they rested on letters, words, and verses of the V Pentateuch. Anyhow, there is ample evidence, both tive and positive, that the *Mishnah* as we now h was not committed to writing in the times of Ra for long afterwards. But it certainly does not that no merit is due to Rabbi in connexion wi *Mishnah*. His merit in connexion with it is gr every way. For (1) Rabbi was himself a link chain of tradition, since he had "received" fro own father and so on up to his ancestor Hillel, an higher; (2) he gave in the *Mishnah* his own dec in most cases in accordance with those of the fam Meir, which are thus in a great part secured to u in giving his own decisions he preserved to us good many decisions of the teachers of the 2d ce (1) in collecting all these decisions he anxiously asce the genuine formulas of the older *Mishniyyoth*;[12] did not merely reproduce the formulas which he es the best, but discussed them anew in his own which was composed of men of the highest emine is well known, (6) although he gave on the who very language of the teachers who preceded hi gauged it, guarding it against the barbarisms whi so plentiful in the other works of the "oral law"; a he scattered the *Mishnah* broadcast (though only b of mouth) over all Palestine and Babylonia by me the disciples who flocked to him from all parts of countries. If the *Mishnah*, as it now exists, is not e his, it certainly belongs to him in a great measure more than one sense.

7. *Value and Appreciation.*—Whatever can be favour of the *Agadah* applies with equal if not force to the *Mishnah*, as the latter is a canonic therefore more reliable work of the "oral law." *Mishnah* is one of the richest mines of archæology the world possesses. But it waits yet for the touch to break the spell which holds it bound. however, as the value of the *Mishnah* is, its larity has never been steady, but has been cont fluctuating, and that for various reasons. Even in his time had to appeal for due attention to it. it was neglected in troublous times by the masse ran after the *Agadah*,[13] which, besides being co needed no particular study, it was, in prosperous neglected by the rabbis themselves through the st the Bible and the Talmud.[14] And much more w

[11] See particularly T. B., *Bobo Metsi'a*, 33*a* and *b*; and also Rashi, *in loco*.

[12] See T. Y., *Ma'aser Sheni*, v. 1; and compare the precedi

[13] See MIDRASH, p. 285, note 14.

[14] R. Yohanan said, This *Mishnah* (*Boraitho*), that no study cel that of *Gemara*, was taught in the time of (and by) Rabbi Then the people went after *Gemara* and neglected the study of t *nah*. Whereupon he again bade them ever run more after than after *Gemara*. T. B., *Bobo Metsi'a*, 33*b*, and Rashi, *in*

se when the Talmud had developed from a mere
s activity to two concrete works of large size.
The Ultimate Writing Down of the Mishnah. The
s of the unhappy Jews had multiplied everywhere
sses, as already stated, preferred, in consequence of
roubles, the *Aggadah*. But the number of the
also diminished through these troubles day by day,
comparatively few that renowned preferred more
re the Talmud (in Palestine the Palestinian and in
nia the Babylonian), which was a better field for
rcise of their ingenuity. The text of the *Mishnah*
have been sealed had it not been ultimately
down. But the writing down of *Halakhoth* or
ad been prohibited in early times. Two considera
owever, ultimately removed all scruples: (1) It
me to do something for God even at a risk when
was apparently deserted.[1] Let one (and a number)
disregarded, so that many (and useful) laws be
ed. The *Halakhoth* of the *Mishnah* were impressed
students few: the power of tyranny increased and
the memory decreased by reason of the persecutions.
Language of the *Mishnah*, although pure and m
rer than the language of several books of the Bible
concise and terse that it could not be understood
t a commentary, and, therefore, even after being
down, it would virtually retain its oral character.
Recensions. The *Mishnah* has three principal recen
(1) the *Mishnah* as presented in the work standing
lf, (2) that on which the Palestinian Talmud rest
) that of the Babylonian Talmud. The first named
last named *Mishnayoth* have always been known
plete; the second, however, was supposed for
hundred years to be imperfect, lacking four
n in *Shabbath*, two entire *Massekhtoth* in the *Seder*
h, the whole of the *Seder Kodashim*, and by far the
part of the *Seder Tohoroth*.[2] But since 1869 this
on also has been known to have been always com
and it is to be found in its entirety in a MS pur
in that year for the University Library of Cam
(Add. 170. 1). Besides these three there are many
recensions, touching, however, only isolated read
These last are to be attributed chiefly to copyists.
igin of the difference between the principal recen
s to be sought in the following two facts. (1)
had himself gone twice through the *Mishnah* and
nself considerably altered the wording of the text;
) his successors in early and late times had wilfully
and corrected the original text.

Divisions and Detailed Contents of the Mishnah. The *Mish*
all recensions is divided into six *Sedarim* (orders), each of
ontains a number of *Massekhtoth* (treatises), which stand
exion with one another. The *Sedarim* are subdivided into *Perakim*
s, and these again into *Halakhoth* or *Mishnayoth* (para-
called *Mishnoth*).[3] The number of the *Sedarim* is six,
the *Massekhtoth* sixty,[4] and that of the *Perakim* 523, or

s is a somewhat inexact application of Ps. cxix. 126, but it ha
re than once acted upon both in ancient and modern times by
s. Compare the explanation given in T. B., *Berakhoth*, 63b,
ithoth, 99*a*.
khah is the only *Massekheth* of this *Seder* of which three entire
s are to be found in the printed editions. Compare Schiller-
, *Occasional Notices*, &c., i. (Cambridge, 1878), Sect. p. 8
T. B., *Baba Metsi'a*, 44*a*, and elsewhere.
ether the word *Massekheth* comes from *Masakh* (מָסַךְ, to pour
mix, &c.), or from *Nasakh* (נָסַךְ, to pour, to mix, to weave
signifies in either case here a mould, a form, a frame. *Me-*
has three several plurals: (1) the common *Massekhtoth* (not
khtoth); (2) the less common *Massekhoth* (see MS. Add. 170. 1,
g to the University Library of Cambridge, leaf 69*a* and else
; and (3) *Massekhtiggoth* (מסכתיות), see *Midrash Rabbah* on
s vi. 8, 9. The Aramaic *Massekhta* (not *Ma'akhta*) has in the
Masekhtha, the use of which is, however, very uncommon.
mpare above, p. 503.
mpare *Midrash Rabbah* on Canticles vi. 8, 9.

with a fourth *Perek* to *Bikkurim*, 524.[5] The following is a
of the whole *Mishnah*.[6]

I. ZERA'IM (on Agriculture) preceded by the Treatise on T
giving[7] (1) *Berakhoth* (blessings), in nine chapters; (2)
Lev. xix. 9, &c., in eight chapters; (3) *Pe'ah* (fruit,
&c., doubtful if tithes), in seven chapters; (4) *Kilayim* (on
of plants, animals, and garments respectively), in nine ch
(5) *Shebi'ith* (year of release), in ten chapters; (6) *Terumoth*
to the priests), in eleven chapters; (7) *Ma'aseroth* (on De
), in five chapters; (8) *Ma'aser Sheni* (on Deu
Levitical tithes), in five chapters; (10) *Hallah* (Num. xv.
in four chapters; (11) *'Orlah* (Lev. xix. 23), in three ch
and (12) *Bikkurim* (Deut. xxvi. 1–11), in three comment
chapters.

II. MO'ED (on Festival Times): (1) *Shabbath* (Sabba
(two), in twenty-four chapters; (2) *Erub* (fictitious or ideal u
extended prohibitions), in ten chapters; (3) *Pesah* (Passover
(Passover), in ten chapters; (4) *Yoma* (commonly *Ki
the Day of Atonement), in eight chapters; (5) *Sukk
(Feast of Tabernacles), in eight chapters; (6) *Shekalim* (Lev
), in five chapters; (7) *Yom Tob* (commonly *Beẓah*
eggs"), so-called from the initial words of the treatise (see *Dikdu
be minute of the treatises), on work prohibited or permitted on festivals, in five chapters; (8) *Ta'anith* (Fasts
on the various kinds of new years, a collection of civil the
procession and confession, &c.), in four chapters; (9) *Megillah*
(the Book of Esther), in four chapters; (10) *Mo'ed Katan* (the
Festival), in three chapters; (11) *Hagigah* (a name of the
on Deut. xvi. 16), in three chapters.

III. NASHIM (Women): (1) *Yebamoth* (so called from t
distinctive word of the treatise, but commonly *Yibbum*
ister-in-law, the levirate &c.), in sixteen chapters; (2) *Ke
(marriage-deed, settlement, &c.), in thirteen chapters; (3)
(vows), in eleven chapters; (4) *Nazir* (Num. vi. 2–21),
chapters; (5) *Sotah* (the bitter water, atonement and other rites),
chapters; (6) *Kiddushin* (betrothal and marriage), in four c
(or *Sotah* and chiefly *Sotah*, Num. v. 12–31), in nine chapters.

IV. NEZIKIN, commonly *Nezikin* (Damages, &c., or Ex
n, &c.): (1) *Nezikin* commonly *Baba Kamma* (the
Gate), in ten chapters; *Baba Mẓi'a* (the Middle Gate),
chapters; and *Baba Bathra* (the Last Gate), in ten chapte
thirty chapters; (2) *Sanhedrin* (Court of justice, &c.), in
chapters; (3) *Makkoth* (forty stripes save one, Deut.
chapters; (4) *Shebu'oth* (oaths), in eight chapters; (5) *
(testimonies or *Edioth* (Witnesses), in eight chapters; (6) *
ter), or *Horayoth* (Errors of judges), in three chapters.

V. KODASHIM (Holy Things): (1) *Zebaḥim* (sacrifices), in
fourteen chapters; (2) *Menaḥoth* (meat-offerings), in
chapters; (3) *Ḥullin* (Profane), laying down rules for slaughter
commonly *Ma'akhaloth* or common food), in twelve chapters;
Bekhoroth (the first-born of beasts and men).

Arakhin, commonly *Erkin* (on valuations, Lev.
2–33), in nine chapters; (5) *Temurah* (Lev. xxvii. 10, 33),
chapters; (6) *Keritoth* (not *Karetoth*), on the punishment
(excision), in six chapters; (7) *Me'ilah* (Num. v. 6–8), in
ter; (8) *Middoth* (dimensions of the temple and its courts
to Middoth, ii. 2), in five chapters; (9) *Tamid* (perpe
daily sacrifice), in seven chapters; (10) *Kinnim* (two species of bird-offerings), in three chapters.

VI. TOHOROTH (on Purifications): (1) *Kelim* (impurity of
in thirty chapters; (2) *Oholoth* (Num. xix. 14–16, &c.), in
chapters; (3) *Nega'im* (effects of leprosy in man, hou
garments), in fourteen chapters; (4) *Parah* (Num. xix.
twelve chapters; (5) *Tebul Yom* (supplement to purifica
chapters; (6) *Makhshirin* (preparations that render
Zabim (Lev. xv. 1–15), in ten chapters; (8) *Makhshirin*

Other records mention a fourth *Perek* or *Bikkurim*,
Rebbi Meïr, which is the Acquisition of the Law
on the *Mishnah*, however, is not to be found in either of the two *Perek*
to be his. Since the discovery of the MS. of the *Mishnah*
the second work above mentioned, as its title, &c., are very
conjectural.

[1] Compare the Psalmist's words, Ps. cxix. 126, *ʿeth laʿasoth laYahweh*
heferu Torathekha.

[2] On the supposed absence of *Massekhtoth Sedarim* previous
Kodashim see Schiller-Szinessy's *Catalogue of Hebrew MSS.*
Cambridge Collection, vol. ii. pt. 1, pref.

[3] In the above-named MS. Add. 170. 1 *Massekhtoth Nezikin*
contains, however, only thirty chapters; compare the
Kallah, leaf 102*a*, *Hadrash Zarnah Tza*, and *Mo'ed Shemini*
[4] See p. 503, note 16.
[5] Also known under *Sheḳalim Ḳadmonim*.

sing for the contraction of impurities, Lev. xi. 34), in six ; (9) *Zabim* [illegible] xv. 2–30, in five chapters; (10) *Tebul* [illegible] chapters; (11) *Yadayim* (purification and [illegible] chapters; (12) *'Okzin* (stalks, peel, &c., of three [illegible]

[illegible] editions of the *Mishnah*, whether as a book or [illegible] incorporated in the Babylonian Talmud are too [illegible] to be mentioned here. The *editio princeps* of the [illegible] book, appeared with Maimonides' code at Naples in 1492 (see Maimonides), and that as [illegible] in the Babylonian Talmud at Venice in 1520–23, both [illegible]. A part of the Palestinian Talmud the *Mishnah* came at Venice, in 1523–24, folio. This Talmud, however [illegible]ective, its *Mishnah* naturally is incomplete, too (and it is moreover, "corrected" by the scribe of 1288–89 [illegible]-Szinessy, *Occasional Notes*, &c., pp. 8–11). The [illegible] the University Press of Cambridge have therefore laid the public under considerable obligations by publishing for the [illegible] the complete original *Mishnah* on which the Palestinian [illegible]s, from the unique MS. preserved in the University

Translations. There exist translations of the *Mishnah* in German and English. (1) There is a Latin translation by [illegible]ers Abendana (R. Ya'akob and R. Yitshak). The former [illegible] (*Hakham*, i.e., chief rabbi) of the Sephardim in [illegible], and the latter was teacher of Hebrew and Rabbinic at [illegible] and Oxford successively. Both brothers, correspondents of Buxtorf, were fine Hebrew and Latin scholars (see Zunz, "The Abendana's," in *Israelitische Annalen* of December [illegible]). This translation is preserved in the Cambridge University Library MS. Mm. 1. 4. 8. (2) The Abendanas' version was [illegible]enhusius when he compiled, from old and new materials, his Latin translation, which appeared (with the text of the [illegible] and the translation also of the commentaries of Maimonides and "Bertinoro") at Amsterdam in 1698–1703, folio. The [illegible]btedness of Surenhusius to the Abendanas is a fact either [illegible] to or ignored by the bibliographers.[1] (3) A German [illegible] by Rose came out in German letters at Onolzbach in [illegible]to. (4) The version last named was in the possession of [illegible]onymous author of the translation, printed in Rabbinic [illegible] the Vienna edition of the *Mishnah* with the commentary of [illegible]*bach*, 1817–35, 8vo. This author (or editor) silently [illegible] the work of his predecessors. (5) Both these translations, [illegible]ssed in German diction, as well as in correctness of [illegible], by that which came out in Hebrew square letters at [illegible] 1832–34, 4to. and which, no doubt, belongs to J. M. [illegible]storian. (6) The English translation which came out at [illegible]n 1843, 8vo, by De Sola and Raphael, extends only over [illegible] treatises.

Commentaries. The commentaries on the *Mishnah* are [illegible] numerous as the editions, and cannot therefore be specifically enumerated here. The principal and the oldest, however are the following. (1) The two Talmuds themselves, of which of course the Babylonian is the only (and that but comparatively) perfect one or at all events the more extensive of the two. It has, however, to be stated, first, that the Palestinian Talmud [illegible]ers on the whole order *Zera'im*, while the Babylonian [illegible] the first "treatise" only of that order (*Berakhoth*); secondly, that the *Gemarath Shekalim* in the Babylonian [illegible]s only borrowed from the Palestinian Talmud. (2) The [illegible]aries on *Zera'im*, *Taharoth*, &c., by Rabbenu Hai Gaon, the [illegible]et, most learned, and in every way noblest of the [illegible]. He flourished in the 10th and 11th centuries. Part of the [illegible]aries, that on *Taharoth*, has appeared in the collection [illegible]

[illegible] W. H. Lowe's critical edition of this grand work (*The [illegible] of the Palestinian Talmud*, 1883, [illegible]

[illegible] Perreau (*Sketches of Anglo-Jewish History*, London, [illegible]; R. Yitshak Abendana translated the *Mishnah* and [illegible] Maimonides and "Bertinoro" also into Spanish [illegible] was executed in by [illegible] great work by the books and [illegible] Genesis on *Berakhoth*, *Peah*, *Demai*, *Kil'ayim*, *Shebi'ith*, [illegible], and *Ma'aseroth*; Schmid on *Shabbath* and *Pesahim*, [illegible] (*Rosh Hashshanah*); Laud (*Ta'anith*), Otho (*Shekalim*), [illegible] (*Sotah*), [illegible] *Megillah*, Fagius (*Aboth*), Arnoldi [illegible] L'Empereur *Horayoth*, and Ulmann (*Zebahim* and *Kare*[illegible]). But without the [illegible] Surenhusius could never have [illegible]ed, much less executed the great task he had before him. [illegible] the probability that the missing parts of the Palestinian [illegible] will one day come to light somewhere in the East, see Schiller-[illegible] in the *Academy*, February 23, 1878, *Hat-Chaim*, xi.; and [illegible]nder, *Handschriften-Verzeichniss der Königlichen Bibliothek* [illegible]n., &c. (1878, 4to), p. 65, where a piece of Palestinian [illegible] *'Okzin* is actually quoted.

[illegible] also a poet of no mean calibre. See his *Musa Hasdel* [illegible]*khel*), *ed. princ.* Fano, 1505 (?), 4to.

Kobets Mi'aseh Yad Ovadi'a, &c. (Berlin, 1856, 8vo). (3) The commentary on various treatises of the B. Talmud, and indirectly on the *Mishnah*, by Rabbenu Gershom Meor Haggolah (the "Light of the *Diaspora*," who flourished in the 10th and 11th centuries). Fragments of this commentary are incorporated in the ordinary Talmud editions (see e.g., *Nedarim*, 22b, &c.), but the greater part lies as yet in manuscript in various libraries. (4) The commentary of Rabbenu H[illegible], [illegible] at Kairawan (in Africa) in the 10th and 11th centuries. His commentary on the Talmud, and thus indirectly on the *Mishnah*, is now being published in the Vilna edition of the Babylonian Talmud. (5) The commentary of Rashi (*ob.* 1105) in all those parts of the B. Talmud on which that "prince of commentators" wrote. Here ought to be mentioned also the separate *editio princeps* of this commentary as far as the *Mishnah* is concerned, which appeared at Leghorn in 1653–54, 8vo. (6) The supplements and additions to the commentary of Rashi by his son-in-law Rabbenu Yehudah b. Nathan (*e.g.*, T. B., *Makkoth*, 19b, &c.) and by his grandsons: Rabbenu Shemuel b. Meir (*vulgo* Rashbam, see *Pesahim*, 99b, and *Baba Bathra*, 29a, &c.) and Rabbenu Shemayah b. Simhah of Vitri,[2] who interpreted the *Massekheth Middoth* before Rashi, his grandfather (see Schiller-Szinessy, *Catalogue of the Hebrew MSS.* preserved in the University Library of Cambridge, pp. [illegible]). (7) The commentary on the whole *Mishnah* by Maimonides (*q.v.*). (8) The commentary by R. Abraham b. David of Posquieres (*vulgo* Rabad) on *'Eduyyoth* (see editions of the B. Talmud, *Avodah Zarah* (with two other commentaries by Rabbenu Zerahyah Halla'ri and R. Asher b. Yehiel, Constantinople, 1731, folio), and on many other *Mishnayyoth* of the orders *Zera'im* and *Tohoroth* (in his "structure," on Maimonides, *Mishneh Torah*, books *Zera'im* and *Toharah*). (9) The commentary of R. Shimshon of Sens (who, like the foregoing, was a contemporary and opponent of Maimonides) on the orders of *Zera'im* (with supplements taken from the works of the somewhat older R. Yitshak b. Malkitsedek) and *Toharoth*.[3] (10) The commentary by R. Meir of Rothenburg (the celebrated captive of Rudolph of Hapsburg); see under (13) below. (11) The commentary by R. Asher b. Yehiel (a disciple of the foregoing, who died at Toledo in 1327) on twenty-one treatises of the orders I. and VI. (12) The commentary on the whole *Mishnah*, by Rabbenu 'Obadyah b. Bertinoro (flourished in the 15th and 16th centuries), the editions of which are very numerous. (13) The commentary on the whole *Mishnah*, by R. Yomtob Lipmann Heller (flourished in 16th and 17th centuries). This famous teacher, called in some of the greatest congregations of the Jews (Prague, Vladimir, and Cracow), incorporated much of the commentary of R. Meir of Rothenburg, compare under (10).

(4) *Works Secondary and Introductory to the Mishnah.*—These may be summed up under the word *Mathnitha*. *Mathnitho* is ostensibly the Aramaic equivalent of the Hebrew *Mishnah*; in reality, however, it signifies and comprises, not merely everything which is understood under that name, but also *Boraitho* (in full, *Mathnitha Boraitho*), *i.e.*, four other works of the oral law, and many literary notices of Mishnic and pre-Mishnic times besides, which are scattered throughout the Talmuds and other early Rabbinic works.

The first of these is *Tosephta*. As its name indicates, *Tosephto* is "Addition," *i.e.*, to the canonical *Mishnah*. All *Mishnah* teachers from time immemorial, notably R. 'Akibah and R. Yehudah Hannasi, left out, when they taught *Mishnah*, a large mass of kindred and explanatory matter, which they only occasionally and supplementarily mentioned, *i.e.*, when absolutely wanted. The chief collection of this additional matter, not incorporated in the system of the canonical *Mishnah*, is called *Tosephth* in Hebrew and *Tosphto* (or *Tosiphta* as some less correctly write it) in Aramaic. The Aramaic singular and the Hebrew plural occur already in the Talmuds and *Midrashim*.[10] *Tosephto* shares with the *Mishnah*, which it enlarges and explains, the number of orders and treatises, but not that of chapters, of which it has only 452. The oldest collection of Tosephtic matter, even as the oldest collection of Mishnic matter, is due to R. 'Akibah. But, whilst

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[1] In the synod called together by Rabbenu Gershom, among several "ordinances" was also one that no Jew is allowed to marry more than one wife.

[2] His commentary on *Pesahim* appeared at Paris in 1868, and that on *Megillah* at Leipsic in 1876, both in 8vo.

[3] These writers (together with Rabbenu Meir another son-in-law and Rabbenu Ya'akob another grandson of Rashi) are the first of the so-called Tosaphists, whose activity continued down to the early part of the 14th century.

[4] Whether the commentary on *Tamid* printed under his name, together with that of R. Asher b. Yehiel on the same treatise (Prague, 1725, 4to), is really his is still matter of dispute.

[10] See T. Y., *Shabbath*, viii. 1, &c.; T. B., *Synhedrin*, 86*a* and elsewhere; *Midrash Rabbah* on Ecclesiastes v. 8, &c. There can be little doubt that in some places the word תוספתא ought to be transliterated *Tosephthe* (*i.e.*, as plural).

ah, as a work, was first sifted by his disciple R Meir, s a work, was first sifted by another disciple R. Nehemyah; s R. Meir's *Mishnah* was sifted again by *Rabbi* and others and was not written down before the 6th century, so as sifted again by R Hiyya, R. Hosha'yah, and others, ot written down in its entirety before the 6th century onder, then, that it now contains matter of a considerably *Tosephta* is not merely of great help for understanding *ah*, which is, in a certain sense, incomplete without it, precise and exact knowledge of Jewish archæology and ces, and in its Agadic parts, of which there are many, for Scriptures also. Here ought also to be mentioned *Both Nathan*, which is, no doubt, *Tosephta* to the *Mechoth* of *osephta* used to be printed till within the last forty years endix to the *Raph*, *i.e.*, the *Halakhoth Rab Alfes* a m of the Talmud by R. Yitzhak b Ya'akob Al Fasi, *i.e.*, of Fez, *ob.* 1103, which appeared first with this at Venice, 1521–22, folio. Here however, it was not ically or printed with even ordinary care. But in the ation of the Babylonian Talmud (1860–72) it came out, t time, worthily after a MS till then uncollated which ed in the Court Library. Dr Zuckermandel has since it from the Erfurt and Vienna MSS., with collation. A slation of *Tosephta* (with the Hebrew text) is to be found, name of *Tosaphta*, in Blasius Ugolinus's *Thesaurus um Sacrarum* (xvii. xx.). It comprises, however, only *Zera'im*, *Mo'ed*, and *Kodoshim*, and came out at Venice 1755–57, folio.

ond of these pieces of literature is *Mekhilta*. The word maic equivalent of the Hebrew *Middah* (measure), and ches mould, form, *i.e.*, of Scriptural exegesis, notably of rts of the Pentateuch. As such it might, of course, ny kind of commentary on any book of the Pentateuch, been composed by any one. And we find, indeed, that ignified at one time a commentary on the books Exodus, Numbers, and Deuteronomy, either by R. Yishma'el or by n,[3] at another time a commentary on Exodus, by R. . Yohai,[4] and at another time again a commentary on the books of Moses, by (Shime'on) Ben 'Azzai.[5] *Mekhilta* ver, means a commentary on the greater part of Exodus, R. Yishma'el (flourished in the 1st century) although, this teacher cannot have been the author of the book. his name is more than seventy times mentioned in it n why the ancient called the book by his name is, no anse the first words of the real work are *Amar Rabbi*. Like the other works of the "oral law," *Mekhilta* was n down before the 6th century, a fact which accounts rt at least, for the loss of several portions of this commentary, which, at present, only extends from xii. 1 to xxv. 3, al gaps between. That *Mekhilta* was once fuller than it know, not only from a statement made by Maimonides, but from a MS. (Add. 704, 1, in the University Library, dge, leaf 40*b*, where an extract is given by a Franco thor of the 12th or 13th century. The Talmud knows *Mekhilta*, and actually quotes *Baraithoth* (non-canonical *th*) which are to be found in our book, and yet the *khilta* can scarcely have been known to the teachers of d. *Mekhilta* is by some called *Midrash* and by others both names are in a certain sense correct. It is *Mid* stance, inasmuch as it contains exegesis, and in form, as it is subdivided into *Parshiyyoth* and follows the order iptural verses. But it is *Mishnah* in substance, inasmuch not only deals with the groundwork of the *Mishnah*, ts of *Baraithoth* (non-canonical *Mishnayoth*), and in much as it is, like the canonical *Mishnah*, divided into *h*. These latter are nine in number, and are called re- (1) *Dephusha* (with 18 *Parshiyyoth* and 1 *Pethihta* or n), (2) *Beshallah* (with 6 *Parshiyyoth* and 1 *Pethihta*), *tha* (with 10 *Parshiyyoth*), (4) *Vayassa'* (with 6 *Par-* (5) *'Amalek* (with 2 *Parshiyyoth*), (6) *Yithro* (with 2 *h*), (7) *Bahodesh* (with 11 *Parshiyyoth*), (8) *Nezikin* and th 20 *Parshiyyoth*), and (9) *Shabbetha* (with 2 *Par-* 1 in the pericope *Ki thissa* and 1 in that of *Vayaqhel*). was published first at Constantinople in 1515, under f *Sepher Haamekhilto*, and in 1545 at Venice as *Mal mekhilto*. In 1712 it appeared at Amsterdam with a y. In 1744 it appeared again at Venice with a Latin by Blasius Ugolinus (*Thes. Antiq. Sacr.*, xiv.). In 1801 at Leghorn with a different commentary. In 1844 it came out at Vilna with a new commentary. All these are in folio. The best and cheapest editions with commentaries are those by Weiss (1865) and Friedmann (1870), both printed at Vienna, and in 8vo.

The third of these pieces of literature is *Siphro*. Both Leviticus itself, because it is the most difficult of all Mosaic books, and the oldest Rabbinic commentary on it, because it is the most difficult of all commentaries on the Scriptures, have been from time immemorial known under the name of *Siphro* (*i.e.*, *the* Book)[6] This book and this commentary are also called *Torath Kohanim*, and the former is spoken of in the Talmud already as *Siphro dibbi Rabbi*. This latter expression has led many great men (among others Maimonides[7][8] to ascribe the authorship of the commentary to Rab (Abba Arikha, a nephew and disciple of R Hiyya). But such a view is erroneous in the extreme, as the book is, so far as form and substance go, both older and later than Rab, paradoxical as the statement may appear. It is older in its origin and in its matter, for not merely do all the anonymous *Baraithoth* which are to be found in it belong to R Yehudah b Ilai, a teacher of the 1st century, but one of the sons of Rabbi (of the 2d century) had actually taught another rabbi two thirds of a third, *i.e.*, two months, of this work.[9] It is later than Rab, for in it are found one "authority" and several "results" of much later date than that of this great Babylonian teacher.[10] The fact is, the word *Rab* in the phrase *Siphro dibbi Rab* is not a proper name at all, but simply stands for "teacher," and *dibbi Rab* thus signifies "of a school," a term used for any teacher and any school of any time. Although most of the *Baraithoth* which it contains are as old as the 1st century, the book as such cannot have been written down earlier than the 6th, in accordance with the treatment, in this respect, of all the other Halakhic works of the "oral law." *Siphro*, although it bears on the pericopes and verses of Leviticus, and is on account of this fact by many called a *Midrash*, is in reality *Mishnah*,[11] a name borne out by the nature of its contents, which are mostly Mishnic, and sometimes represent actual canonical *Mishnayoth*. *Siphra* exhibits a curious conglomeration of matter. It opens with the "Rules of the Interpretation of Scripture," ascribed to R Yishma'el, a *Baraitha* which, although important in itself, is not more important for this than for any other commentary on the Pentateuch. And this conglomerate nature shows itself even more strikingly in form; for *Siphra* contains as forms of division *Dibburim*, *Mekhilta*, *Parshiyyoth* (some of which mean pericopes, whilst others mean chapters), *Perakim*, and *Pisqoth*. All this points, of course, to various divisions of the book made at various times. Whilst none of these divisions can be later than the 12th century,[12] the earliest is at least as old as the 2d, and belongs perhaps to the 1st.[13] *Siphra* is chiefly of importance for the understanding of the *Mishnah* of the orders *Kodoshim* and *Toharoth* (which were, no doubt, the earliest *Mishnayoth* put into "order"); but, whilst it is a sure help for the *Mechoth*, the *Mishnah* is no sure help for it. *Siphra* is a genuine specimen of the "oral law," inasmuch as it cannot be mastered without a teacher. Owing to the difficulty of understanding it, *Siphra* has not been often studied, and consequently not often printed. The *editio princeps* is of 1545, the second edition with the commentary *Korban Aharon* is of 1609–11, both at Venice. The third edition with the just-named commentary is of 1702, and came out at Dessau. The fourth edition, with a Latin translation, is to be found in Blasius Ugolinus's *Thesaurus Antiquitatum Sacrarum*, &c., Venice, 1744–69, vol. xiv. All these are in folio. The fifth edition, with the commentary *Torath Kohanim* (vol. i.), appeared at Vilna, 1845, 4to. The sixth edition, with the commentary *Derech Hayyim*, appeared at Lemberg, 1848, folio. The seventh edition with the commentary *Hattorah Vehaa Mitsvah*, appeared at Bucharest, 1860, 4to. The eighth edition, with the commentary of R. Abraham b. David of Posquières, &c., appeared at Vienna, 1862; and the ninth edition, with the commentary by R. Shimshon of Sens, appeared at Warsaw, 1866, both in folio. Siphro.

The fourth of these pieces of literature is *Sipherê*. *Sipherê*, or *Sipherê Sipherê dibbi Rab*, which in earlier times certainly included the oldest Rabbinic commentaries on Exodus, Numbers, and Deuteronomy (and perhaps also that on Leviticus), means now the oldest Rabbinic commentary on the last two books of Moses only.

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n the order *Zera'im* came out at Vilna in 1799, 4to; but ety it came only out between 1837, 1841, and 1871, folio. at Pasewalk and Treves from 1877 to 1882, 8vo.

imonides's preface to the *Mishneh Torah*.

manides's commentary on the Pentateuch (on Gen. xlix. 31)

hasin Hasshalem (ed. Filipowski, London and Edinburgh, p. 30, col. 2.

[6] See T. B., *Berakhoth*, 18*b*, and Rashi, *in loco*. The *Sipherê* said here to have been studied by Benaiah the son of Jehoiada may well have been our Leviticus, though of course it cannot have been the *Sipherê* with which we are here concerned.

[7] *Ibid.*

[8] Preface to *Mishneh Torah*.

[9] See T. B., *Kiddushin*, 33*a*.

[10] See the pericope *Kedoshim*, vi.

[11] It, or rather its founder (R. Yehudah b. Ilai) identifies *Mishnah* and *Midrash*, T. B., *Kiddushin*, 49*a*.

[12] They were known to R. Abraham b. David (Rabad).

[13] T. B., *Kiddushin*, 33*a*.

Both book [illegible] *Derech Eretz* [illegible], of which *Sophrim* on Numbers [illegible] that on Deuteronomy has 357. The ancient division [illegible] *Sedarim* cannot now be accurately traced. The Sedarim now at Numbers vi. 1, and goes to the end of [illegible]. The pieces accordingly given in [illegible] by the Babylonian Talmud to R. Shimeon b. Yohai [illegible] disciple of R. Akiba, and the reputed author [illegible] Enough to [illegible] no doubt the virtual author of [illegible] *Tikkun Sedarim*, which [illegible] to be found at the com[illegible] to usually-specified author. For, in the [illegible] not only repeatedly name[illegible] the book, but even [illegible] to other [illegible], and, [illegible] that are [illegible] anonymously, even, in the book which can only [illegible] Talmudic study, [illegible] comments to [illegible] composition of the Talmud. The fact that *Midrash*, [illegible] work of the [illegible] boy," was not written down [illegible] It [illegible] to be mentioned here that the [illegible] Hin[illegible] [illegible] century, and even somewhat [illegible] which they variously designate [illegible] *Beraita*, *Tosefta*, *Sifra*, *Sifre*, *Mekilta*, *Pesikta*, *Midrash* [illegible] *Yelamdenu*. To quote from the [illegible] which have [illegible] text, that would must not only have been of much later date, but it would be less valuable than the work [illegible] *Yelamdenu* referred to, the latter [illegible] and with a Latin translation by Ecchellensis, under the title *Mosis Maimonidis Liber Misnae*, Amst. 1701, folio; Venice, 1703, folio; and in 1709. The third edition appeared at Hamburg in 1761, and the fourth at Sudylkow in 1802, both in 8vo. The latest edition, with the commentary of *Tif'eret Yisrael* appended in two volumes, of which the first was printed at Dyhernfurt in 1811 and the second at Rodowill in 1820, both in folio. There is also a Hebrew translation of Maimonides' text, by Moses Narboni, and the seventh edition of Venice, 1566, both in 8vo.

There is also a fifth piece of Midrashic literature known specially by the name *Midrash*. Besides the *Midrashim* contained in the *Talmuds*, *Midrash Sepher*, and *Midrash Sepharim*, there are hundreds of other *Midrashim* to be found scattered about in both Talmuds. The most, however, most important of the vast *Midrash* consists of Midrashic works composed by Rabbi Kappara, Rabbi Hoshaya, and hundreds of other teachers, which in course of time must have perished. There is, however, enough left of the *Midrash* canonical and non-canonical, to prove the correctness of the Cabbalistic axiom that *Midrash* is the equivalent of *Yesh Sheesh* and *Yesh*. This axiom is based on the fact that the two words (מישה: מישה) accidentally consist of the same letters, and further on the communication of immediate truth, what the soul *Midrash* is to the body, the *Midrash* is to Mosaism. The soul gives life to the body, and the *Midrash* gives life to the Pentateuch. "For the letter killeth, but the spirit giveth life." (M. S.)

MISKOLCZ, capital of the Cis-Tibiscan county of Borsod, Hungary (48° 6′ N. lat., 20° 49′ E. long.), is picturesquely situated in a valley watered by the Szinva, 90 miles north-east from Budapest, with which, as also with Debreczen and Kassa (Kaschau), it is directly connected by railway. Miskolcz is one of the most thriving provincial towns in the kingdom, and has many fine buildings, including Roman Catholic, Greek Catholic, Lutheran, and Calvinist churches and school, a Minorite convent, synagogue, Hungarian theatre, hospital, royal and circuit courts of law, district and town offices, and the administrative bureaus for the county. There are manufactories of earthenware, porcelain, boots and shoes, and paper, woollen, leather, and both steam and water mills. The trade is chiefly in corn, wheaten flour, wine, fruit, cattle, honey, wax, and the agricultural produce of the neighbourhood. The great fairs, held five times a year, are much resorted to by strangers from a distance. Not far from the town are stone quarries and iron mines. At the end of 1880 the entire population amounted to 24,343, of whom the majority were Magyars by nationality.

During the 16th and 17th centuries Miskolcz suffered much from the desolating hordes of Cossacks who then ravaged the country, and also from the [illegible] Protestant princes and leaders, especially those of Transylvania and Hungary. In 1781, 1813, and 1847 it was [illegible] by fire, and on the 30th August 1878 a great portion of the [illegible] was destroyed by a terrific storm. See HUNGARY, vol. xii. [illegible].

MISREPRESENTATION. See FRAUD.

[1] *Sepher Ikkarim*, 856.

[2] According to T. B., *Hagigah*, 14b, there used to be at one time no less than [illegible] or seven hundred *Midrash* orders.

MISSAL,[1] the book containing the liturgy, or the mass, of the Latin Church. This name (*e.g.*, Gothicum, Francorum, Gallicanum Vetus) began to [illegible] the older word *Sacramentary* (Sacramentarium, Sacramentorum) from about the middle of the 8th c. At that period the books so designated contained the fixed canon of the mass or consecration (actionem, precem canonicam, canonem actionis), variable collects, secrets or orationes super oblata, and post-communions for each fast, vigil, festival, of the ecclesiastical year, for a due celebration of Eucharist they required accordingly to be supplemented other books, such as the *Antiphonarium*, afterwards the *Gradale*, containing the proper antiphons (introits, responsories (graduals), tracts, sequences, offertories, communions, and other portions of the communion designed to be sung by the schola or choir, and the *Lectionarium* (or *Epistolarium* and *Evangelistarium*) with the lessons. Afterwards missals began to be prepared, containing more or less fully the antiphons and lessons as the prayers proper to the various days, and these were *missalia plenaria*. All modern missals are of this description. The *Missale Romanum ex decreto SS. Tridentini restitutum*, now in almost exclusive use throughout all the churches of the Latin obedience, owes its present form to the council of Trent, which among its other [illegible] undertook the preparation of a correct and uniform missal, and entrusted the work to a committee of its members. The committee had not completed its labours when the council rose, but the pope was instructed to receive it when ready and to act upon it. The "reformed" missal accordingly was promulgated by Pius V. on July 14, 1570, and its universal use enjoined on all branches of the Latin Church, the only exceptions allowed being in the case of churches having local and independent liturgies which had been kept in unbroken use for at least two centuries. It has subsequently undergone slight revision under Clement VIII. (1604) and Urban VIII. (1634); and a few new masses, both obligatory and permissive, universal, have been added by the competent authority. Although the Roman missal is very much larger in bulk than any other liturgy, it need hardly be explained that the [illegible] office to which it relates is not in itself more than one. By much the greater part of it is contained in the "ordinary" and "canon" of the mass, usually printed about the middle of the missal, and occupies, though in large type, only a few pages in any printed copy. The work owes its bulk and complexity to two circumstances. On the one hand, in the celebration of the sacrifice of the mass practically nothing is left to the impulse or discretion of the officiating priest, everything—what he is to say, the tone and gestures with which he is to say it, and colour of the robe he is to wear—is carefully prescribed either in the general rubrics prefixed to the text, or in the numerous rubrics which accompany it.[2] On the other hand, the Roman, like all the Western liturgies, is distinguished

[1] *Missa*, *Liber*, *Missale*, from *Missa*; see vol. xviii.

[2] The English missal consequently continued to be used by Catholics until towards the end of the 17th century, when it was superseded by the Roman through Jesuit influence. The Sarum held its ground until much more recently, but has always been under the Ultramontanism of the bishops.

In all the older liturgies the comparative absence of [illegible] rubrics is very perplexing. It is very noticeable in the Roman *Secreta*, but the want is to some extent supplied by the very detailed directions for a high pontifical mass in the texts of the *Ordo Romanus* mentioned below. That there was an absolutely fixed set of rubrics in use in France during the 8th century is shown by the fact that each priest was required to write an account of his own practice ("libellum ordinis") and present it for approbation to the bishop in Lent (see Baluze, *Cap. Reg. Franc.*, ii. 824, quoted in Smith's, *Dict. of Chr. Antiq.*, ii. 1521).

those of the Eastern Church by its flexibility. by conscious effort, no doubt, but partly also by accident, a well marked distinctive character has given in one or all of the above mentioned respects office for each ecclesiastical season, for each fa t or l of the year, almost for each day of the week, and on has also been made of a suitable communion ser r many of the special and extraordinary occasions both ic and of private life. This richness of variety is seen y in the collects but also in the lessons and antiphonal f the service, passages of Scripture in the selection and tion of which an exquisite delicacy of religious and ic instinct has been for the most part strikingly shown different parts of the Roman communion office are of the same antiquity. Its essential and characteratures are most easily caught, and their rationale derstood, by reference to the earliest *Sacramentaries* ularly the Gregorian, which was avowedly the basis labours of the Tridentine committee), to the ian *Antiphonary*, and to the oldest redaction of the *Romanus*.[1] The account of the mass (qualiter Missa celebratur) as given by the *Sacramentarium* is to the effect that there is in the first place *Introit* according to the time, whether for a festival a common day, thereafter *Kyrie Eleison* (In on to this *Gloria in Excelsis Deo* is, and if a bishop celebrant], though only on Sundays and festivals, priest is by no means to say it, except only at tide. When there is a litany (quando letania agitur *Gloria in Excelsis* non *Alleluia* is sung.) After the *Oratio* is said, whereupon follows the *Apostolus*, e *Gradual* and *Alleluia*. Afterward the *Gospel* i Then comes the *Offertorium*,[2] and the *Oratio super* is said." Then follow the *Sursum Corda*, the *Pre anon*, Lord's Prayer and "embolismus (ἐμβολισμός ertion, *Libera nos*, *Domine*), given at full length ly as they still occur in the Roman missal very liturgy of all the five groups a passage similar s occurs, beginning with *Sursum Corda*, followed *Preface* and the recitation of the *Sanctus* or e Hymn. The "canon" or consecration prayer, in all of them comes immediately after invariably s our Lord's words of institution, and (except in the ian liturgy) concludes with the Lord's Prayer and olism." But within this framework there are certain ces of arrangement, furnishing mark by which the s groups of liturgies can be classified (see vol. xiv. sq.). Thus it is distinctive of the liturgy of dem that the "great intercession" for the quick and d follows the words of institution and an Epiklesis (περὶς τοῦ πνεύματος ἁγίου) or petition for the descent Holy Spirit upon the gifts; in the Alexandrian the intercession" has its place in the *Preface*, in the yrian it comes between the words of institution and iklesis; in the Ephesine it comes before the *Preface*, n the Roman it is divided into two, the commemoration the living being before, and that of the dead after, rds of institution. Other distinctive features of the liturgy are (1) the position of the "Pax after the ation, and not as in all the other liturgies at a very stage of the service, before the *Preface* even, and absence of the Epiklesis common to all the others.

The words of its "canonical prayer" are of m antiquity: they are found in the extant manuscript *Sacramentarium Gelasianum*, and were already old forgotten authorship in the time of Gregory the Gre in a letter to John, bishop of Syracuse (*Registr. Ep* 64), speaks of it as "the prayer composed by a "scho (precem quam scholasticus composuerat). The letter is interesting as containing Gregory's defence, ground of ancient use, of certain parts of the Rom to which the bishop of Syracuse had taken exce merely borrowed from Constantinople. Thus we that, while at Constantinople the *Kyrie Eleison* wa all simultaneously, it was the Roman custom for the to repeat the words first and for the people to r *Christe Eleison* being also repeated an equal num times. Again, the Lord's Prayer was said imm after the consecration aloud by all the people and Greek, but at Rome by the priest alone.

The somewhat meagre and imperfect liturgical furnished by the *Sacramentarium Gregorianum* are mented in a very full and interesting manner by the sive texts of the *Ordo Romanus*, the first of which from about the year 730. The ritual they enjoin for a pontifical high mass in Rome it is, but the diffi to be observed by a priest "quando in titulo facit are comparatively slight. Subjoined is a precis *Romanus I.*

It is first of all explained that Rome has seven eccle regions, each with its proper deacons, subdeacons, and Each region has its own day of the week for high eccle functions, which are celebrated by each in rotation. This for the Station of S. Mariam Majorem, at S. Laurentium in S. Petrum, &c., prefixed to most of the masses in the *Sacramentaries*, and still retained in the "Propriums de Tem the Roman missal. The regulations for the assembling marshalling of the procession by which the pontiff is met, escorted to the appointed station are minutely given, as the adjustment of his vestments "at home (domi)," w secretly has been rehearsed. He does not receive the kiss of *Introit* has been begun by the choir in the church. Be *Gloria* he takes his seat at the altar, and after the *Kyrie* has been sung (the number of times left to his discre begins the *Gloria in Excelsis*, which is taken up by the choi ing the singing he faces eastward at its close he turns rou moment to say "Pax vobis," and forthwith proceeds to the This finished, all rest themselves in order while the ascends the ambo and reads [the *Epistle*]. After he has d cantor with his book (cantatorium) ascends and gives out the *Responsum* with the *Alleluia* and *Versus* in addition at th call for either. The deacon then silently kisses the fo pontiff and receives his blessing in the words "Dominus s tuorum [or later, tui]." Proceeding to the subdeacons with folded and subdeacon-hymnus) he ascends the ambo where th *Gospel*. At the close with the words "Per ill "Dominus vobiscum." The pontiff then recites the *Oratio*, to the "secretarium," a chapel at the extremity of the aisle and receives in order the oblations of the relevant oblationa puna: the archdeacon who follows relieves them (suscipi and pouring them into a large vessel, until all offerings are from the other side and stands apart with them, the bishop. This completed, the pontiff and subdeacons wash their ha offering—hence nowhere mentioned by the subdeacons on t and water supplied by the head of the choir in lumpar[1] being mingled with the wine. During the ceremony th have been engaged in singing the *Agnus Dei*, which the pontiff sends to them to stop and enter upon the *Preface*, deacon giving the response. At the Angelic Hymn eve kneel and continue thereafter except the pontiff, who r and begins the *Canon*. At the words "per quem haec o archdeacon fits the oblata with the oblate, and at "Per D super sublata" he serves the peace to the clergy in the and to the laity. The pontiff then breaks off a particle consecrated bread and lays it upon the altar; then a deac the paten held by the deacon. It is then that the *Diptycha* are read. The pontiff in communicating puts the host the cup, saying, "Fiat commixtio et consecratio corporis Domini nostri Jesu Christi accipientibus nobis in vitam a These present communicate in their order and the pe

[1] Quam collectam dicunt, *Ord. Rom. II.*

[2] After singing "Credo in unum Deum," *Ord. Rom.*

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[1] For the genealogical relationships of the Roman with other s, the reader is referred to the article LITURGY (vol. xiv. 706 ere some account is also given of the three *Sacramentaria* e doctrines involved in the "sacrifice of the mass," see ass, vol. viii. p. 650 *sq.*

[2] The editions do not mention the Offertory here.

[3] This was one of the points discussed at the council of Florence, dinal Bessarion for a time succeeded in persuading the Greeks up the Epiklesis.

ontiff descends into the senatorium to give the communion, la begins the communion *Antiphon*, and continues singing *m* until, all the people having communicated, they receive to begin the *Gloria*, after which, the verse having been peated, they stop. The celebrant, then, facing eastward, *Oremus* (*Complendum*, which being finished the arch ng of the people, "He ris a est," they responding with den.

mplete our idea of the Roman communion office as it to the end of the 8th century we must now turn to ecessian *Antiphonarius sive Graduale Liber ordinatus ndum anni*, which as its name implies contains those portions of the mass which were intended to be the schola or choir. It gives for each day for proper masses provided (1) the *Antiphona* (Anti d Introitum) and *Psalmus*; (2) the *Responsorium ersus*, with its *Alleluia* and *Versus*; (3) the *rium* and *Versus*; (4) the *Communio* and *Psalmus*. xplanation of each of these terms is necessary. (1) ord *Antiphon* (ἀντίφωνον, Old English *Antefn*, *Anthem*) in its ecclesiastical use has reference very ancient practice of relieving the voices of the by dividing the work between alternate choirs. In its most usual meaning it has the special significa a sentence (usually scriptural) constantly sung by ir between the verses of a psalm or hymn sung by . According to the Roman liturgiologists it was Celestine who enjoined that the Psalms of David be sung (in rotation, one presumes) antiphonally mass, in process of time the antiphon came to be the beginning and end only, and the psalm itself uced to a single verse. In the days of Gregory at the introit appears to have been sung precisely resent, that is to say, after the antiphon (proper *excellence*), the *Psalmus* with its *Gloria*, then the n again. (2) The *Responsorium*, like the Greek n, derives its name from the responsive manner of . As introduced between the epistle and gospel it bably at first a comparatively long passage, usually re psalm or canticle, originally given out by the from the steps from which the epistle had been ence the later name *Gradual*), the response being p by the whole choir. (3) The *Offertorium* and *nio* correspond to the "hymn from the book of " mentioned by early authorities (see, for example, me, *Ecc.*, ii. 11; *Ap. Const.*, viii. 13) as sung the oblation and also while that which had been was being distributed to the people. A very e connexion between these four parts of the choral can generally be observed, thus, taking the first in the ecclesiastical year, we find both in the *mary* and in the modern *Missal* that the antiphon xxv. 1–3, the psalmus Ps. xxv. 4, the responsorium ale) and versus Ps. xxv. 3 and xxv. 4, the offertorium sus Ps. xxv. 1–3 and Ps. xxv. 5. The communio lxxxv. 12, one of the verses of the responsorium . lxxxv. 7. In the selection of the introits there trace of a certain rotation of the psalms in the having been observed.

n 1 page of the modern Roman missal are occupied he *Calendar* and a variety of explanations relating year and its parts, and the manner of determin e movable feasts. The general rubrics (*Rubrica les Missalis*) follow, explaining what are the various of mass which may be celebrated, prescribing the of celebration, the kind and colour of vestments to d, and the ritual to be followed (ritus celebrandi), and giving directions as to what is to be done in various defects or imperfections which may arise. *raparatio ad Missam*, which comes next, is a short l of devotion containing psalms, hymns, and prayers to be used as opportunity may occur before and a celebration. Next comes the proper of the sea (*Proprium Missarum de Tempore*), occupying more t half of the entire volume. It contains the proper int collect (one or more), epistle, gradual (tract or sequen gospel, offertory, secreta (one or more), communion, post communion for every Sunday of the year, and for the festival and ferias connected with the ecclesiast season, as well as the offices peculiar to the ember d Holy Week, Easter, and Whitsuntide. Between the for Holy Saturday and that for Easter Sunday the ordin of the mass (*Ordo Missæ*), with the solemn and proper faces for the year, and the canon of the mass are inser The proper of the season is followed by the proper of saints (*Proprium Sanctorum*), containing what is spe to each saint's day in the order of the calendar, and by *Commune Sanctorum*, containing such offices as the mon of one martyr and bishop, the common of one ma not a bishop, the common of many martyrs in paschal t the common of many martyrs out of paschal time, and like. A variety of masses to be used at the feast of dedication of a church, of masses for the dead, and of v masses (as for the sick, for persons journeying, for bridegr and bride) follow, and also certain benedictions. missals have an appendix also containing certain masses of saints to be celebrated "ex indulto apostolic

Masses fall into two great subdivisions: (1) ordinar regular (secundum ordinem officii), celebrated accor to the regular rotation of fast and feast, vigil and feria the calendar. (2) extraordinary or occasional (extra ordi offices), being either "votive" or "for the dead," and the nature of the case having no definite time prescr for them. Festival masses are either double, half-do or simple, an ordinary Sunday mass being a half do The difference depends on the number of collects secretæ: on a double only one of each is offered, on a double there are two or three, and on a simple there be as many as five, or even seven, of each. Any may be either high (missa solemnis) or low (missa priv The distinction depends upon the number of officia clergy, certain differences of practice as to what is nounced aloud and what inaudibly, the use or absen incense, certain gestures, and the like. Solitary m are forbidden, there must be at least an acolyte to the responses. The vestments prescribed for the pries the amice, alb, cingulum or girdle, maniple, stole, chasuble (planeta), see COSTUME, vol. vi. p. 462. T are certain distinctions of course for a bishop or abbot. colour of the vestments and of the drapery of the altar v according to the day, being either white, red, green, vi or black. This last custom does not go much further than Innocent III., who explains the symbolism inten

Subjoined is an account of the manner of celebra high mass according to the rite at present in force.

1. The priest who is to celebrate, having previously confess necessary and having finished matins and lauds, is to seek l for private prayer (fasting) and to use as he has opportunit "prayers before mass" already referred to. How the robing sacristy is next to be gone about is minutely prescribed, and p are given to be used as each article is put on. The sacram elements having previously been placed on the altar or on a cre table, the celebrant enters the church and takes his stand the lowest step of the altar, having the deacon on his right an sub-deacon on his left. After invoking the Trinity (In n Patris, &c.) he repeats alternately with those who are with hi psalm "Judica me, Deus," which is preceded in the usual way antiphon (Introibo ad altare Dei), and followed also by the and Antiphon.[1] The versicle "Adjutorium nostrum," wi

[1] This antiphon is not to be confounded with the Antiphe Introitum further on. This use of the 43d Psalm goes as far b least as the end of the 11th century, being mentioned by Micr (1080). It is omitted in masses for the dead and during Holy

"Qui fecit," is followed by the "Confiteor,"[1] said alter-
y the priest and by the attendants, who in turn respond with
er for divine forgiveness, "Misereatur." The priest then
absolution ("Indulgentiam"), and after the versicles and
s beginning "Deus, tu conversus" he audibly says,
s," and ascending to the altar silently offers two short
one asking for forgiveness and liberty of access through
nd another indulgence for himself "through the merits of
ts whose relics are here." Receiving the thurible from the
e incenses the altar, and is thereafter himself incensed by
on. He then reads the Introit, which is also sung by the
he "Kyrie Eleison" is then said, after which the words
in Excelsis"[2] are sung by the celebrant and the rest of the
mpleted by the choir.

ssing the altar, and turning to the people with the formula
nus vobiscum," the celebrant proceeds with the collect or col-
per to the season or day, which are read secretly. The
r the day is then read by the subdeacon, and is followed
gradual, tract, alleluia, or sequence, according to the time
shed, the deacon places the book of the gospel on the
d the celebrant blesses the incense. The deacon then
e altar and offers the prayer "Munda cor meum," after-
akes the book from the altar, and kneeling before the
t asks his blessing, which he receives with the word
nus sit in corde tuo." Having kissed the hand of the priest,
accompanied by acolytes with incense and lighted candles
ulpit, and with a "Dominus vobiscum" and minutely pre-
rossings and incensings gives out and reads the gospel for the
he close of which "Laus tibi, Christe" is said, and the book
ht to the celebrant and kissed with the words "Per evan-
ta deleantur nostra delicta." The celebrant then standing
iddle of the altar sings the words "Credo in unum Deum,"
rest of the Nicene creed is sung by the choir.
ith "Dominus vobiscum" and "Oremus" the celebrant
to read the Offertory, which is also sung by the choir.
shed he receives the paten with the host from the deacon,
offering the host with the prayer beginning "Suscipe,
Pater" places it upon the corporal. The deacon then
s wine and the subdeacon water, and before the celebrant
he water with the wine he blesses it in the prayer "Deus
name." He then takes the chalice, and having offered it
nus tibi, Domine") places it upon the corporal and covers
he pall. Slightly bowing over the altar, he then offers the
"In spiritu humilitatis," and, lifting up his eyes and
g out his hands, proceeds with "Veni sanctificator"
essing the incense ("Per intercessionem beati Michaelis
eli") he takes the thurible from the deacon and incenses the
d wine and altar, and is afterwards himself incensed as well
thers in their order. Next going to the epistle side of the
washes his fingers as he recites the verses of the 26th Psalm
g "Lavabo." Returning and bowing before the middle of
, with joined hands he says, "Suscipe, sancta Trinitas," then
himself towards the people he raises his voice a little and
Orate, fratres" ("that my sacrifice and yours may be
ble to God the Father Almighty"), the response to which
scipiat Dominus sacrificium de manibus tuis," &c.
n recites the secret prayer or prayers, and at the end
ith an audible voice, "Per omnia saecula saeculorum"
men")
gain saluting with a "Dominus vobiscum," he lifts up his
d goes on to the "Sursum Corda" and the rest of the Pre-
different intonation is given for each of the prefaces.[3] At
tus the handbell is rung. If there is a choir the Sanctus
while the celebrant goes on with the Canon.[4] After the
f consecration of the wafer, which are said "secretly, dis-
and attentively," the celebrant kneels and adores the
sing elevates it, and replacing it on the corporal again

orm very similar to the present is given by Micrologus, and it
adowed even in liturgical literature of the 8th century.
ing Lent and Advent, and in masses for the dead, this is
In low masses it is of course said, not sung (if it is to be
It may be added that this early position of the *Gloria in*
is one of the features distinguishing Roman from Ephesine

tract is peculiar to certain occasions, especially of a mournful
and is sung by a single voice. By a sequence is understood a
less metrical composition, not in the words of Scripture, having
bearing on the festival of the day. See, for example, the
, "Lauda Sion Salvatorem," on Corpus Christi day.
certain days the *Credo* is omitted.
y eleven; they were at one time much more numerous.
approved usage appears to be in that case that it is sung as
"Hosanna in Excelsis" before the elevation, and "Benedictus
t" is reserved till afterwards. In France it was a very com-
tom, made general for a time at the request of Louis XII., to
"salutaris hostia" at the elevation.

adores it (the bell meanwhile being rung).[7] The same
observed when the chalice is consecrated. Immediately be
Lord's Prayer, at the words "per ipsum et cum ipso et i
the sign of the cross is made three times over the chalice w
host, and towards the close of the "embolism" the fractio
host takes place. After the words "Pax Domini sit semp
cum" the emission of the particle into the cup takes pla
the words "Haec commixtio et consecratio," &c. The c
then says the Agnus Dei three times.

5 While the choir sings the Agnus Dei and the Commun
celebrant proceeds, still "secrete," with the remainder of th
which though printed as part of the canon is more conve
called the Communion and Post-communion. After the pr
the peace and unity of the Church ("Domine Jesu Chr
dixisti") he salutes the deacon with the kiss of peace, saying
tecum"; the subdeacon is saluted in like manner, and then
the "pax" to the rest of the clergy who may be assisting. T
himself communicates under both species with suitable
and actions and afterwards administers the sacrament to th
communicants if there be any. Then while the wine is pou
the cup for the first ablution he says, "Quod ore sumpsi
having taken it he says, "Corpus tuum, Domine." After th
ablution he goes to the book and reads the Communion. Th
ing to the people with "Dominus vobiscum" he reads th
communion (one or more), turning once more to the congreg
use the old dismissal formula "Dominus vobiscum" (*R.* Et
spiritu tuo, and "Ite, missa est" for "Benedicamus Dom
three masses from which "Gloria in Excelsis" has been
(*R.* Deo Gratias). Bowing down before the altar he offers th
"Placeat tibi sancta Trinitas," then turning round he ma
sign of the cross over the congregation with the words
benedictio ("Benedicat"[8]). He then reads the passage f
gospel of John beginning with "In principio erat Verb
else the proper gospel of the day."

MISSIONS. The history of Christian mission
for practical purposes, be best divided into three
periods (1) the primitive, (2) the mediaeval, a
the modern. None of these periods can be neglec
they have an intimate connexion with each oth
illustrate the activity respectively of individuals,
church in her corporate capacity, and of societies.

1. *The Primitive Period.*

Christian missions had their origin in the examp
the command of our Lord Himself (Matt. xxviii. 1
the unparalleled boldness on the part of the Fou
Christianity, which dared to anticipate for the Ch
faith a succession of efforts which should never c
cause its propagation to be undertaken as "a
and direct work," has been justified by the voice of hi
Whereas other religions have spread from coun
country as component parts of popular opinion
travelled with migration or conquest, have passed
train of things and by the usual channels of comm
tion, the first foundations of the church had hard
laid before individual missionary activity marked
of each one of the circle of the apostles.

Of the actual details of their labours we have be
mitted to know but little. Three only of the inn
followers of the Saviour have any conspicuous place
apostolic records, and the most illustrious in the
domain of missionary activity, St Paul, did not
to the original twelve. His activity took the f
journeys and voyages, chiefly to large towns, wh
message found a point of contact either with the
synagogue or the aspirations of the Gentile world
result of his labours and of those of his su

[1] The history of the practice of elevating the host is
obscure. It seems to have arisen out of the custom of hold
oblation, as mentioned in the *Ordo Romanus*, or also
elevation of the host, as at present practised, was not enj
Pope Honorius III. The use of the handbell at the elevatio
later, and was first made general by Gregory XI.

[2] The benediction is omitted in masses for the dead.

[3] The reading of the passage from John on days which h
proper gospel was first enjoined by Pius V.

[4] Dawson, *On Prophecy*, p. 278.

at toward the middle of the 2d century the had gradually extended its conquest through A Gaul, southern Gaul, and northern Africa a treatise history can tell but little of the church tenacity and the intimacy of many of the primitive enturies wrapped in hopeless darkness. Whatever ss of was due to the evangelizing labours of bishops and clergy who occupied themselves in ief cast of Aegean, and toiled zealously and ily in the bread of the church though having no ribed devotion. Among the most distinguished natives of this individual activity in the 4th and uries may be mentioned Ulfila, the Apostle of in about 360; Frumentius, a bishop of Abyssinia, 37; Chrysostom, who founded at Constantinople n institution in which Goths might be trained h the gospel to their own people; Valentinian, the of Noricum, about 440; and Honoratus, who from ns to home in the islet of Lerins, about 410, sent numerous labourers to southern and western Gaul, me the leading missionaries of their day among

of heathendom in the neighbourhood of Arles, Troyes, Metz, and Nice.

The Medieval Period

the 5th century the church found a very different proposed to her missionary energies and zeal pel of civilization had scarcely been planted when confronted with numberless hordes which had long othered out in their native wilds, and which ow precipitated over the entire face of Europe. for one time ceased to plead for toleration, and to be aggressive, she not only stood the shock of but girded herself for the difficult work of calming tated elements of society, of teaching the nations a faith than a coarse form of nature worship, of ze and reforming their restless independence, controllable love of liberty, and attuning them to members of an enlightened Christendom.

The Celtic Missionaries. The first pioneers who went n crusade in this difficult enterprise came from the l Celtic churches of Ireland and the Scottish nds, which, though almost lost sight of amid the ne contest which was to change the Roman world, n sooner founded than they sent forth swarms of to pour back upon the Continent the gift of ion and the gospel. Of many who deserve n connexion with this period, the most prominent Columba, the founder of the famous monastery of and the evangelizer of the Albanian Scots and n Picts; Aidan, the apostle of Northumbria ianus, the apostle of the Burgundians of the Vosges, er Gallus, the evangelizer of northeastern Switzerland Virgilius, the apostle of Thuringia, idpert, the martyr of the Black Forest. These three secular men at the head of ardent disciples to take the world by storm. Travelling comically poor and carrying a simple outfit, these Celtic ries chose themselves on the Continent of Europe, and, ation with reproduction at Annegray or Luxeuil the ion boat-shaped hut, the chapel and the round tower, they had left behind in Derry or in the Island of Hy, raved the dangers of the northern seas, and penetrated as far as the Faroes and even to distant Iceland.[1]

The Pagan Missionaries. Thus they laid the tions, awing the heathen tribes by their indomitable of self sacrifice and the sternness of their rule of life.

But, marvellous as it was, their work lacked the of permanence, and it became clear that if Europe be carried through the dissolution of the old society nissionary operations consolidated, a more practical must be devised and carried out. The men for this were now ready. Restored to the commonwealth of by the labours of the followers of Augustine of Cant and the Celtic missionaries from Iona, the sons newly evangelized English churches were ready to go to the help of their Teutonic brothers in the C forest. The energy which warriors were accustomed put forth in their efforts to conquer was now "exhibited the enterprise of conversion and teaching." By Wilfrid the court of England, by Willibrord in the neighbourhood of Utrecht, by the martyr brothers Ewald or E among the "old" or continental Saxons, by Sw the apostle of the tribes between the Ems and the by Adelbert, a prince of the royal house of Northu in the region north of Holland, by Wunsing, a na England, and one of the disciples of Willibrord, some region, and last, not least, by the famous W of Boniface, the "Apostle of Germany," who went first to assist Willibrord at Utrecht, then to labo Thuringia and Upper Hesse, then, with the aid kinsmen Wunibald and Willibald, their sister Wa and her thirty companions, to consolidate the w earlier missionaries, and finally to die a martyr shore of the Zuyder Zee.

(c) *Scandinavian Mission.* Devoted, however, a the labours of Boniface and his disciples, the battl not yet nearly won. All that he and they and the e Charlemagne after them achieved for the fierce un world of the 8th century seemed to have been done when, in the 9th, "on the north and north we pagan Scandinavian were hanging about every coa pouring in at every inlet, when on the east the Hungarians were warming like locusts and deva Europe from the Baltic to the Alps; when on the and south-east the Saracens were pressing on and c their victorious hosts. It seemed then as if every life were choked, and Christendom must be stifle smothered in the fatal embrace."[2] But it was eve that one of the most intrepid of missionary ente was undertaken, and the devoted Anskar went fo proved himself a true apostle of Denmark and S sought out the Scandinavian viking in his native ho icy lands, and after persevering in the face of app insurmountable difficulties and hardships, handed torch of self-denying zeal to others, who "casting bread on the waters" saw, after the lapse of many the close of the monotonous tale of burning churche pillaged monasteries, and taught the fierce North lay aside his old habits of piracy, and gradually respect for civilized institutions.

(d) *Slavonic Missions.* Thus the "gospel kingdom" was successively proclaimed to the Rom Celtic, the Teutonic, and the Scandinavian wor conquest, still more stubborn remained with the S tribes, with their triple and many-headed divinitie powers of good and powers of evil, who could be appe only with fear and horror, and propitiated only human sacrifices. Mission work commenced in t during the latter part of the 9th century; th extended to Moravia, where two Greek missionaries and Methodius provided for the people a Slavoni

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[1] Church, *Gifts of Civilization*, p. 330.
[2] Bede, *H. E.*, v. 19.
[3] "Annal. Xantenses," Pertz, *Mon. Germ.*, ii. 220.
[4] Bede, *H. E.*, v. 10.
[5] See Lightfoot, *Ancient and Modern Missions.*

Slavonic Liturgy; thence to Bohemia, and so
s to the Scythian wilds and level steppes, where
he Russian kingdom of Rurik the Northman, and
about the close of the 10th century the Eastern
"silently and almost unconsciously bore into the
mightiest offspring."[1] But, though the baptism
ingir and the flinging of the triple and many headed
to the waters of the Dnieper was a heavy blow to
c idolatry, mission work was carried on with but
success; and it taxed all the energies of Albrecht,
of Bremen, of Vicilin, bishop of Oldenburg, of
Otto of Bamberg the apostle of the Pomeranians,
bert the martyr apostle of Prussia, to spread the
that country, in Lithuania, and in the territory of
nds. It was not till 1168 that the gigantic four
image of Swantevit was destroyed at Arcona,
tal of the island of Rügen, and this Mona of
superstition was included in the advancing
Christian civilization. As late as 1230 human
s were still being offered up in Prussia and
nia, and, in spite of all the efforts of the Teutonic
s to expel by force the last remains of heathenism
e face of Europe, idolatrous practices still lingered
t the people, while in the districts inhabited
Lapps, though successful missions had been
rated as early as 1335, Christianity cannot be said
e become the dominant religion till at least two
es later.

Moslem Missions.—The mention of the order of the
ic Knights reminds us how the crusading spirit had
d Christendom, and exchanged the patience of a
e or an Anskar for the fiery zeal of the warrior of
ss. Still it is refreshing to notice how even now
was found the famous Raymond Lully to protest
propagandism by the sword, to urge on pope after
e necessity of missions amongst the Moslems, and
his testimony with his blood outside the gates
giah in northern Africa (June 30, 1315). Out
crusades, however, arose other efforts to bear the
of the cross into the lands of the East, and to
the work which Nestorian missionaries from
d, Edessa, and Nisibis had already inaugurated
the Malabar coast, in the island of Ceylon, and
neighbourhood of the Caspian Sea. In 1245
oman pontiff sent two embassies, one to charge
ngol warriors to desist from their desolating inroads
urope, the other to attempt to win them over to
ristian faith. The first, a party of four Dominicans,
the commander-in-chief of the Mongol forces in
the second, consisting of Franciscans, made their
to Tartary, and sought to convert the successor
ai-Khan. Their exertions were seconded in 1253
labours of another Franciscan whom Louis IX. of
sent forth from Cyprus,[2] while in 1274 the
ted traveller Marco Polo, accompanied by two
Dominicans, visited the court of Kublai-Khan,
the commencement of the 14th century two
scans penetrated as far as Peking, and kept alive a
ng spark of Christianity in the Tartar kingdom,
anslating the New Testament and the Psalter into
artar language, and training youths for a native
y.[3]

Missions to India and the New World.—These ten
missions in the East were now to be supplemented by
on a larger scale. In 1486 the Cape of Good Hope
unded by Dias, and in 1508 the foundations of the
Portuguese Indian empire were laid by Albuqu
Columbus also in 1492 had landed on San Salvad
the voyages of the Venetian Cabot along the coast of
America opened up a new world to missionary ente
These bold discoverers had secured the countenance
pope on the condition that wherever they might p
flag they should be also zealous in promoting the ext
of the Christian faith. Thus a grand opportunit
given to the churches of Portugal and Spain. B
zeal of the Portuguese, even when not choked by the
lust of wealth and territorial power, took too o
one sided direction, repressing the Syrian Christia
the Malabar coast, and interfering with the Abys
Church,[4] while the fanatic temper of the Spe
maddened by his prolonged conflict with the infidel at
betrayed him into methods of propagating his faith
we cannot contemplate without a shudder, consigni
Mexico and Peru, multitudes who would not re
their heathen errors to indiscriminate massacre or
slavery.[5] Their only defender for many years w
famous Las Casas, who, having sojourned amongst
till 1516, has drawn a terrible picture of the oppr
he strove in vain to prevent.[6] Some steps indeed
taken for disseminating Christian principles, and th
in granting territory to the crowns of Spain and Po
had specially urged this duty, and had been instru
in inducing a band of missionaries, chiefly of the men
orders, to go forth to this new mission field.[7] B
results were scanty. Only five bishopries had
established by 1520, and the number of genuin
verts was small. In settling, however, his real
conqueror of Mexico evinced no little solicitude
spiritual welfare of his charge; and the labours
devoted men whom he begged the emperor to se
were successful in banishing every vestige of the
worship from the Spanish settlements.[8]

(*g*) *The Jesuit Missions.* It was during the pe
which we have now arrived that the great organiza
the Jesuits came into existence, and one of th
of Loyola's associates, Francis Xavier, was also one
greatest and most zealous missionaries of his or any
era. Encouraged by the joint co-operation of the
and of John III. of Portugal, and strongly tinge
Loyola with ideas of chivalry and self-devotion, he
barked at Goa on the 6th of May 1542, and bef
death on the Isle of St John (Hiang-Shang), Decem
1552, he had roused the European Christians of Go
new life, laboured with singular success amongst the
vars, a fisher caste near Cape Comorin, gathered
converts in the kingdom of Travancore, visited the
of Malacca, made his way to and founded a miss
Japan, thence revisited Goa, and impelled by the que
desire to unfurl the banner of the cross in China, h
out thither to fall a victim to malignant fever
early age of forty six, within sight of that vast empire
conversion had been the object of his holy ambition

The immediate successor of Xavier, Antonio Crim
was regarded by the Jesuits as the first martyr o
society (1562). Matthæo Ricci, an Italian by birt
also an indefatigable missionary in China for twenty
years, while the peculiar methods of unholy comp
with Brahmanism in India followed by Robert de'
drew down the condemnatory briefs of pope after pop
were fatal to the vitality of his own and other mi

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[1] ley, *Eastern Church*, p. 294.
[2] nder, vii. 69; Hakluyt, 171; Huc, i. 207.
[3] nder, vii. 79; Gieseler, iv. 259, 260; Hardwick, *Middle Ages*,
[4] Geddes, *History of the Church of Malabar*, p. 4; Neale, *Church*, ii. 343.
[5] Prescott, *Conquest of Mexico*, i. 318, iii. 218
[6] *Relacion de la Destruycion de las Indias.*
[7] Prescott, *Mexico*, iii. 218 n
[8] Prescott, iii. 219.

representatives of the same order worked with
in evangelizing the Spanish settlement of Paraguay
82, while their defeated foes the Huguenots sent
nder a French knight of Malta a body of devoted
attempt the formation of a Christian colony at Rio
. By the close of the 16th century the unflag-
al of the Jesuits led to a more complete development
ganization of the missionary system of the Roman
. To give unity and solidity to the work of missions,
nittee of cardinals was appointed under the name
"Congregatio de propaganda fide," and to it was
ed the entire management of the mission, conducted
he superintendence of the pope. The scheme origin-
ith Gregory XIII., but was not fully organized till
ears afterwards, when Gregory XV. gave it plenary
ty by a bull dated June 2, 1622. Gregory's suc-
Urban VIII., supplemented the establishment of the
gation by founding in connexion with it a great
ary college, where Europeans might be trained for
labours, and natives might be educated to undertake
work wherever new colonies were settled. At
lege is the missionary printing press of the Roman
, and its library contains an unrivalled collection of
treasures bearing on the particular work. From its
ave gone forth numbers of devoted men, who have
themselves able to promote in a singular degree the
ment of the boundaries of the church by means of
al as well as spiritual forces.

3. *The Modern Period.*

last period of missionary activity is distinguished
ecial degree by the exertions of societies for the
ment of mission work.

ontrasted with the colossal display of power on the
the Church of Rome, it must be allowed that the
es which in the 16th century broke off from their
nce to the Latin centre at first presented a great
anxiety for the extension of the gospel and the
n of the heathen. The causes of this, however, are
to seek. The isolation of the Teutonic churches
e vast system with which they had been bound up,
flicts and troubles among themselves, the necessity
g their own principles and defining their own rights,
nated their attention upon themselves and their own
ork, to the neglect of work abroad.

the development of the maritime power of England,
he Portuguese and Spanish monarchies noted with
d jealousy, was distinguished by a singular anxiety
spread of the Christian faith. Edward VI. in his
tions to the navigators in Willoughby's fleet, Cabot
for the direction of the intended voyage to Cathay,
ld Hakluyt, who promoted many voyages of dis-
in addition to writing their history, agree with
mphrey Gilbert's chronicler that "the sowing of
anity must be the chief intent of such as shall make
empt at foreign discovery, or else whatever is builded
other foundation shall never obtain happy success
dinance." When on the last day of the year 1600
Elizabeth granted a charter to George, earl of
rland, and other "adventurers," to be a body-
nte by the name of "The Governor and Company of
ants of London trading with the East Indies," the
sed recognition of higher duties than those of com
may by some be deemed a mere matter of form,
use the words of Bacon, "what was first in God's
ence was but second in man's appetite and intention."
keen sense of missionary duty marks many of the
les of English mariners. Notably was this the case
he establishment of the first English colony in
ca, that of Virginia, by Sir Walter Raleigh. The
philosopher Heriot, one of his colleagues, laboured for
conversion of the natives, amongst whom the first bapt
is recorded to have taken place on August 13, 15
Raleigh himself presented as a parting gift to the Virgi
Company the sum of £100 "for the propagation of
Christian religion" in that settlement.[2] When Jame
granted letters patent for the occupation of Virginia
was directed that the "word and service of God
preached, planted, and used as well in the said colo
as also as much as might be among the savages borde
among them"; and the honoured names of Nicolas Fer
John Ferrar, Dr Donne, and Sir John Sandys, a pupil
Hooker, are all found on the council by which the h
management of the colony was conducted.

In the year 1618 was published *The True Honou
Navigation and Navigators*, by John Wood, D.D., dedica
to Sir Thomas Smith, governor to the East India Compa
and much about the same time appeared the well-kn
treatise of the famous Grotius, *De Veritate Religi
Christianæ*, written for the express use of settlers in dis
lands. The wants, moreover, of the North Ameri
colonies did not escape the attention of Archbishop L
during his official connexion with them as bishop
London, and he was developing a plan for promotin
local episcopate there when his troubles began and
scheme was interrupted. During the Protectorate,
1649, an ordinance was passed for "the promoting
propagating of the gospel of Jesus Christ in New Engla
by the erection of a corporation, to be called by the n
of the President and Society for the Propagation of
Gospel in New England, to receive and dispose of mon
for the purpose, and a general collection was ordered t
made in all the parishes of England and Wales;
Cromwell himself desired a scheme for setting up a cou
for the Protestant religion, which should rival the Ro
Propaganda, and consist of seven councillors and
secretaries for different provinces.[3] On the restoratio
the monarchy, through the influence of Richard Ba
with Lord Chancellor Hyde, the charter already gra
by Cromwell was renewed, and its powers were enlar
For now the corporation was styled "The Propagation
the Gospel in New England and the parts adjacent
America," and its object was defined to be "not only
seek the outward welfare and prosperity of those colo
but more especially to endeavour the good and salvatio
their immortal souls, and the publishing the most glori
gospel of Christ among them." On the list of
corporation the first name is the earl of Clarendon, w
the Hon. Robert Boyle was appointed president. Amo
the most eminent of its missionaries was the celebr
John Eliot, who, encouraged by Boyle, and assisted by
with considerable sums of money, brought out the Bibl
the Indian language in 1661–64, having revealed at the
of the Indian grammar which he had composed the secre
his success: "prayer and pains, through faith in Jesus Ch
will do anything." Boyle displayed in other ways his
for the cause of missions. He contributed to the
of printing and publishing at Oxford the four Gospels
the Acts of the Apostles in the Malay language, and at
death left £5400 for the propagation of the gospe
heathen lands.

The needs of the colonial church soon excited the at
of others also, and great efforts were made by
Beveridge, Archbishop Wake, Archbishop Sharpe,
Gibson, and afterwards by the philosophic Bishop T
and Bishop Butler, the famous author of the *Analogy*

[1] Hakluyt, *Voyages*, iii. 345.
[2] Oldy, *Life of Raleigh*, p. 118.
[3] Neale, *History of New England*, i. p. ; Burnet, *Histo
his own Times*, i. p. 132.

p the colonial church and provide for the wants of the
tribes. In 1696 Dr Bray, at the request of the gover-
d assembly of Maryland, was selected by the bishop of
n as ecclesiastical commissary; and, having sold his
, and raised money on credit, he sailed for Maryland
9, where he promoted, in various ways, the interests
church. Returning to England in 1700–1, and
rted by all the weight of Archbishop Tenison and
Compton, he was graciously received by William III.,
received letters patent under the great seal of
nd for creating a corporation by the name of the
ety for the Propagation of the Gospel in Foreign
' on the 16th of June 1701.

h the establishment of this corporation the era of
tivity of societies for carrying out mission work may
d to commence, though the opening of the 18th
y saw other movements set on foot for the same
. Thus in 1705 Frederick IV. of Denmark founded
ion on the Coromandel coast, and inaugurated the
s of Ziegenbalg, Schultze, and Schwartz, whose
on and success told with such remarkable reflex
ce on the church at home. Again in 1731 the
ians illustrated in a signal degree the growing
ousness of obligation towards the heathen. Driven
rsecution from Moravia, hunted into mountain caves
rests, they had scarcely secured a place of refuge in
y before, "though a mere handful in numbers, yet
the spirit of men banded for daring and righteous
they formed the heroic design, and vowed the
ion of it before God, of bearing the gospel to the
and perishing tribes of Greenland and the West
, of whose condition report had brought a mournful
r to their ears." And so, literally with "neither
nor scrip," they went forth on their pilgrimage, and,
ible as it sounds, within ten years they had established
ns in the islands of the West Indies, in South
ca, Surinam, Greenland, among the North American
in Lapland, Tartary, Algiers, Guinea, the Cape of
Hope, and Ceylon.[1]

h were the preparations for the more general move-
during the last hundred years, and the manifesta-
missionary zeal on a scale to which it would be diffi-
find a parallel in Western Christianity.

progress that has been made may be best judged of
consideration of the following details:—

At the close of the last century there were only seven
ary societies in existence, properly so called. Of these
only, the Society for the Propagation of the Gospel in
Parts, the Halle-Danish Society, and the Moravians, had
work for the greater part of the century, whilst four, the
Missionary Society, the Baptist Missionary Society, the
Missionary Society, and the Dutch Society at Rotterdam,
their work only in its tenth decade. To-day these seven
in Europe and America alone, increased to upwards of
, and to these must be added, not only several independent
s in the colonies, but numerous missionary associations on a
scale, the offspring of English and American societies.

The following chronological lists illustrate the growth of
ary societies in Britain and the United States:—

Great Britain and Ireland.

rristian Faith Society for the West Indies.
ciety for Promoting Christian Knowledge.
ciety for the Propagation of the Gospel in Foreign Parts.
oravian (Episcopal) Missions of the United Brethren.
ptist Missionary Society.
ndon Missionary Society.
otrish Missionary Society.
urch Missionary Society.
ligious Tract Society.
itish and Foreign Bible Society.
ndon Society for Promoting Christianity among the Jews
esleyan Missionary Society.
neral Baptist Missionary Society.
lonial and Continental Church Society.
urch of Scotland Mission Boards.
tional Bible Society of Scotland.
1831. Trinitarian Bible Society.
1832. Wesleyan Ladies' Auxiliary for Female Education in Foreign Cou
1834. Society for Promoting Female Education in the East.
1835. United Secession (now United Presbyterian) Foreign Missions.
1836. Colonial Missionary Society.
1840. Foreign Aid Society.
Coral Missionary Fund.
1840. Welsh Calvinistic Methodist Missionary Society.
1841. Colonial Bishoprics Fund.
1841. Edinburgh Medical Missionary Society.
Waldensian Missions Aid Fund.
1843. British Society for the Propagation of the Gospel among the Jews
1843. Free Church of Scotland Missions.
1844. Primitive Methodist African and Colonial Missions
Methodist New Connexion in England Foreign Missions.
1844. South American Missionary Society.
1849. Evangelical Continental Society.
1852. Indian Female Normal School Society.
1853. Lebanon Schools.
1855. Presbyterian Church in England Foreign Missions.
1856. Turkish Missions Aid Society.
1856. United Methodist Free Churches Foreign Missions.
1858. Christian Vernacular Education Society for India.
1860. Central African Mission of the English Universities.
1860. British Syrian Schools.
Melanesian Mission.
1865. Ladies' Association for Promoting Female Education among the
1866. China Inland Mission.
1867. Delhi Female Medical Mission.
1867. "Friends" Foreign Mission Association.
1868. Cape Town Aid Association.
1869. "Friends" Mission in Syria and Palestine.
Irish Presbyterian Missions.
1876. Spanish and Portuguese Church Aid Society.
Columban Mission.
Original Secession Church Indian Mission.
1877. Cambridge Mission to Delhi.
1880. Church of England Zenana Missionary Society.

United States of America.

1733. Corporation for the Propagation of the Gospel in New England.
1787. Society for Propagating the Gospel among the Indians at Boston.
1800. New York Missionary Society.
Connecticut Missionary Society for Indians.
1803. United States Mission to the Cherokees.
1806. Western Missionary Society for Indians.
1810. Board of Commissioners for Foreign Missions.
1814. Baptist Missionary Union.
1819. Methodist Episcopal Church Missionary Society.
1833. Free will Baptist Foreign Missionary Society in India.
1835. Foreign Missions of the Protestant Episcopal Church.
1837. Board of Foreign Missions of the Presbyterian Church.
1837. Evangelical Lutheran Foreign Missionary Society.
1842. Seventh Day Baptist Missionary Society.
Strict Baptist Missionary Society.
1843. Baptist Free Missionary Society.
1845. Methodist Episcopal Church, South.
1845. Southern Baptist Convention.
1846. American Missionary Association.
1857. Board of Foreign Missions of (Dutch) Reformed Church.
1859. Board of Foreign Missions of United Presbyterian Church.
American United Brethren, Moravian.
United States German Evangelical Missionary Society.
American Mexican Association.
Indian Home Missionary Association.
Indian Missionary Association.
Local Baptist Missionary Society.
Women's Union Zenana Missionary Society.

(*c*) At the beginning of the present century the total s
tributed for Protestant missions can hardly be said
amounted to £50,000; in 1882 the amount raised by Brit
tributions alone to foreign missions amounted to upw
£1,090,000,[2] thus divided:—

Church of England Missions	£460,
Joint Societies of Churchmen and Nonconformists	153,
Nonconformist Societies, English and Welsh	313,
Scottish and Irish Societies	155,
Roman Catholic Societies	10,

(*d*) At the same date it is calculated that there were abo
heathen converts under instruction, not counting those b
to the Roman Catholic missions. At the present day the
from heathenism may be estimated certainly at no l
1,800,000, a single year (1878) showing an increase of about

(*e*) When the Society for the Propagation of the Go
founded in 1701, there were probably not twenty clergyme
Church of England in foreign parts. The spiritual con
the settler in America and elsewhere was terrible in the
and no effort was then made by the church to win over the
to Christ. But now the position which the church hold
British colonies and dependencies and many parts of hea
is recognized by all. In those regions where the society
and which before it commenced its work were spiritu
"waste places" of the earth, there are, including the A
Church (the first fruits of the society's efforts), 138 bisho
than 5000 clergy, and upwards of 2,000,000 members
communion.

The above tables sufficiently indicate how varied
missionary agencies now at work, covering the

[1] mes, *Hist. Sketches of the Missions of the United Brethren*,
rant, *Bampton Lectures*, p. 190.

[2] See Scott Robertson, *Analysis of British Contributions to Missions*, 1883.

vith a network of mission outposts, which within century have won nearly two millions of converts hristian faith.

continuity of missionary enthusiasm maintained the primitive, the mediæval, and the modern periods hurch's history, operating at every critical epoch, viving after periods of stagnation and depression, y significant fact. It is true that other religions en called missionary religions, and that one of them the first place in the religious census of mankind.[1] nis ionary activity of Buddhism is a thing of the d no characteristic rite distinguishing it has found its a second continent; while, as for Mohammedanism, acter of its teaching is too exact a reflexion of the e, place, and climate in which it arose to admit ecoming universal." These and other religions of East may still maintain their hold over millions, but be admitted that their prospect of endurance in sence of advancing Christianity is very small, and fficult to trace the slightest probability of their izing with the intellectual, social, and moral progress odern world. With all its deficiencies, the Christian has gained the "nations of the future," and whereas 3d century the proportion of Christians to the uman race was only that of one in a hundred and is has now been exchanged for one in five,[3] and it putable that the progress of the human race at this is entirely identified with the spread of the e of the nations of Christendom.

by side with this continuity of missionary zeal, able feature is the immense influence of individual and the subduing force of personal character. individuals penetrated with Christian zeal and self has centred not merely the life, but the very e, of primitive, mediæval, and modern missions. Ulfila was to the Gothic tribes what Columba disciples were to the early Celtic missions, what ine or Aidan was to the British Isles, what Boniis to the churches of Germany and Anskar to Denmark and Sweden, that, on the discovery of a rld of missionary enterprise, was Xavier to India, Egede to Greenland, Eliot to the Red Indians, to the church of Cawnpore, Marsden to the Maoris, nd Marshman to Burmah, Heber, Wilson, Milman, ff to India, Gray, Livingstone, Mackenzie, Steere, y to Africa, Broughton to Australia, Patteson to ia, Mountain and Feild to Newfoundland, Crowther Niger Territory, Brett to Guiana. At the most epochs such men have ever been raised up, and the fluence of their lives and self-denial has told upon rch at home, while apart from their influence the istory of important portions of the world's surface ave been altered.

om the agents themselves we turn to the work that en accomplished it will not be disputed that the of missions has been marked amongst rude and nal tribes. What was true in the early missions n found true in these latter times. The rude and us northern peoples seemed to fall like "full ripe efore the first breath of the gospel." The Goths Vandals who poured down upon the Roman empire angelized so silently and rapidly that only a fact nd there relating to their conversion has been ed. Now this is exactly analogous to modern nce in the South Seas, America, and Africa. st here content ourselves with a cursory survey of what missionary enterprise has accomplished in regions and among the more civilized nations of Ea Asia.

The South Seas.—That missions have done much in these re in suppressing cannibalism, human sacrifices, and infant humanizing the laws of war, and elevating the social condit women, is a fact confirmed by the researches of Meinicke, V Gerland, Oberlander, and even of Darwin.[4]

In Australia work among the aborigines, wherever it has zealously conducted, has been blessed with signal success. An the Papuans the Moravian stations of Ebenezer in the distr Wimmera, and Ramahyuck in that of Gippsland, can po then little villages of 125 native Christian inhabitants, cleanly houses, and their well-ordered churches. In the dist South Adelaide, at Point Macleay, the Scottish Presbyterian M has been similarly successful, while in New Zealand the population was converted almost within a single generation. islands north and north west of Australia the Dutch missio have been especially successful in the Minahassa (see CEL of whose 114,000 inhabitants more than 80,000 have been over to the Christian faith, forming 195 communities wit schools, and in southern Borneo, the Rhenish Mission in the and the Society for the Propagation of the Gospel in the north been enabled to establish themselves firmly, while the f society has also done a great work among the Battaks in Su Amongst the dark coloured races of Polynesia missionary wo made great advances through the labours of the London Miss Society, the Wesleyans, and the American Board. Making its basis of operations, the first-named society has carri missionary operations in the islands of Australasia, Hervey, S Tokelau, and Ellice, while the American Board has wit equally favourable results in the Sandwich Islands, and in Mier (Caroline, Marshall, and Gilbert Islands) the agents of the Ha Association are actively at work under the direction of Am missionaries. In Melanesia the Society for the Propagation Gospel, the Wesleyans, the London Missionary Society, a Presbyterians are all actively engaged. The Fiji group stan as one of the most promising centres of Christian civilizatio the governor, Sir A. Gordon, was enabled to report in 1879 that, a population of about 120,000, 102,000 are now regular worsh in the churches, which number 800, while over 42,000 childr in attendance on 1531 Christian day schools. The Loyalty I have been occupied partly by Roman Catholic missions and by the London Missionary Society, while in the New Hebrid missionaries of the Free Church of Scotland and of the P terian churches of Canada, New Zealand, and Australia, i of many obstacles, the unhealthiness of the climate, and the v of the dialects spoken, have upwards of 3000 natives re Christian teach . 800 communicants, and 100 native te On the islands Banks, Santa Cruz, and Solomon, the E Episcopal Church is achieving no little success, sending native for months at a time to Norfolk Island to receive instruction, v they return again in order to spread the knowledge of truth at These islands will ever be famous in connexion with the death of the noble Bishop Patteson.

The Uncivilized Peoples of America.—The quiet humble l of the Moravians have accomplished much in Greenlan Labrador, whilst among the Indians of Canada and the pe Hudson's Bay the Society for the Propagation of the Gosp not laboured in vain, nor the Church Missionary Society dioceses of Rupertsland, Red River, Saskatchewan, and Mac At Columbia, on the coast of the Pacific, a practical missionary named William Duncan has succeeded in civilizing a body of I degraded by cannibalism, and at his Metlakahtla mission at the head of a community of some thousand persons, which larger church than is to be found between there and San Fra Testimony to the value of the results achieved was borne in by Lord Dufferin, then governor-general of Canada, who de that he could hardly find words to express his astonishment a he witnessed. Amongst the Indian tribes of the United work is carried on by the Moravians, the American Board of Mi the Presbyterians of the North and South, the Baptists, the copal Methodists, and the American Missionary Society; an result is that 27,000 Indians, divided amongst the 171 commu of different denominations (including the Roman Catholic) are membership with the church, and have 219 places of wo besides 366 schools attended by about 12,222 Indian children Cherokees, the Choctaws, the Creeks, the Chickasaws, have own churches, schools, and academies, and may compare favo both intellectually and morally with their white neighbo Missouri, Arkansas, and Texas.[5] Amongst the negroes in the States more than 1000 places of worship have been built sin last war, while the American Missionary Association alo erected 26 academies with about 6000 students, for the purp

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Müller, *Chips*, iv. p. 26.

man, *Grammar of Assent*, p. 124.

tfoot, *Comparative Progress of Ancient and Modern Missions*,

[4] See Christlieb, *Foreign Missions*, p. 88.

[5] *Ibid.*, pp. 9

ring freed slaves to be teachers and missionaries. Amongst
ndians on the Essequibo and Berbice in British Guiana, the
ns of the Society for the Propagation of the Gospel have been
y extended, and now upwards of half the Indian population
embers of Christian churches. In the British West Indies,
gh the united labours of various missionary societies, out of
000 inhabitants upwards of 248,000 are returned as regular
ers of the churches, 85,000 as communicants, while 78,600
n receive instruction in 1123 day schools, of which number
45,000 belong to Jamaica.

sing to the southern promontory of South America, we find
he self-denying labours of Allen Gardiner are beginning to
the devotion that prompted them. The London South
can Missionary Society not only carries on its operations in
alkland Islands, where youths from Tierra del Fuego receive
ction, but has founded stations in Tierra del Fuego itself, has
the natives of Patagonia from their spiritual deadness, and
tended its labours even to the Indians in Brazil

ica.—Here there are three great regions of missionary activity,
he west coast, in the south, and in some parts of the east
largest and most fruitful mission field in West Africa is
f Sierra Leone, where at least seven eighths of the people
w Christians, though the first mission does not date further
han the present century,[1] and important results have also
btained in Senegambia (on the Ponga-), in Old Calabar, and
republic of Liberia. On the Gold and Slave Coasts the
s of English Wesleyan missionaries and of the North German
nary societies have been crowned with no small success, while
sel Society, which celebrated its jubilee in 1878, has extended
here of activity to Ashantee, translating the Scriptures into
tive languages, and changing primeval marshes into bright-
g Christian villages. In the Yoruba lands the Church
nary Society has 11 stations, 5994 Christians, and 1657
rs, while on the Niger we are confronted with the interesting
cle of negro preachers and teachers labouring under the
ed Bishop Crowther, carrying on a work which within the
w years was consecrated by the blood of martyrs
th Africa has for some time been a centre of missionary
y. Here thirteen British and Continental associations have
that all the South African races, Hottentots and Kaffirs,
s and Bechuanas, Basutos and Zulus, are capable of attaining
nderable degree of Christian civilization, and can not be
ted in handicraft and agriculture, but trained as ministers
achers. A single instance of this is afforded in British
ria by the Lovedale Institute of the Free Church of Scotland,
youths from all the above-mentioned tribes are taught along
Europeans, and every Sunday sixty students proclaim the
in the neighbouring villages. In the cause of mission work
ew ever laboured more zealously than the late Bishop Gray,
diocese, when first constituted, included the whole colony
Cape, but whose successor has now for his suffragans the
s of Grahamstown, Maritzburg, St Helena, Bloemfontein,
nd, St John's, and Pretoria.

and East Central Africa, so long neglected, is now being
y occupied by missionary enterprise. Here the island of
gascar has been in great part evangelized, while on the island
auritius the Anglican Mission has developed pre-eminent
. On the mainland, the coast of Zanzibar calls for special
Here the little island of the same name has long been the
the Universities Mission to Central Africa, and the heroic
Steere has not only erected a cathedral on the site of the
slave-market, but translated the New Testament into
ili, a language which can be understood by the tribes around
ces, and even in Uganda.

a.—"O mighty fortress! when shall these impenetrable
gates of thine be broken through?" was the mournful
nation of Valignani, the successor of Xavier, as he gazed in
s at the mountains of China. The words well express the
ible difficulties which this largest and most thickly peopled
n land in the world, with its petrified constitution and
of three thousand years, presents in the way of missionary
The country itself, the people, their speech, their manners,
religion, their policy, seemed to unite in opposing an insuper
arrier, but history has to record how efforts have been made
ny bodies, and at many times, to break it down. An early
ian Church established itself in the empire, but was either
ed, or died out in course of time. In the 16th century the
s undertook the task, and in spite of the persecutions which
ave undergone the missions of the Roman Church, with their
ous foreign clergy and their hosts of natives of different
astical degrees, have attained no small measure of success.
the country was really opened to foreigners by the treaty
ntsin, pioneers proceeded thither from America, and from
London Missionary Society. The labours of Dr Legge
nslating and reducing to system the Chinese classics are

[1] See Lightfoot, *Ancient and Modern Missions*, p. 10.

well known. At the present day it is estimated that t
upwards of 29 societies at work in the country, with al
ordained missionaries and 63 female teachers, and the n
constantly increasing. These societies, of which the larg
portion belong to England, and the next largest to America,
it is estimated, 20 theological schools, 30 higher boarding
for boys with 611 scholars, 38 for girls with 777 scholars,
schools for boys with 4000 to 5000 pupils in attendance, 82
with 1307, while 16 missionary hospitals and 24 dispens
under the direction of medical missionaries, whose work in C
been recognized almost from the first as the source of the
blessing. The mission centres stud the east coast from Ho
and Canton to the frontiers of Manchuria in the north
they advance little by little every year into the interior,
yet the western provinces are scarcely touched by missiona
The literary labours of the various societies have been c
with the utmost perseverance, and on the foundations l
Morrison and a Milne later toilers have been enabled to
superstructure of translations of various portions of the
well as various Christian books and religious and general pe
which constitute a mean of vast importance towards g
gaining over this land of culture. At Peking a Russian
has been labouring for more than one hundred and fift
The Society for the Propagation of the Gospel and the
Missionary Society have lately opened up new centres
almost limitless country.[2]

Japan.—Of the missions in Japan it is as yet too early
cast the future. The signing of the commercial treaties
and 1858 with America and England was followed in
efforts on the part of the American churches to extend a ki
of Christianity, and in these Bishop Williams, an accom
Japanese scholar, proved himself a valuable leader an
Soon afterwards other societies found their way into the
and in March 1872 the first Japanese congregation, at H
was constituted in Yokohama. Within the last eight ye
11 have increased to 1200, while the American missions h
supplemented by those of the Church Missionary Society
Society for the Propagation of the Gospel. Nearly every
has what may be called a high school for girls, and these
tions are very popular. Thousands of copies also of the
have been circulated in Japanese, and representatives of
the missions are engaged in translating the entire New Te
while a Russo-Greek mission has established itself in the ne
is advancing steadily, having already made about 3000 c
Thus, when it is considered that in the beginning of
century the Japanese Government drove out the Portug
massacred the native Catholic converts, and prohibited all C
under pain of death for ever setting foot in the country, a
it is borne in mind that many of these old laws against Chr
have not yet been repealed and that the old distrust of str
still plainly discernible among the governing classes, it is c
while there is much ground for hope, effectual results can
the work of time.

India.—What is true of China and Japan applies with
force to India. Here the results achieved resemble those wh
attained in the conflict between Christianity and the religio
pagan Rome, with its mass of time-honoured customs int
with the literature, institutions, and history of the
Against the influence of prestige and settled prejudice the
the gospel beat for centuries in vain. Slowly and gradual
undermining the fabric, but no striking results were imm
visible. So also in India with the Hindu proper Christia

[2] The Roman Catholic Mission had 464,530 converts in China in 1
yearly increase of about 2000.

[3] Christlieb, *Foreign Missions*, p. 222.

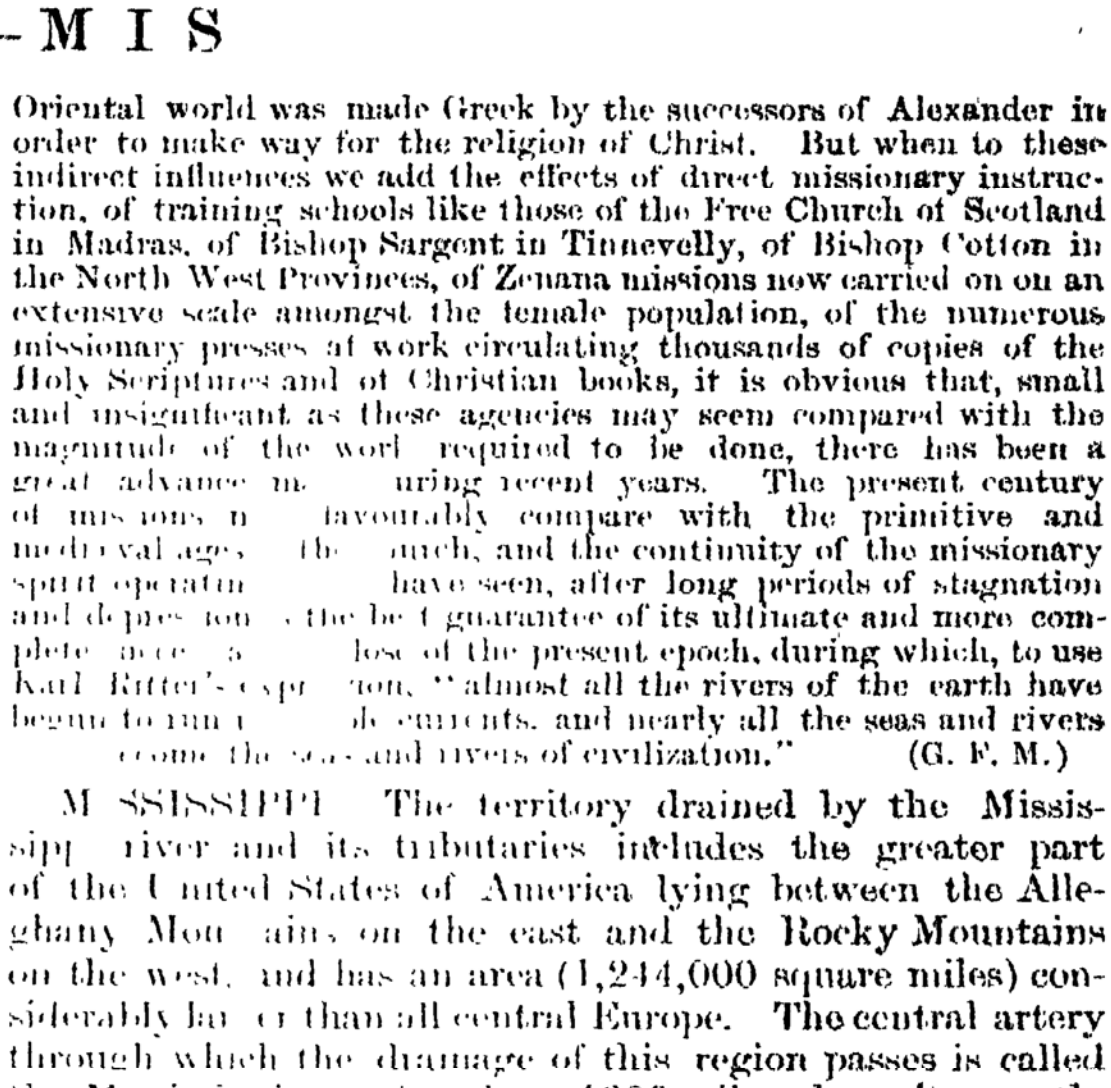
rapid. In Cuddapah, *e.g.*, in the Telugu territory, the
or the Propagation of the Gospel and the London Mission-
ty laboured side by side for upwards of thirty years without
over more than 200 converts. Then on a sudden there
p a revival among the non-caste population, and the 200
early 11,000. Among the Kols, after five years' waiting,
e missionaries baptized their first converts in 1850; now
mean and English stations together these amount to about
since the famine, however, in 1878-79, the increase of new
has been still more rapid, and the practical experience of
nority of Christian pay to heathen self-lness and of the
ss of their heathen doctr ntrasted with the effect produced
ent missionary labour in past years brought thou-ands
old of the church. Tru in the Tinnevelly district, where
h Missionary Society carries on its operations, upwards of
athens applied in 1878 to Bishop Sargent and his native
instruction preparatory to baptism. In the same district
xion with the Society for the Propagation of the Gospel,
July 1877 and the end of June 1878 upwards of 23,561
took themselves to Bishop Caldwell and his fellow-
for Christian teaching. Thus the English Church mi-
Tinnevelly and Ramnad received in little more than a year
an increase of 35,000 souls, and the Propagation Society
proclaiming the gospel in nearly six hundred and fifty
the Tinnevelly district, amongst not merely food seeking
rstians" but those who have had the courage to face severe
on for joining the Christian church. Encouraging progress
een made among the Santals and the Karens in Burmah

Speaking generally, it may be said that the largest
s of native converts are in the south, in the presidency of
next to southern India the most fruitful field is Burmah,
American Baptist missionaries are carrying on a success-ful
ng the Karens, while the Propagation Society has founded
ools on the Irrawadi, and penetrated up to Rangoon, and
ritish territory to Mandalay, next in point of number stand
of the North West Province. Here the largest contingent
d by the missionaries in Chutia Nagpúr, among the aboriginal
the Kols, while the Santal mission also presents many
g features. For the Punjab district and that of Sind,
h Missionary Society has printed in Lahore a flourishing
l seminary for Christian literature. Sikhs, and Mohammed
Christianity has advanced thereby way of Peshawur
anistan and Kohat. It thus appears that by far the
greatest success has been obtained amongst the aboriginal
those who are either of low caste or of no caste at all,
real strongholds of the Hindu religion and civilization
four life-strong fortresses and defy the attempts of the
Still the disintegrating agencies of contact with Chris-
working out their slow but sure results. "Statistical facts,"
Battle Frere, "can in no way convey any adequate idea
al done in many part of India. The effects often enormous
to be met by a single avowed conversion. The teaching
anity among st 160 millions of cavilling Hindus
immediate in India to effect three changes, moral, social, and
which for extent and rapidity are effected far more extra-
than any that have been witnessed in modern Europe."
mber of actual converts to Christianity in India," says
ence, "does not by any means give an adequate result
nary labours. There are thousands of persons scattered
e wide from the knowledge they have acquired either
ol indirectly through dissemination of Christian truth
stian principles have lost all belief in Hindu ism and
dation, and are in their conduct influenced by motives
who yet fear to make an open profession of the change
t they should be looked upon as outcasts and lepers
own people." To some such a negative result may at
appear discouraging, but read by the light of history,
critical, almost necessary, stage of transition from
to a purer religion to Christianity. The Brahmo Somaj
ce in Bengal where a system too vague and shadowy
to contain in the element of a permanent religion has
proved a bridge between the abandonment of the old and the
of the new faith. The cultured classes amongst the
and Romans experienced in their day, after the popular
y had ceased to satisfy, a period of utter scepticism before
ity had recovered hold. Meantime in India the indirect
which are at work—the results of war and conquest of
science and European literature, of the telegraph and
s, the book and the newspaper, the college and the school,
e of law hallowed by immemorial usage the disregard of
ained prejudices, the very presence of Europeans in all
the country—all these various influences are gradually
about results analogous to that to which Sir James Mack-
ferred in a conversation with Henry Martyn, when the

ct of Church Missionary Society's Report for 1879, p. 13.
t of the Propagation Society for 1879, p. 31 *sq.*

Oriental world was made Greek by the successors of Alexander in order to make way for the religion of Christ. But when to these indirect influences we add the effects of direct missionary instruction, of training schools like those of the Free Church of Scotland in Madras, of Bishop Sargent in Tinnevelly, of Bishop Cotton in the North West Provinces, of Zenana missions now carried on on an extensive scale amongst the female population, of the numerous missionary presses at work circulating thousands of copies of the Holy Scriptures and of Christian books, it is obvious that, small and insignificant as these agencies may seem compared with the magnitude of the work required to be done, there has been a great advance m uring recent years. The present century of missions favourably compare with the primitive and mediæval ages hurch, and the continuity of the missionary spirit operatin have seen, after long periods of stagnation and depression, the best guarantee of its ultimate and more complete success. lose of the present epoch, during which, to use Karl Ritter's expr ion, "almost all the rivers of the earth have begun to run d currents, and nearly all the seas and rivers become the seas and rivers of civilization." (G. F. M.)

MISSISSIPPI. The territory drained by the Mississippi river and its tributaries includes the greater part of the United States of America lying between the Alleghany Mountains on the east and the Rocky Mountains on the west, and has an area (1,244,000 square miles) considerably larger than all central Europe. The central artery through which the drainage of this region passes is called the Mississippi river for about 1300 miles above its mouth. The name is then usurped by a tributary, while the main



The Mississippi and its Tributaries.

stream becomes known as the Missouri. From its remote sources in the Rocky Mountains to the Gulf of Mexico the total length of the river is about 4200 miles. The other principal tributaries are the Ohio, the Arkansas, and the Red River, but the Yazoo and the St Francis often make dangerous contributions in seasons of flood.

The tables given below exhibit the hydraulic features of the Mississippi and its principal tributaries.

Below the influx of the Ohio the Mississippi traverses alluvial bottom lands liable to overflow in flood seasons. The soil is of inexhaustible fertility, producing large crops of corn in the northern portion, cotton in the middle district, and sugar, rice, and orange groves near the mouth. These bottom lands, averaging about 40 miles in width, extend from north to south for a distance of 500 miles, having a general southern slope of 8 inches to the mile. The river winds through them in a devious course for 1100 miles, occasionally on the east side washing bluffs from 100 to 300 feet in height, but usually confined by banks of its own creation, which, as with all sediment-bearing rivers of like character, are highest near the stream itself. The general lateral slope towards the foot hills is about 6 inches

00 feet, but the normal fall in the first mile is about . Thus apparently following a low ridge through the n lands, the tawny sea sweeps onward with great ty, eroding its banks in the bends and rebuilding on the points, now forming islands by its deposits, now removing them as the direction of the flow is ied by the never-ending changes in progress. Chief g such changes is the formation of cut-offs. Two ng bends gradually approach each other until the water a passage across the narrow neck. As the channel nce between these bends may be many miles, a cascade ps 5 or 6 feet in height is formed, and the torrent s through with a roar audible for miles. The bank ve like sugar. In a single day the course of the river nged, and steamboats pass where a few hours before lough had been at work. The checking of the current upper and lower mouths of the abandoned channel obstructs them by deposit, and forms in a few years f the characteristic crescent lakes which are so marked ure on the maps.

The total area of the bottom lands is about square miles, of which only a narrow strip alo immediate banks of the main river and of its p bayous and tributaries has even yet been brough cultivation. A proper system of protection against would throw open 2,500,000 acres of rich sug 7,000,000 acres of the best cotton land in the wo 1,000,000 acres of corn land of unsurpassed fertilit

The work of embankment began in 1717, wh engineer De la Tour erected a dyke or levee 1 mile protect the infant city of New Orleans from o Progress at first was slow. In 1770 the sett xtended only 30 miles above and 20 miles belo Orleans; but by 1828 the levees, although quite insi in dimensions, had become continuous nearly to the of Red River. In 1850 a great impulse was g systematic embankment by the U.S. Government gave over to the several States all unsold swamp an flowed land within their limits to provide a fund claiming the district liable to inundation. The

Tributaries of the Lower Mississippi

River.	Distance from			Range between High & Low Water	High Water	
Missouri—	Miles.	Feet				
Source	2,908	6,800				
Three Forks	2,821	4,319				Area of basin, 518,000 square miles; rainfall
Fort Benton	2,644	2,845	1,500			inches; annual discharge, 3,⅝ billions
Fort Union	1,894	2,188	1,500			3,780,000,000,000 cubic feet; ratio b
Sioux City	842	1,065				drainage and rainfall, ⅛, mean discha
St. Joseph	484		3,000		75,000	second, 120,000 cubic feet.
Mouth	0		3,000		75,000	
Upper Mississippi—						
Source	1,330	1,680				
Minnesota River	998	1,290				Area of basin, 169,000 square miles; rainfal
St. Paul	658		1,200		100,000	inches; annual discharge, 3,⅛ billions
Rock Island	310		1,000	16	100,000	feet; ratio between drainage and rainfall
Mouth	0		1,000		100,000	mean discharge per second, 105,000 cubic
Minnesota—						
Anderson	1,265	1,619				Area of basin, 214,000 square miles; rainfal
Pittsburg	975	699	1,200	45	50,000	inches; annual discharge, 5 billions cubi
Cincinnati	515	432		12		ratio between drainage and rainfall, ⅛;
Mouth	0		3,000	51	150,000	discharge per second, 150,000 cubic feet.
Arkansas—						
Source	1,514	10,000	150			
Fort's Fort	1,289	3,672	5,000		30,000	Area of basin, 189,000 square miles; rainfal
Great Bend	992	1,658	5,000			inches; annual discharge, 2 billions cubi
Fort Smith	522	418	1,500		70,000	ratio between drainage and rainfall, ⅛;
Little Rock	250	252	1,500		70,000	discharge per second, 63,000 cubic feet
Mouth	0	162	1,500		70,000	
Red River—						
Far source	1,200	2,459	2,000		12,000	Area of basin, 97,000 square miles; rainf
Alston	820	611				inches; annual discharge, 1, billions cub
Shreveport	330	180			10,000	ratio between drainage and rainfall, ⅛
Mouth	0	51			40,000	discharge per second, 40,000 cubic feet.

The Lower Mi

	Distance from Mouth.	High Water Elevation above Sea	Fall per Mile.	Width between Banks	Depths in the		Drainage
	Miles	Feet.	Feet				
South of Missouri	1,286	420·0					1,711,000
Louis	1,270	408·0	0·500				miles, rainf
ro	1,097	322·0	0·497		51·0		inches, ann
mbus	1,076	310·0	0·571	4,470		191,000	charge abo
aphis	872	221·0	0·436				three outle
es landing	647	149·0	0·320				·3, 21,5
chez	378	66·0	0·309	1,080		199,000	of cubic fe
River landing	316	49·5	0·266		44·3		between d
on Rouge	245	33·9	0·220		31·1	200,000	and rainfa
aldsonville	193	25·8	0·156		24·3		mean discha
rollton	121	15·2	0·147		14·4		second,
t. St Philip	37	5·2	0·119	2,470	4·5	199,000	cubic feet.
d of Passes	17	2·9	0·115		2·3		
f	0	0·0	0·171		0·0		

ng from this caused alarm in Louisiana, for the great
lands above were believed to act as reservoirs to
the highest flood wave; and it was imagined that
were closed by levees the lower country would
rwhelmed whenever the river in flood rose above
nal banks. The aid of the Government was in
and Congress immediately ordered the necessary
gations and surveys. This work was placed in
of Captain (now General) Humphreys, and an
e report covering the results of ten years of investi-
was published just after the outbreak of the civil
1861. The second of the tables given above, and
most of the physical facts respecting the river are
from this standard authority.

nderstand the figures of the tables it should be noted
the mouth of Red River, 316 miles above the passes,
er surface at the lowest stage is only $5\frac{1}{10}$ feet above
l of the Gulf, where the mean tidal oscillation is
$\frac{6}{10}$ feet. The river channel in this section is there
freshwater lake, nearly without islands, 2600 feet
d 100 feet deep along the deepest line. At the
ge the surface rises 50 feet at the mouth of Red
ut of course retains its level at the Gulf, thus giving
d necessary to force forward the increased volume
harge. Above the mouth of Red River the case
tially different. The width increases and the depth
es, islands become numerous, the oscillation be-
high and low water varies but little from 50 feet
he mouth of the Ohio is reached a distance of
00 miles. Hence the general slope in long distances
nearly the same at all stages, and the discharge
ated by the varying resistances of cross section, and
changes in slope due to the passage of flood waves
nted by the different tributaries. The effect of
ifferent physical condition appears in the compara
lumes which pass through the channel. At New
the maximum discharge hardly reaches 1,200,000
eet per second, and a rising river at high stages
only about 100,000 cubic feet per second more than
alling at the same absolute level; while just below
uth of the Ohio the maximum flood volume reaches
00 cubic feet per second and at some stages a
iver may carry one third more water than when
at the same absolute level.

percentage of sedimentary matter carried in suspen
the water varies greatly at different times, but is
y not dependent upon the stage above low water
rgely determined by the tributary whence the water
, but is also influenced by the caving of the banks,
always excessive when the river is rapidly falling
he spring flood. In long periods the sedimentary
is to the water by weight nearly as 1 to 1500, and
as 1 to 2900. The amount held in suspension
nually contributed to the Gulf constitutes a prism
square and 263 feet high. In addition to this
a large volume, estimated at 1 mile square and
high annually, is pushed by the current along the
and then transported to the Gulf.

me the general succession of stages for long periods
uniform, but so many exceptions are noted that
ate predictions can safely be made for any particular
The river is usually lowest in October. It rises
until checked by the freezing of the northern
ries. It begins to rise again in February, and attains
est point about the 1st of April. After falling a few
gain rises until, early in June, it attains nearly the
vel as before. After this it rapidly recedes to low-
mark. As a rule the river is above mid stage from
y to August inclusive, and below that level for the
ler of the year.

It has been established by measurement and obse
that the great bottom lands above Red River before t
struction of their levees did not serve as reserv
diminish the maximum wave which passed t
Louisiana in great flood seasons. They had already
filled by local rains and by water escaping into the
the Mississippi through numerous bayous, so that
date of highest water the discharge into the river ne
southern borders was fully equal to the volume wh
wave had lost in passing along their fronts.

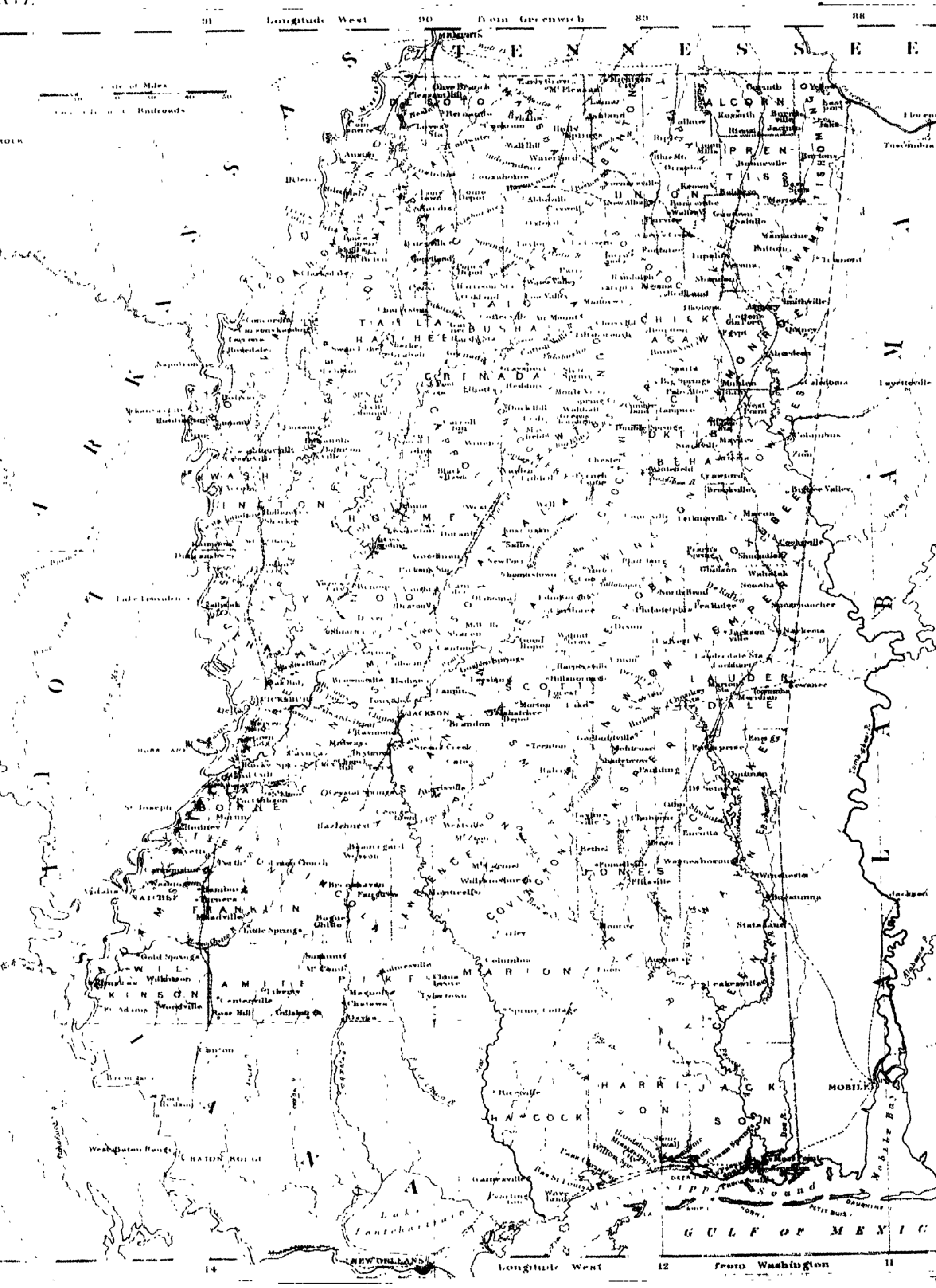
In fine, the investigations between 1850 and 1860
lished that no diversion of tributaries was possible;
reservoirs artificially constructed could keep back the
freshets which caused the floods; that the making
offs, which had sometimes been advocated as a meas
relief, so far from being beneficial, was in the highest
injurious; that, while outlets within proper limit
theoretically advantageous, they were impracticabl
the lack of suitable sites; and, finally, that levees p
constructed and judiciously placed would afford pro
to the entire alluvial region.

During the civil war (1861-65) the artificial embar
were neglected, but large sums were expended
States directly interested in repairing them. The work w
without concert upon defective plans, and a great flood
1871 inundated the country, causing terrible suffering a
Congress, then in session, passed an Act creating a comm
five engineers to determine and report on the best system
permanent reclamation of the entire alluvial region. Their
rendered in 1875, endorsed the conclusions of that of 18
advocated a general levee system on each bank. This
comprised 1st a main embankment raised to specified
sufficient to restrain the floods; and 2d, where reasonable
against caving required considerable areas near the rive
thrown out, exterior levees of such a height as to exclude
high water, but to allow free passage to great floods, wh
rule only occur at intervals of five or six years. The back
would thus be securely protected, and a safe refuge would
vided for the inhabitants and domestic animals living u
portion subject to occasional overflow. An engineering o
tion was proposed for constructing and maintaining these
and a detailed topographical survey was recommended to de
their precise location. Congress promptly approved and
the survey, but strong opposition on constitutional grou
raised to the construction of the levees by the Government.

In the meantime complaints began to be heard respec
low water navigation of the river below the mouth of th
Forty three places above the mouth of Red River allorde
of less than 10 feet, and thirteen places depths less than 5
aggregate length of such places being about 150 miles.
of five army engineers, appointed in 1878 to consider
relief, reported that 10 feet could probably be secured by
ing the wide places to about 3500 feet with hurdle work
ropes, or brush dykes designed to cause a deposit of
and by protecting caving banks, when necessary, by such
cheap mattresses as experience should show to be best suite
work. Experiments in these methods were soon begun u
river above Cairo and have since proved of decided benefit.

In June 1879 Congress created a commission of seven
to mature plans to correct, permanently determine, and dee
channel, to protect the banks of the river, to improve a
safety to navigation, to prevent destructive floods, and to
and facilitate commerce. Up to 1882 appropriations am
to $1,785,000 were made to execute the plans of this com
but with provisos that none of the funds were to be e
in repairing or building levees for the protection of land
overflow, although such levees might be constructed if n
to deepen the channel and improve navigation. Acting un
its duties the commission have allotted considerable sums
closing breaks in the levees; but their chief dependence
contracting the channel at low water by promoting lateral
to rely upon protecting the high water banks against caving by
brush, wire, &c., ballasted where necessary with stone,
tially the plans proposed by the army board of 1878.

The bar at the efflux of the passes at the mouth of the Mi
have long been recognized as serious impediments to co
The river naturally discharges through three principal bran
south west pass, the south pass, and the north-east pass, t
through two channels, the most northern of which is calle
Pourre. The ruling depth on the several bars varies
discharge over them, which in turn is controlled by the s
advances of the passes. In the natural condition the


91 Longitude West 90 from Greenwich 89 88
TENNESSEE
DE SOTO
TATE
TUNICA
COAHOMA
TALLAHATCHIE
PANOLA
TIPPAH
ALCORN
PRENTISS
UNION
TISHOMINGO
YALOBUSHA
GRENADA
CHICKASAW
ITAWAMBA
MONROE
CLAY
WEBSTER
CHOCTAW
WINSTON
LEFLORE
CARROLL
MONTGOMERY
HOLMES
ATTALA
OKTIBBEHA
LOWNDES
NOXUBEE
WASHINGTON
SUNFLOWER
HUMPHREYS
YAZOO
LEAKE
NESHOBA
KEMPER
LAUDERDALE
SCOTT
RANKIN
JACKSON
GREENE
WAYNE
JONES
CLARKE
SMITH
COVINGTON
JEFFERSON DAVIS
FRANKLIN
LINCOLN
AMITE
PIKE
MARION
LAWRENCE
WILKINSON
ADAMS
HARRISON
HANCOCK
PEARL RIVER
STONE
GEORGE
JACKSON
MOBILE
Memphis
Vicksburg
Jackson
Meridian
Natchez
Greenville
Columbus
Tupelo
Corinth
Hattiesburg
Laurel
Gulfport
Biloxi
Pascagoula
Pass Christian
Bay St. Louis
Waveland
Lake Pontchartrain
NEW ORLEANS
Mississippi Sound
GULF OF MEXICO
14 Longitude West 12 from Washington 11

depth does not exceed 12 or 13 feet. The first appropriation by Congress to secure increased depth was made in 1837, and was expended in an elaborate survey and in a system of dredging by buckets, but the plan of a ship canal was also discussed. At the next appropriation, made in 1852, a board of officers, appointed by the war department, recommended trying in succession (1) stirring up the bottom by suitable machinery, (2) dredging by buckets, (3) constructing parallel jetties 5 miles long at the south west pass, to be extended as found necessary, (4) closing lateral outlets, and (5) constructing a ship canal. A depth of 18 feet was secured by the first plan, and was maintained until the available funds were exhausted. Under the next appropriation (1856) an abortive attempt was made to apply the plan of jetties to the south west pass. This failed from defects in execution by the contractors, but a depth of 18 feet was finally secured by dredging and scraping. The report of 1861 discussed the subject of deformation at length. Although it approved the plan of jetties and closure of outlets as correct in theory, the stirring up of the bottom by scrapers during the flood stages of the river six months annually was recommended by it as the most economical and practicable. After the war this recommendation was carried into effect for several years with improved machinery, giving a maximum annual cost a depth at times reaching 20 feet at extreme low water, but experience indicated that not much more than 18 feet could be steadily maintained. This depth, entirely satisfactory in 1873, soon became insufficient to meet the growing demands of commerce, and in 1873 Major Howell, the engineer in charge, revived the project of a ship canal. The subject was discussed before a board of army engineers, the majority approving a jetty plan. In 1874 Congress constituted a special board which, after visiting Europe and examining similar works of improvement there, reported in favour of constructing jetties at the south pass, substantially upon the plan used by M. Caland at the mouth of the Meuse; and in March 1875 Captain J. B. Eads and associates were authorized by Congress to open by contract a broad and deep channel through the south pass upon the general plan proposed by the board. The contract called for "the maintenance of a channel of 30 feet in depth and 350 feet in width for twenty years" by "the construction of thoroughly substantial and permanent works by which said channel may be maintained for all time after their completion." The jetties were to be not less than 700 feet apart. The sum of $5,000,000 was to be paid for obtaining the channel, and $4,000,000 for maintaining it for twenty years. In addition the contractors were authorized to use any material on the public lands suitable for mattress in the work. The south pass was 12½ miles long. It had an average width of 730 feet and a minimum interior channel depth of [illegible]. The distance from the 30 foot curve inside the jetties to the 30 foot curve outside was 11,900 feet. The minimum depth at average flood tide on the bar was about 8 feet. The discharge at the mouth was about 57,000 cubic feet of water per second, transporting annually about 22 million cubic yards of sediment in suspension to the Gulf. A small island and shoal existed at the head of the pass, the channel there having a minimum depth of 17 feet. The work was begun on June 2, 1875, and has been so far successful that during the year ending June 30, 1882, a channel was maintained having a least depth of 30 feet between the jetties and extending through the bar. Its least width was 20 feet, the average being 105 feet. The 26-foot channel had a least width of 200 feet, except for a few days. In the pass itself the 26 foot channel had a least width of 50 feet. A very powerful dredge boat was at work between and beyond the jetties 87 days, of which 51 were devoted to the channel in the Gulf. A deepening of 6 feet has occurred in Pass à l'Outre near its head since 1875. Up to the present time the work has proved of great benefit to the commerce of New Orleans.

For further details, see RIVER ENGINEERING. (H. L. A.)

MISSISSIPPI, one of the Southern States of the American Union, derives its name from the river which for more than 500 miles forms its western boundary between the 35th and 31st parallels of north latitude, separating it from Arkansas and Louisiana. The boundary with the latter State is continued along the 31st parallel, for 110 miles, to the Pearl river, and then down the Pearl to its mouth. The Gulf of Mexico, eastward from the mouth of Pearl river, completes the southern boundary. On the north the 35th parallel, from the Mississippi river to the Tennessee, separates the State from Tennessee, and the boundary then follows the latter river to the mouth of Bear Creek, in 34° 53′ N. lat. and 88° 15′ W. long. The eastern boundary of the State, separating it from Alabama, follows a line drawn from the mouth of Bear Creek about seven degrees west of south to what was "the north western corner of Washington county on the Tombigbee," and thence due south to the Gulf of [illegible]. Ship, Horn, Cat, and Petit Bois Islands, and those on the shore, form a part of Mississippi. The extreme length of the State, north and south, is 330 miles, and its maximum breadth is 188 miles. Under the United States surveys, begun in 1803, the State has been divided into townships and sections, except such parts as were at first owned by individuals. The area of the State is given in the census reports for 1880 at 46,340 square miles.

Topography. There are no mountains in Mississippi, but a considerable difference of level exists between the almost continuously low, flat, alluvial region lying along and between the Mississippi and Yazoo rivers, called "the Bottom," and nearly all the remainder of the State, which is classed as upland. The latter part, comprising two-thirds of the whole, is an undulating plateau whose general elevation above the water of the Gulf of Mexico is from 100 to 150 feet within a few miles of the coast, and thence elsewhere from 150 to 500 or 600 feet. Some exceptional points are probably 800 feet high. The streams in this region flow in valleys varying in width from a few yards to several miles, and [illegible] bluff of each river is usually a considerable part of the valley of each larger stream, several feet above its high water mark, and forms the "hammock," or "Bottom" land. On some of the rivers the lowest part of the valley, subject to overflow, is several miles wide, and bears a resemblance to the Mississippi Bottom. Ridges or plateaux everywhere in the upland divide the contiguous basins of creeks and rivers, descending more or less abruptly to their valleys. In the northern part of the State, almost level prairies cover large areas, overlying a Cretaceous formation called Rotten Limestone.

A line of abrupt bluffs, extending southward from the north west corner of the State, divides the upland region from the Bottom, where the general surface lies below the high water level of the Mississippi river. A few ridges, running north and south, and embracing 200,000 acres, are barely above high water. The elevated lands in the Bottom lie on these, and on the banks of the rivers and the numerous lakes and bayous, which are slightly elevated. Low swamps or marshes, in which flourish large cypress trees (*Taxodium distichum*), lie between the streams, and frequently receive the surface drainage from their banks. Large forest trees and dense cane brakes (*Arundinaria gigantea*) occupy the ground. The Mississippi river is prevented from flooding the Bottom during high water by a system of levees or embankments built by a fund derived partly from a tax on the land and partly from the proceeds of the sale of public lands in the State classed as "swamp lands," which were given over for the purpose by Congress. The original compensation for the injury done when breaks in the levees occur is the deposit of alluvial matter on the overflow, which adds to the productiveness already wonderfully fertile soil. The present levee system usually protects about one fourth of the 4,000,000 acres in the Bottom. Many crescent-shaped lakes (*Oxbows*) occur on the Bottom. Similar phenomena present themselves in the channels of the other river bottoms.

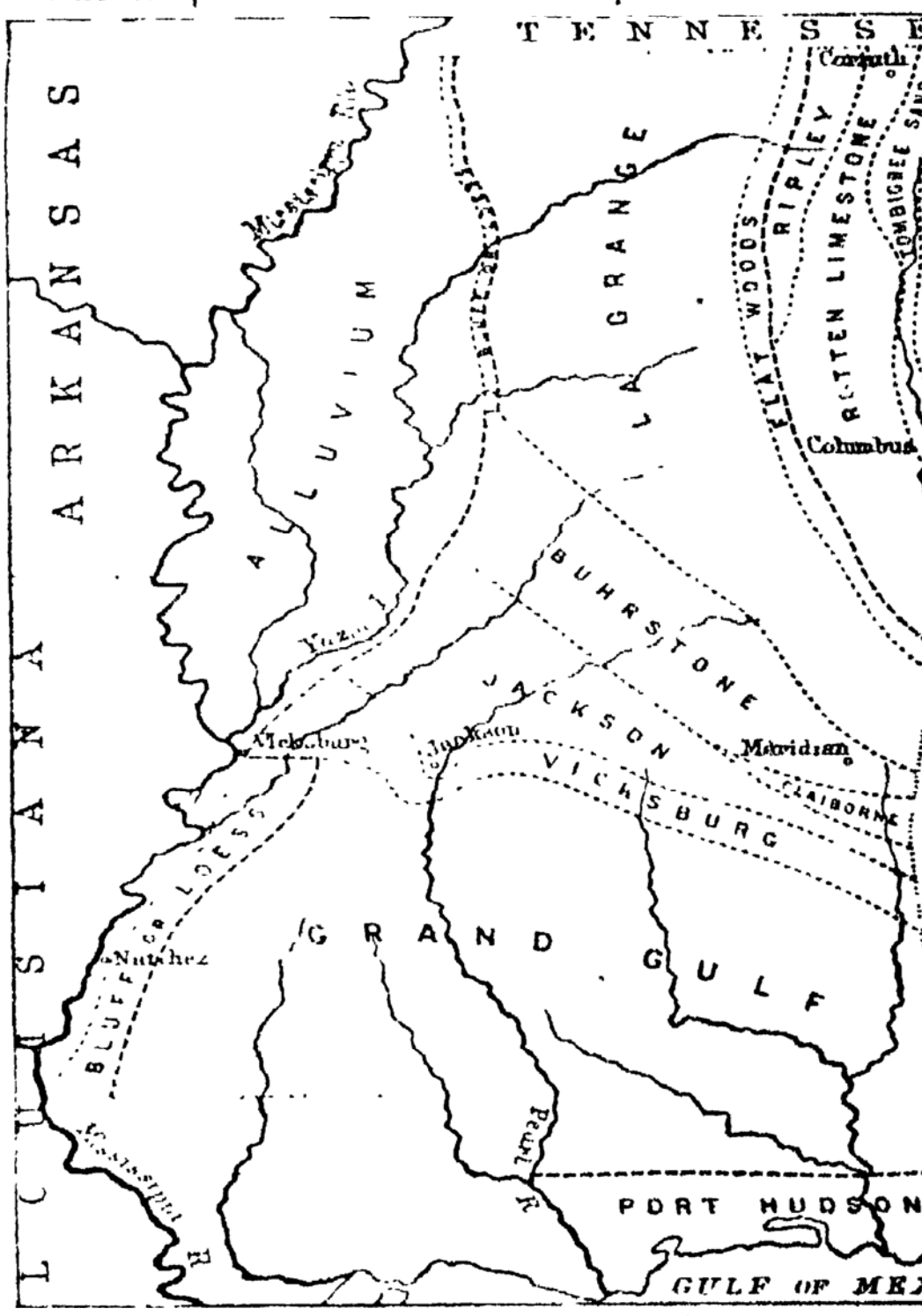
The volume of water in the streams varies greatly in the year, and is usually largest between the months of January and April. During high water all the principal streams are navigable by steamboat. These ply on the Mississippi, Tennessee, and Yazoo rivers throughout the whole year. The rivers flowing into the Gulf are obstructed by sand bars, and are chiefly used for floating logs to the saw-mills on the coast.

oest and only deep harbour on the coast is the well-
d roadstead inside of Ship Island. It has a depth
eet, a firm clay bottom, and is readily accessible to
from the shallower harbours along the coast.

e. Near the waters of the Gulf of Mexico the climate is
ilder than in the northern parts of the State. On the
border the temperature rarely falls to 32° Fahr., or exceeds
annual mean being about 68°. The orange, lemon,
banana and olive can be grown without protection. In
ne of Vicksburg the temperature ranges from 98° to 20°,
y lower, the annual mean is 65°. The range in the
part of the State is from 98° to 15°, or rarely 10°, and the
ean is 61°. The first and last hoar frosts occur, in the
arts of the State, usually in the latter part of October and
The ground is seldom frozen to the depth of 5 inches, and
a few days at a time. The rainfall on the coast is 60 to 65
r annum, and at the northern boundary 50 inches. While
o-thirds of the precipitation occurs in winter and spring,
seldom passes without several inches of rainfall
and sea breeze on the south, and variable winds elsewhere,
heat of summer tolerable. In healthfulness Mississippi
s favourably with other States. The average death rate of
States, variously situated as given in the census of 1880,
er cent.; that of Mississippi is 1·19 per cent. Where the
s flat and poorly drained malarial fever are prevalent during
season. Yellow fever has become endemic after importa
strict quarantine has been successful in preventing it.

y. In accordance with an Act of the legislature passed in
agricultural and geological survey of the State was begun,
ntinued, with interruption, until 1874. Two reports have
lished, one in 1854 and another in 1860.

eological structure of the State is comparatively simple,
sely related to that of the adjacent States. The older
ns are nearly all overlaid by deposits of the Quaternary
which will be described first. In the extreme north
portion are found the oldest rocks in the State, an ex
of the Subcarboniferous formation which underlies the
coal-fields of Alabama. The strata here show some trace
upheaval which formed the Appalachian mountain chain
outh-west termination is found in Alabama. When this
med the Atlantic mountain-border of the continent, except
north-east corner, Mississippi had not emerged from the
f the ancient Gulf of Mexico. As the shore-line of this
wly receded southward and westward, the sediment at its
gradually came to the surface, and constituted the Cretaceous
tiary formation of this and adjacent States. Wherever
ation is observed in these formations in Mississippi, it
dip west and south of 20 or 30 feet to the mile. The
ous region includes, with the exception of the Subcarboni-
all that part of the State eastward of a line cutting the
e boundary in 89° 3′ W. long. and drawn southward
ward through the towns of Ripley, Pontotoc, and Stark
ossing into Alabama in latitude 33° 15′. Four groups of
ous strata have been determined in Mississippi, defined by
ving the same general direction as the one just described
dest, bordering the Subcarboniferous, is the Eutaw or
roup, characterized by bluish-black or reddish laminated
d yellow or grey sands, containing lignite and fossil resin
d and southward to the city of Columbus is the
bee sand group, consisting chiefly of fine-grained micaceous
t a greenish tint, with many marine fossils. Next in
estward and southward, is the Rotten Limestone group,
p of a material of great uniformity, a soft chalky rock,
pale blue, composed chiefly of tenacious clay, and white
e of lime in minute crystals. Borings show the total
ss of this group to be about 1000 feet. Fossils are abundant,
ous species. The latest Cretaceous is the Ripley group,
st of the northern part of the last named group, and
ed by hard crystalline white limestones, and dark-
d, micaceous, glauconitic marls, whose marine fossils are
ly preserved. One hundred and eighty species have been
ed. The total thickness of the Cretaceous is about 2000
Deposits of the Tertiary period form the basis of more than
State extending from the border of the Cretaceous west-
early or quite to the Yazoo and Mississippi Bottom, and
nd to within a few miles of the Gulf coast. Seven groups
Tertiary strata have been distinguished. Beginning nearest
taceous, the Flatwoods group is characterized by grey or
clays, and a soil which responds poorly to tillage. The
e group, lying to the west of the last, is marked by grey
d sands, fossil plants, and beds of lignite or brown coal,
es 8 feet in thickness. The Buhrstone group, lying south-
d from the last, is characterized by beds of white siliceous
nd of silicified shells, and sandy strata containing glauconite
able quantities. The Claiborne group lies south of the
d is slightly developed in Mississippi, but well-marked in



Geological Map of Mississippi State.

hese ferruginous sandstones are very fantastic,—tubes,
spheres, plates, &c., being common. The name stratified
used by the geologist of Alabama to indicate its connexio
the northern drift. The fossils are few, and in some cases p
lerived from the underlying formations. Well-worn peb
amorphous quartz, agate, chalcedony, jasper, &c., are found
stratified drift along the western side of the Tertiary re
the State, and from Columbus northward. "While this
tion is not well understood, it seems tolerably well esta
at the melting of the great glaciers of the north furnish
water which brought with it fragments of the rocks over
it passed, and flowed into the Gulf with a current whi
most rapid where the pebbles were dropped, but overspr
remainder of the State with a gentler flow, leaving sa
clay." (E. A. Smith). The second Quaternary formation
Port Hudson, occurring within 20 miles of the Gulf coast, ar
ably outcropping occasionally in the Mississippi Bottom.
gravel, and sands, containing cypress stumps, drift-wo
mastodon bones, are characteristic. The loess or bluff fo
lies along the bluffs bordering the Bottom, nearly conti
through the State. Its fine-grained, unstratified silt cont
remains of many terrestrial animals, including fifteen mam

MISSISSIPPI

surface and subsoil of nearly all the upland region of ppi, the southern part being the exception, is composed of loam or brick-clay containing no fossils, and showing no ation. The soil of the Rotten Limestone region is similar in eral make up, but is black, and contains more lime and Both are regarded as an independent aqueous deposit, pos- o the stratified drift and bluff formations, and anterior alluvium of the present epoch. The "second bottoms" y, are later than the yellow loam, and belong to the "terrace

The latest formation, alluvium, is strongly marked, and large area in the Yazoo and Mississippi Bottom, and along reams.

following are the equivalents of the Mississippi groups in *Geology*:

y.	20*d* Alluvium		Alluvium
	20*c* Loam and loess		Loam and Loess
	20*b* Port Hudson		Port Hudson
	20*a* Drift		Stratified drift.
	19*a* Eocene	Upper	Grand Gulf
			Vicksburg
		Middle	Jackson
			Claiborne
		Lower	Buhrstone, Co
			Hatchetigbee
			Tallahatta
	18*b*	Upper	Rotten Limestone
as	18*a*	Lower	Lombardy
			Cotton
niferous			Cretaceous

rals.—Metallic ores are not found in Mississippi in paying ies. The only valuable minerals are sandstone and lime marls, sands, lignite or brown coal, and fire clay. None o ave been extensively brought into market. Potable water almost everywhere. Artesian wells furnish it in the Rotten ne region, when bored into the underlying Cotton-stone.

a.—Mississippi affords perhaps no species which are not n the neighboring States. There are thirty or forty species *malia*, the most remarkable being the American opossum, hite abundant. The deer (*Cervus canadensis*), black bear *americanus*), wolves (*Canis lupus* and *Lupus occidentalis*), unt (*Felis concolor*), and wild-cat (*Lynx rufus*) have much ed in number, and may, like the buffalo and elk, shortly extinct. About one hundred and fifty species of birds nd during at least part of the year. Many are seen only *situ*, and about twenty species, from the north spend the here. The mocking bird (*Mimus polyglottus*), the most able songster, is very abundant. The wild turkey (*Meleagris o*) survives by virtue of its wary and watchful character. fty species of *Reptilia* have been found, prominent among is the alligator (*A. mississippiensis*), which attains a length r 15 feet, and is common in the southern river bottoms. ttlesnake, moccasin, and copperhead, venomous serpents, are ually found. About half of the sixty three species of fish ing in the fresh and salt waters of the State are valuable d. The edible oysters and crustaceans of the coast are ably fine.

z.—Originally nearly the entire State was covered with a of forest trees of large size, mostly deciduous. The under- was kept down by annual burnings by the natives, and ound became carpeted with grasses and herbs. Over 120 of forest trees are found; many valuable ones are abundant, eir timber constitutes a large item in the resources of the Of the 15 species of oak the most valuable are the live-oak *rens*), found near the coast, and the white oak (*Q. alba*), distributed. The cypress (*Taxodium distichum*) is very ant in the bottoms. Various species of hickory, the chest ack walnut, sweet gum, cucumber tree, cottonwood (*Populus s*), red cedar, elms, holly, magnolias, maples, ash, persim ycamore, tupelo, and many others valuable for their timber, ndant and of large size. The long-leaved pine (*P. australis*) the principal forest growth south of lat. 32° 15'. It attains meter of 2 or 3 feet, has a tall and shapely trunk, and its is unsurpassed in the variety of its uses. The census reports te the merchantable timber of this species now standing in ate at 18,200,000,000 feet, board measure. The amount cut 0 was 108,000,000 feet. The short-leaved pine (*P. mitis*), as valuable, is found in various parts, the quantity now ng being estimated at 6,775,000,000 feet. The total val pine timber of the State is about $250,000,000.

riculture is the leading industry in Mississippi. Over 0 of the population are directly engaged in the cultivation of 000 acres of land. The character of the soil is varied, and productive, except that in the Flatwoods region and in the t covered with long-leaved pine, where only the valleys are At least half the State is exceptionally fertile. Not more one-fourth of the arable land has been brought into culti- , and two millions of acres of the best lands in the State, in the Bottom, might be made arable by proper drainage.

ton is the chief agricultural product; in 1880 Mississippi d first among the States in the amount raised. The crop of 1879-80 amounted to 955,808 bales, worth $43,000,000. were produced also of cotton seed 28,000,000 bushels, $3,000,000; of Indian corn, 21,340,800 bushels; of oats, 1,9 bushels; of wheat, 218,890 bushels; of rice, 1,718,950 lb. quantities of rye, barley, molasses, and tobacco, and abundan of potatoes, yams, pease, and all garden vegetables, are a produced.

Fruits of various kinds flourish in many parts of the Stat with early vegetables, are largely shipped to the northern m in spring and early summer. The value of the cotton about three times as great as that of all the other prod the soil, which are sometimes insufficient for home consum Economically this specialization of agriculture is to be reg but successful efforts are being made to diversify it by g other crops to which the soil and climate are equally well su

Manufactures.—The principal articles manufactured are l cotton and woollen goods, cotton seed oil, and agricultural ments.

Population.—The number of inhabitants at each census to th date to return in 1880 is given in the following table:

				Per cent. of Increase.
	791,711		1,131,597	17
	829,209	484,549	441,069	17
	1,131,597	479,071	662,241	21

Of the colored population, mostly freedmen and their d ats, 1735 were Indians or half-breeds in 1880, and about mulattoes. The whites own nearly all the farms and oth property. The total property valuation in the State de from $607,324,911 in 1860 to $209,197,345 in 1870, one ac the losses in war and the liberation of the slaves. There h however, a rapid increase in the last decade. The towns State have small populations. In 1880 Vicksburg had 11, habitants, Natchez 7058, and Jackson, the State capital, 5,

Administration.—The three departments, legislative, ex and judiciary, are similar to those of other States. The g and other executive officers are elected for four years. Th latures, which meets biennially, is composed of forty s serving four years, and one hundred and twenty representa serving two years. These are apportioned to the seve counties according to population, and elected by the peopl judiciary officers, consisting of three justices of the supreme twelve circuit judges, and twelve chancellors, are appointed governor with the consent of the senate. One attorney and twelve district attorneys are elected by the people. Th maintains a public school system, with separate schools for races, costing in 1880 $830,704, besides a State univers other schools of high grade for each of the races.

History.—Mississippi was first visited by Europeans w when the adventurous expedition of De Soto reached its n parts. After the disastrous termination of this expedi other Europeans visited this region until 1673, when Jo Pere Marquette descended the Mississippi to lat. 33°. In Salle and Tonty descended to the mouth of the riv claimed the whole region drained by it for the king of giving it the name Louisiana. In 1699 the first colony the coast of Mississippi, sent from France under I Settlements were made on Ship Island and Cat Island, an the mainland on the eastern side of Biloxi Bay, at Bay St and at Mobile. The colony did not prosper, and in 1712 A Crozet obtained by charter from the king all the com privileges of the lower Mississippi valley. Under his man the colony languished, and in 1717 the king accepted the s of his charter, and granted another with more extended p to the "Western Company," or "Mississippi Scheme," wi Law as director-general, and Bienville as governor of the Under this management the rich alluvial lands on the Mi river began to be occupied; tobacco, rice, and indigo we vated, and African slaves were introduced. Settlements we near the present city of Natchez in 1720. Two years late company becoming bankrupt, much embarrassment in th followed, and troubles also began with the natives. On N the Natchez Indians surprised and murdered al of the white male residents, and made captives of al women and children and negroes. A war followed, resulti destruction of the Natchez tribe. The representatives "Western Company" returned their franchises to the king, the number of colonists and slaves being then about 7,000 two unsuccessful campaigns against the Chickasaw Indian northern part of what is now Mississippi. Bienville wa by the Marquis de Vaudreuil in 1740.

By the treaty of Paris, in 1763, France ceded all her po east of the Mississippi river to England, excepting the New Orleans, ceded to Spain. The British province

Florida at first extended west and from the Mississippi river along the Gulf coast, with a northern limit at the 31st parallel of north latitude. Soon afterward its northern boundary was fixed at a line drawn eastward from the point where the Yazoo river unites with the Mississippi.

Under Peter Lamb the Natchez country, which had been deserted since the revolt of 1729, and the southern part of the present State of Mississippi rapidly filled with settlers, many of them emigrants from the Atlantic colonies. Cotton, indigo, and sugar were cultivated, and negro slaves continued to be freely introduced. During the revolutionary war of the Atlantic colonies, West Florida was successively wrested and ceded until 1779. Spain and England being then at war, Galvez, the governor of New Orleans, declared his sympathies with the revolutionary colonists, took possession of the whole of West Florida for the king of Spain. At the peace of 1783 England acknowledged the 31st parallel as the southern boundary of the United States, and ceded West Florida to Spain. The district between the 31st parallel and the parallel 32° 28' on the mouth of the Yazoo was therefore claimed by the United States and by Spain, the latter being in possession. After fruitless negotiations the latter power relinquished the district in March 1798, and Congress at once formed it into "the Mississippi Territory," which extended from the Mississippi river eastward between the two above-mentioned parallels of latitude to the Chattahoochee river.

The State of Georgia claimed as a part of its domain all of the district east of the Mississippi river and between the 31st and 35th parallels. In 1802 it ceded its claim to the Federal Government for certain considerations, and in 1804 Congress extended the limits of the Mississippi Territory northward to the 35th parallel. Nearly all of the Territory was then owned by the native Indians. The Choctaws occupied the southern part, and the Chickasaws the northern part of what is now the State of Mississippi. In 1812 the United States troops occupied Spanish West Florida, and the district east of Pearl river and south of lat. 31° was added to the Mississippi Territory. The latter was divided by the present line between Alabama and Mississippi, and the State of Mississippi admitted into the Union in 1817. In 1830–32 the native tribes exchanged their land for others west of the Mississippi river, and were nearly all removed, and a rapid influx of settlers followed. In January 1861 the State seceded from the Federal Union, and joined the Southern Confederacy, furnishing a large number of troops during the civil war. It was the field of many important campaigns, and suffered great loss. Exhausted by the conflict, and harassed by processes of political reconstruction, the State was in a deplorable condition for several years. But within the last decade an era of prosperity commenced, marked by a large increase in population and great activity in agriculture and other pursuits.

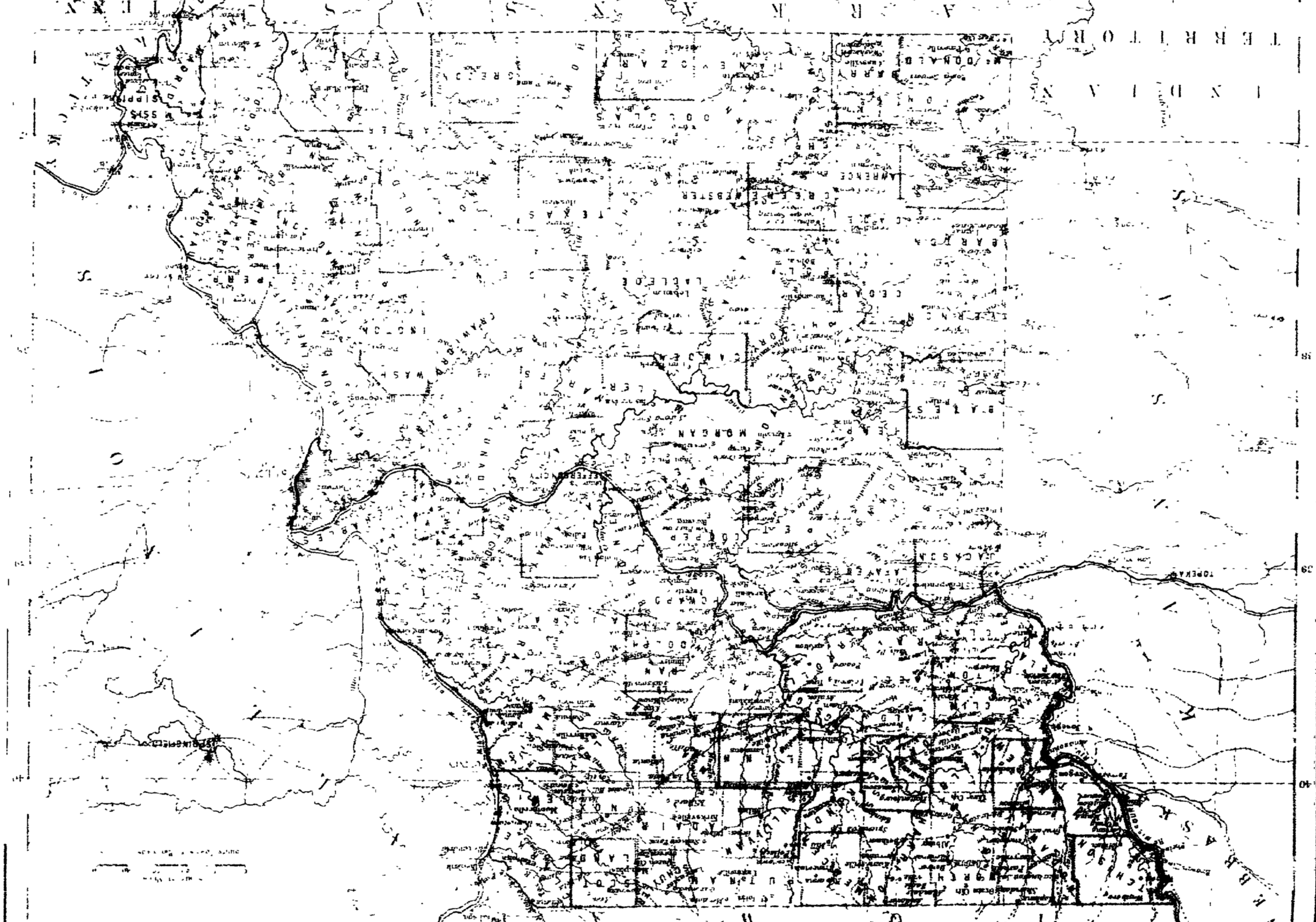
Encyclopædia; see also *Historical Collections*, Memoirs, *Bibliography of the Mississippi Valley*, New York, 1876; Claiborne, *Mississippi as a Province, Territory, and State*, 1880; Wailes, *Report on the Agriculture and Geology of Mississippi*, Jackson, 1854; Ritzema, *Statistics and Geology of Mississippi*, 1860; Smith, *Outline of the Geology of Tallahatta*, Montgomery, 1890; Wall, *Handbook of Mississippi*, 1891; etc. (E. L. D.)

MISSOLONGHI, or MESOLONGHI (Μεσολόγγιον), a city of Greece, the chief town of the nomarchy of Acarnania and Ætolia, situated on the north side of the Gulf of Patras, about 7 miles from the coast, in the midst of a shallow lagoon, with a population of 6321 in 1879. It is noted for the siege of two months which Mavrocordato with a handful of men sustained in 1821 against a Turkish army 15,000 strong, and for the more famous defence of 1825–26 (see vol. xi. p. 125). Byron died there in 1824, and is commemorated by a cenotaph.

MISSOURI, a Central State of the American Union, lying almost midway between the Atlantic and the Rocky Mountains, North America, and the Gulf of Mexico. Its eastern boundary is the Mississippi, separating it from Illinois, Kentucky, and Tennessee. North and south its boundaries with Iowa and Arkansas respectively are mainly coincident with the parallels of 40° 30' and 36° 30' N. lat., but a small peninsula between the Mississippi and St Francois rivers stretches 31 miles farther south between Arkansas and Tennessee. The western border, with Nebraska, Kansas, and the Indian Territory, is nearly coincident with the course of the Missouri to the junction of that stream with the Kansas, and then follows the meridian of 17° 10' W. of Washington (94° 43' W. of Greenwich). The area of the State is 65,350 square miles, the extreme length from north to south 282 miles, the extreme width 348 miles. Missouri is divided into a northern and southern portion by the Missouri, flowing 100 miles in a generally easterly direction its junction with the Kansas to the point 12 miles St Louis where it unites with the Mississippi. The Missouri has a surface broken and hilly, but not tainous. It is mainly prairie land, well watered by and fit for agriculture, but there is a good deal of m the eastern parts, especially along the bold bluffs two great rivers. Southern Missouri is almost divided between timber land in the east and p the west. In its south western portion rises the ta of the Ozark hill (highest point 1600 feet above The Osage, the Gasconade, and other streams flo ward and eastward into the Missouri. The south lowlands form an undulating country, readily drai ram, with gentle inclines generally running north an occasional abrupt isolated hills, forests of oak, elm, maple, ash, locust, willow, persimmon, pecan, and cherry trees, and in the lowest parts swa morasses. High rocky bluffs extend along the the Mississippi from the mouth of the Meramec Ste Genevieve, rising sometimes precipitously height of 350 feet above the water, and low bott with many lakes and lagoons extend from Ste G to the Arkansas border. The south east corne State is 275 feet above the sea, the north east 60 feet, and the north west corner 1000 feet.

Climate. The climate of Missouri, lying as it from the ocean and unprotected by mountain r one of extreme in heat and cold, moisture and The Ozark range is high enough to influence the locally but not to affect that of the whole Sta mean summer temperature for the ten years ranged from 75° in the north west of the State to the south east, but the thermometer has been know to 101°. The winter temperature averaged 3 the whole State, varying from 28° 5 in the north 39° 5 in the south east. In some winters the ten hardly falls to zero, in others 20° below zero ha registered. The Mississippi at St Louis freezes o in four or five years, but this is partly caused accumulations of floating ice coming down from th The river has closed as early as the first week in D and, again, has remained open until the last February. It is in cold seasons sometimes pass the heaviest teams. The Missouri river is ofte during the whole winter. The mean annual tem of the State varies from 53° to 58°. The clima the whole, dry; for in spite of the abundant rain ally in the spring, evaporation is so rapid that t sphere is rarely overloaded with moisture. Apr driest month. The greatest amount of rain fall south eastern part of the State. An unusual am fair weather, prevailing clearness of sky, general of soil and climate, are chief among the natural ad of this great State.

Geology. The stratified rocks of Missouri belon following divisions: Quaternary, Tertiary, Carbo Devonian, Silurian, and Archæan. The Quaternar comprises the drift, 155 feet thick; the bluff, 200 fe the drift, then the bottom prairie, 35 feet thick the surface the alluvium, 30 feet in thickness. Cl strata of sands, marls, and humus form the alluvial of the two great rivers of the State, and make up a s light, and incomparably rich. Beneath the alluvium the bottom prairie, made up also of sands, clays, a table moulds. This formation is found only in th lands of the Missouri and Mississippi rivers, a abundantly in those of the former. Numerous preserved organic remains are found in the botton



ng the shells found in great quantities in the bluff
nains of the mastodon and many trees and plants.
this formation, resting upon the drift, is the bluff.
sts upon the ridges and river bluffs, and thus is
phically higher, although geologically lower, than
ttom prairie. It is composed chiefly of a grey
s marl, coloured sometimes to a deep brown or red
stains of oxide of iron. This formation extend-
he bluffs of the Missouri from Fort Union to it-
and is found capping those of the Mississippi from
ne to the mouth of the Ohio. It is sometimes 200
ek, at St Joseph it is 140, at Booneville 100, at
is 50, in Marion county only 30 feet. The former
s interesting fossils (*Elephas primigenius*, &c.). The
he lowest of the Quaternary system, appears in the
drift, the boulder formation, made up largely of the
sand metamorphic rocks, with rock from the Palæozoic
upon which the others rest. Large boulders, some
in diameter, are found, usually of granite or meta-
e sandstone, no fossils except a few log in the altered
ave been found in this formation. The Tertiary
ion in Missouri is composed of clay shale, iron
ndstone, and sand, and extends along the bluff and
s of the south-east part of the State. Iron ores
in this formation in great abundance, and of the
ality for glass-making and clay for pottery and
are also abound. Below the Tertiary bed are found
which strongly resemble Cretaceous bed found in
places in the United States. These strata are in such
of irregularity and disturbance as to indicate the
nce of some great movements after their deposition
ore the formation of the Tertiary strata. The Upper
iferous system, or coal measures, made up of sand
limestone, marl, coal, and iron ore, cover an area
than 23,000 square miles in Missouri, occupying
tern and northern portions of the State. The supply
mineral and cannel coal found here would seem to
nigh inexhaustible. In the Lower Carboniferous
e found many varieties of limestone and sand-stone
; these are the Upper Archimedes Limestone, 200
Ferruginous Sandstone, 195 feet; Middle Archimedes
one, 50 feet: St Louis Limestone, 250 feet. The
ian system is represented by limestone in Marion,
Pike, Callaway, Saline, and Ste Genevieve counties,
which occur the Chouteau Limestone, 85 feet,
raphic Limestone, 125 feet, Onondaga Limestone,
et. Of the Upper Silurian series are the following
ions: Lower Helderberg, 350 feet; Niagara Group,
et; Cape Girardeau Limestone, 60 feet. Prominent
the Lower Silurian formations are the Trenton
one, 360 feet; the Black River and Birds Eye
one; and the Magnesian series. The last named
s valuable both in a scientific and an economic sense
ers much of the southern and south eastern portions
State, and in it are found vast deposits of lead,
opper, cobalt, iron ores, and marble. The Archæan
occur below the Silurian deposits, and contain silicious
ner slates in which no fossils are found. The porphyry
of this formation also contain iron ore.

The exposed coal in Missouri include upper, middle and
measures. In the first are about 4 feet of coal, and the area
sure is about 8400 square miles. The middle coal measures
about 7 feet of coal, and cover an exposed area of about
quare miles. The lower measures have no workable seams,
from 18 inches in thickness to 4½ feet, and also some thin
of only a few inches. In 1880 556,504 bushels of bitu-
coal were raised in thirty-five counties of Missouri, the
the pit mouth being $1,060,225. 862,772 were paid in
o 2599 persons. The Missouri coal mines are easily worked.
The iron ores are red hæmatite, red oxide, specular iron,
hæmatite or limonite, and clay ironstone. Manganiferous and
s specular ores occur in the porphyries of the Archæan rocks,
and in the granites. The greatest exposure of specular iron
covered is Iron Mountain, the pure mass or body of iron ore
Analysis shows it to contain from 65 to 69 per cent. of metall
The ore of Shepherd Mountain is not so rich as that of Iron
tain, but is uniform in character, free from sulphur and pho
acid and on the whole superior to any other yet developed in M
Pilot Knob ore gives 53 to 60 per cent. metallic iron, and
deleterious substances. It is fine grained, light brush
colour. The ore of the Scotia iron beds and Iron Rangers are
like in appearance and character, being peculiar boulders m
of red hæmatite. In one of the boulders are cav
which the ore has taken botryoidal form, and upon these pe
stalactitic crystallizations are formed that a gorgeous show of pr
colours is presented. The above are the best deposits of ir
Specular hæmatite are found mostly in the southern part of the
The counties of Ste Genevieve, Madison, St Francois, Cape
deau, Bollinger, Wayne, Stoddard, Washington, Reynold
Iron, Carter, and Ripley have the greatest deposits of the
although they are found in many others. The supply of
is indeed, practically inexhaustible.

Lead stands second only to iron among the metals of Mi
Next to deposits of lead found in the southern part of the State
great lead-bearing region occupies about one-half of the
ern portion of Missouri, and about a quarter of St Francois
But in the mineral region lies some of the largest quantities
been found. In Franklin county galena is found in associa
fossiliferous clay and coarse gravel. In the great mineral
in Washington county a
pound of lead were found

State
copper, Moore and Mc , Mille Bollinger, Ma
Oregon, the southern lead region, the counties of Perry,
Texas, Wright, Webster, Douglas, Howell, and Oregon
western lead-district include the counties of Hickory, Polk
St Clair, Cedar, and Dade; the south-western, the coun
Jasper, Newton, Lawrence, Barton, Barry, and McDonald
two counties, Jasper and Newton, produce fully one-fifth of
lead of Missouri. The lead mines of Granby are among t
known in the State, and millions of pounds of lead have been
from the district.

Copper deposits have been found in several counties
the south western part of the State. *Zinc* is found in the
sulphuret and also in the state of ore, principally in the
south-western Missouri. Both are often found in
sociation, but not in sufficient quantities to induce operations
when railroad facilities have given to the ore a market even
a nearer locality. Barytes is also important and productive
of the lead mines of Missouri. *Cobalt* and *nickel* are found
La Motte and in a few other places. *Silver* is found in small
quantities in lead mines in Madison county, combined with the
Coal for the manufacture of ordinary household fuel, and
and for the local export or consumption, beyond comparison
Laclede has been found in a few places. *Marble* of various
and quality abounds in Missouri, and is important as
mineral wealth. *Limestone* and suitable for
purposes are found in nearly part
Indian Corn Indian corn, which
product, but cotton, tobacco, and
in the southern counties. The
of 30 bushels, and their
of a higher quality or more in demand in Europe than
market than their
especially as
and red and white
and the
a very profitable
carefully cultivated. The more tender fruits, such as
farmers, figs, and nearly every kind of vegetables grow
the more northern fruits, the apple, the pear, the plum
cherry. Apples and pears
native varieties of grapes are found in luxuriant growth
cultivated vines have been
not even Catawba, can hope ultimately to rival Mi
production of both red and white wines. Sheep farming
remunerative in the southern counties, chiefly where the
mate, the fine grass, and the abundance of good water
favourable to this branch of agricultural industry. The
Missouri in round numbers, 10,000,000 acres of
13,000,000 of unimproved land, including 9,000,000 a
land. The cash value of the farms is estimated at
In 1880 there were on the farms in the State 607,
192,027 mules and asses, 9020 oxen and 10 cows, 1,110,
cattle, 1,111,298 sheep, and 1,653,123 swine. Missouri
maize producing State of the Union, it applies more
any State except California and is a rival of Kentucky
Tennessee, and Maryland in the culture of tobacco. W

the rich counties in the northern central part of the ordering upon the Missouri river. No State raises so ules, asses, and hogs. The production of cereals in 1880 n, 202,185,723 bushels; wheat, 24,966,627 bushels; rye, u-hels, oats, 20,670,958 bushels; barley, 123,031 bushels; at 57,840 bushels. The production of tobacco for the same , 12,015,647 lb from 15,521 acres, valued at $600,256. arts of this amount was raised in Chariton, Marion, e, Howard Callaway, and Saline counties.

Forests. Red-deer are found in every part of the State, n the thinly-settled and mountainous districts. Venison, n season, is as cheap as good beef in the markets of St Wild turkeys are numerous in the swampy and mountainous and are found in all parts of the State. Prairie chickens, ed grouse, are found in the prairie portion of Missouri and ed in great numbers to Eastern markets. In all parts of are found the quail or Virginia partridge, thousands of which are shipped from the State each season. The s or crows of both species are to be considered a pest. squirrel and the red fox-squirrel are also found in large all over the State. Black bass, perch, catfish, buffalo r, and pike are the leading varieties of native fish.

Industries. In 1880 Missouri had about 20,000 manufacturing establishments, in which a capital of about $125,000,000 was d. The products of these establishments were valued at of $300,000,000. The leading manufacturing counties the city of St Louis are Jackson, Buchanan, St Charles, Franklin, Greene, Cape Girardeau, Platte, Boone, and but more than three-fourths of the manufactures are at St Louis, which is the fourth manufacturing city of n. The chief manufacture is that of flour, which employs 0 mills, and is rapidly increasing. Twenty-four mills made in 1880, 2,112,949 barrels of flour, having a daily outmore than 11,000 barrels. St Louis millers and dealers 880 to Europe and South America 619,103 barrels of flour; e world's fairs at Paris, Vienna, and Philadelphia, Missouri ved the first award. The iron industry, which finds second ance, is yet only in its infancy, and St Louis seems destined of the great centres of iron and steel manufacture. The of iron made in Missouri in 1880, in twenty-two establishploying 3139 hands, was 176,758 tons. St Louis made the 102,051 tons of pig iron, steel, and rolled iron and blooms. ly values of a number of other industries are estimated as meat packing $29,000,000, tanning, $10,000,000, bags ing, $7,000,000, shoes, $6,000,000, coal, $6,000,000; and publishing, $5,000,000, furniture, $5,000,000, car nd waggons, $4,500,000, marble and stone, $4,000,000, et, and lead iron, $4,000,000, agricultural implements, 00. The manufacture of plate glass is carried on derable extent, especially in St Louis. At Crystal City, Mississippi, 30 miles below St Louis, is a very large of land suitable for the manufacture of plate glass, and a been organized and is now in successful operation, apital of $1,000,000.

The extensive commerce of Missouri centres at St tween which city and the ports on the Mississippi and river steamboats are constantly plying. Railroad transin recent years, furnished additional and cheaper for much of the trade which formerly depended upon the trade in cotton especially has been greatly increased since 1870 by the use of railroad transportation, which ent one of the great cotton centres of the United ive cotton presses were built in St Louis in that ceipt of cotton from the more southern States, by ly from 12,261 bales in 1869–70 to 157,563 bales in Iron connections have made the interior portions of Texas more accessible to St Louis than to the ew Orleans merchant, and the trade with the south-west ern Mexico is constantly increasing. In 1875 ade by Act of Congress a port of entry to which ould be brought in bond. The value of the ports ending 30th June 1882 was $1,933,312.

Missouri is divided into 114 counties. The following number of inhabitants since 1850:

			Density per square mile
		682,044	11·37
50	682,291	1,182,012	18·08
0	896,314	1,721,295	26·31
0	1,147,187	2,168,380	33·15

50 the foreign born residents numbered 211,578, or 9·7 per whom 109,974 were Germans and Scandinavians, there 145,046 of African descent. The early settlers of the State were French, and their descendants are still found in St Louis a Ste Genevieve and a few other smaller towns. Many Germans ha recently settled in all parts of the State, while English, Irish, Scot and Swedes have also made Missouri their home in considera numbers. The native American population is mostly descend from immigrants from the States of Kentucky, Tennessee, No Carolina, and Virginia. During recent years there has been a la accession to the population from the eastern and north-west States.

St Louis, the chief city of the Mississippi valley, situa upon the Mississippi river about 12 miles below the mouth of Missouri, has a population of 350,518; Kansas City, a thriv town on the western border, situated on the banks of the Missou has 55,785; St Joseph, in the north-west, has 32,431; Hannib in the north-east, has 11,074; and Jefferson City (the State capita in the centre, has 5971.

Education. Missouri has a public school system of educat first adopted in 1839. There are district schools, elementary a ungraded; city schools, graded, with high school courses; f normal schools and a State university. Free public schools white and coloured children between the ages of six and twe years are required by law for every district in the State. Besi these public institutions supported by the State there are ma private schools and colleges for both sexes. Chief among these the St Louis University, an institution managed by the Jesu the College of Christian Brothers, also under the control of Roman Catholics, and Washington University, a non-sectarian dowed school, whose property estimated at $1,000,000, more than 1500 students. The Baptists have a college at Libe called William Jewell College, the Congregationalists one at Spri field called Drury College, and the Methodists and Presbyteri several colleges and seminaries.

Religion. The early settlers of Missouri were Roman Cathol and in the river towns may be found to-day a large number of t faith. The Baptists have 88,999 members, with 1385 church the Methodists, 96,270 members and 913 churches; the Protest Episcopal Church, 25,000 members and 65 church buildings; Presbyterians, with their various branches, 34,628 members and churches.

Administration. The legislative power is vested in a body c sisting of a senate and a house of representatives, which me once in every two years, on the Wednesday after the first day January next after the election of the members thereof. Memb of the legislature receive a sum not to exceed $5 a day for first seventy days of the session, and after that not to exceed $ day for the remainder of the session. They are also allowed m age. The executive department consists of a governor, a l tenant-governor, a secretary of state, a State auditor, St treasurer, an attorney-general, and a superintendent of pu instruction; these are all elected by the people. The supre executive power is vested in the governor, who is chosen for years, and also are the other members of this department. governor has a qualified veto upon the acts of the legislature, such other powers as are common to that officer in the sev States. The judicial power of the State is lodged in a supre court, the St Louis court of appeals, circuit courts, crimi courts, probate court, and municipal courts. All judicial offi are elected by the people. Judges of the supreme court are elec for ten years, those of the St Louis court of appeals for two years, those of the circuit courts for six years. Executive judicial officers are liable to impeachment by the house of re sentatives. All impeachment cases are tried by the senate.

Every male citizen of the United States, and every male per of foreign birth who may have declared his intention to becom citizen of the United States, according to law, not less than one nor more than five years before he offers to vote, who is o the age of twenty-one years, is entitled to vote at all elections the people if he has resided in the State one year immedia preceding the election at which he offers to vote, and has resi in the county, city, or town where he shall offer to vote at l sixty days immediately preceding the election.

History. On the 9th April 1682, the French voyager and explorer La Salle took possession of the country of Louisiana in name of the king of France. Its limits were quite indefinite, and included the present territory of Missouri (see LOUISIANA). The settlements of Missouri were made in Ste Genevieve and at Bourbon, but uncertainty exists as to the exact date. By s the year is fixed at 1763; by others, and by many traditions early as 1735. St Louis was settled by Pierre Laclede Liguest native of France. The site was chosen in 1763, and in Febru 1764 Auguste Chouteau went at the order of Liguest to the previously selected, and built a small village. For a long t the settlements were confined to the neighbourhood of the ri On the 31st of October 1803 the Congress of the United St passed an Act by which the president was authorized to possession of the territory according to the treaty of Paris, and formal transfer of Lower Louisiana was made on 20th Decem

In 1804 Congress divided the territory into two portions. rthern part, commonly called Upper Louisiana, was taken on of in March 1804. In June 1812 Missouri was organ- a Territory, with a governor and general assembly. The overnor (1813-1820) was William Clarke. In 1818 i applied for admission to the Union as a State. Two bitter controversy followed, which convulsed the country eatened the dissolution of the Union. This controversy l a resolution introduced into Congress which had in view slavery restriction upon the admission of Missouri to the This was at last settled by the adoption of the "Missouri mise," which forbade slavery in all that portion of the Louisa chase lying north of 36° 30' except in Missouri, and on ly 1820 Missouri was admitted to the Union. A conven- frame a constitution had already been called, and the ution then adopted remained without material change until The first general assembly under the constitution met in is in September 1820, and Alexander M'Nair was chosen r in August. The seat of government was fixed at St in 1820, and removed to Jefferson City, the present State in 1826. The first census of the State was taken in 1821, e number of inhabitants was found to be 70,617 of whom were slaves. In the Black Hawk war in 1832, the Florida 1837, and the Mexican war in 1846 Missouri volunteer ld their share of the work. In the troubles in Kansas and ter discussion upon the question of slavery, Missouri was nvolved. A strong feeling in favour of secession showed many parts of the State. Governor Jackson, in his al address on the 4th of January 1861, said that Missouri and by the slaveholding States, whatever might be their The election of a majority of Union men, however, a s to a convention called to consider the affairs of the showed that public sentiment was hostile to secession, and nvention adjourned without committing the State to the n party. United States troops were soon gathered at St and forces were also sent to Jefferson City, and to Rolla r Jackson fled from the capital, and summoned all the roops to meet him at Boonville. General Lyon defeated roops, 17th June 1861, and soon most of the State was he control of the United States forces. The State convention reassembled. This body declared vacant the offices of r, lieutenant-governor and secretary of state, and filled y appointment. The seats of the members of the legislature so declared vacant. Governor Jackson soon issued a proclamation declaring the State out of the Union, and Confederate were assembled in large number in the south western part State. General Lyon was killed at the battle of Wilson's ear Springfield, and General Fremont, commanding the ent of the west, decreed martial law throughout the State. ar matters were favourable to the Confederates, and at the of 1862 their troops held nearly half the State; but in y a Federal force under General Curtis drove General Price kansas. He returned in 1864, and overran a large part of te, but was finally forced to retreat, and but little further arose in Missouri during the war. Missouri furnished to ted States army during the war 108,773 troops. In 1865 onstitution was adopted by the people. In 1869 the XV nent to the United States constitution was adopted by a large y. In 1875 still another State constitution was drawn up nvention called for that purpose, and ratified by the people, ow the fundamental law of the State. (M. S. S.)

STLETOE[1] (*Viscum album*, L.), a species of *Viscum*, family *Loranthaceæ*. The whole genus is parasitical, venty-six species have been described; but only the oe proper is a native of Europe. It forms an ever- ush, about 4 feet in length, thickly crowded with) dichotomous branches and opposite leaves. The are about 2 inches long, obovate-lanceolate, yellowish the dioecious flowers, which are small and nearly same colour but yellower, appear in February and ; the fruit, which when ripe is filled with a viscous nsparent pulp (whence birdlime is derived), is always white, but there is said to be a variety with it. The mistletoe is parasitic both on deciduous and en trees and shrubs, and "it would be difficult to say on what dicotyledonous trees it does not (Loudon). In England it is most abundant on the tree, but rarely found on the oak. The fruit is ea most frugivorous birds, and through their agency, p larly that of the thrush (hence missel-thrush or thrush), the plant is propagated. (The Latin prove it that "Turdus malum sibi cacat"; but the sow really effected by the bird wiping its beak, to wh seeds adhere, against the bark of the tree on which alighted.) The growth of the plant is slow, and it bility proportionately great, its death being dete generally by that of the tree on which it has esta itself. See Loudon, *Arboretum et Fruticetum Britan* vol. ii. p. 1021 (1838). The mistletoe so extensive in England at Christmas tide is largely derived fr apple orchards of Normandy.

Pliny (*H. N.*, xvi. 92, 95, xxiv. 6) has a good deal to te the *viscum*, a deadly parasite, though slower in its action t He distinguishes three "genera." "On the fir and lar what is called *elate* in Eubœa and *hyphear* in Arcadia." called *drymos hyphear* is most plentiful on the esculu (quercus), but occurs also on the robur, *Prunus sylvest* terebinth. Hyphear is useful for fattening cattle if they a enough to withstand the purgative effect it produces; a vescum is medicinally of value as an emollient, and in tumours, ulcers, and the like; and he also notes it "con feminarum aduvare commune cum habeant." Pliny's authority for the reverence in which the mistletoe when growing on the robur was held by the Druids. The robur, is their sacred tree, and whatever is found growing upon regard as sent from heaven and as the mark of a tree ch God. Such cases of parasitism are rare, and when the attract much attention (est autem id rarum admodum in repertum magna religione petitur), particularly on the si of the) moon, with which their months and years and, a lapse of thirty years, their "ages" begun. Calling it in th language "all heal" (omnia sanantem), after their sacrif banquet have been duly prepared under the tree, they bi two white bulls whose horns are then for the first time The priest clothed with a white robe ascends the tree, c mistletoe with a golden hook, it is caught in a white They then slay the victims, praying God to prosper His gift unto whom He has given it. Prepared as a draught, it is cure for sterility and a remedy for poisons. The mistleto also in Scandinavian legend as having furnished the ma the arrow with which Baldur (the sun-god) was slain by t god Hoder. Most probably this story had its origin in a p theory as to the meaning of the word mistletoe.

MITAU (the Lettish Jelgava), a town of Russia, of the government of Courland. It is situated 2 by rail to the south west of Riga, on the right bank river Aa, in a fertile plain which rises only 12 feet sea level, and which probably has given it name to th (*Mitte in der Aue*). At high water the plain and son also the town are inundated. Mitau is surrounde canal occupying the place of former fortifications. A canal was dug through the town to provide it with but this now receives the sewage, and water is bro cars from a distance of 3 mile. Though so nea Mitau has quite a different character. It has broad streets, bordered with the low pretty man the German nobility who reside at the capital of C either to enjoy the social amusements for which M renowned or to provide education to their children. is well provided with educational institutions. A nasium occupies a former palace of the dukes of C and has a rich library; and there are about ten schools. The town is also the seat of a society of literature, of a natural history society, which has local museum, and of the Lettish Literary Society. castle of the dukes of Courland, which has witne many conflicts, was destroyed by the Duke Biro erected in its place a spacious palace, now occupied governor and the courts. Mitau has 22,200 inha mainly Germans, but including also Jews (about Letts (5000), and Russians. Manufactures are few

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[1] Gk. ἰξία or ἶξός, hence Latin *viscum*, Italian *vischio* or *vi co*, nch *gui*. The English word is the Anglo-Saxon *mistelltan*, e *mistelteinn*, in which *tan* or *teinn* means a twig, and *mistl* associated either with *mist* in the sense of fog, gloom, because ominence of mistletoe in the dark season of the year, or with root in the sense of dung (from the character of the berries pposed mode of propagation).

ght iron ware and of white lead being the most im . The river Aa being Mitau in connexion with the f Riga, small vessels carrying goods to the amount t £150,000 a year.

is supposed to have been founded in 1266 by the grand- Count of Mecklenburg. It has often changed its rulers. In on of it was plundered by Lithuanians, it was already an t town. In 1601 it became the residence of the dukes of Prussia the 17th century it was thrice taken by the ians, removed it with Courland in 1795. At the be of the century it was the residence of the count of ahrwald from XVIII. In 1812 it was taken by ch.

ITCHEL, Ormsby Mckinght (1810–1862), American and writer on astronomy, was born in Union county, ky, August 28, 1810. He began life as a clerk, aining an appointment to a cadet-ship at West Point , he graduated there in 1829, and became assistant or of mathematics in 1833. Subsequently he was to the bar, but for ook law to become professor of ics and natural philosophy at Cincinnati college. e established an observatory, of which he became From 1859 to 1861 he was director of the observatory at Albany. He took part in the war nder several of volunteers, and for his skill and in seizing certain important strategic points was l 11, 1862, made major-general. He died of yellow t Beaufort, South Carolina, October 30, 1862. making important improvements on several astrono instruments, Mitchel was the author of several works onomy, the principal of which are *The Planetary ellar Worlds* (1848) and *The Orbs of Heaven* (1851). *mour* by Headley (1865).

CHELL, Sir Thomas Livingstone (1792–1855), an explorer, was a son of Mitchell of Craigend, shire where he was born June 16, 1792. From to the end of the Peninsular War he served in rton's army, and for his services received the medal clasps, and was raised to the rank of major. He pointed to survey the battlefield of the Peninsula, map of the Lower Pyrenees is still admired. In was appointed deputy surveyor-general, and after surveyor-general of New South Wales. He devoted to the exploration of Australia, making four ons for that purpose between 1831 and 1846. these expeditions he discovered the Peel, the the Gwyder, and other rivers, traced the course Darling and Glenelg, and was the first to pene to that portion of the country which he named ia Felix. His first expedition was mainly devoted discovery of a route between Sydney and the Gulf ntaria, and during the journey he explored the Down, and discovered the Balonne, Victoria rd and other streams. In 1838, while in England, ll published the narrative of his first three journeys *Tropical Australia, with the Interior of East Australia* (2). In 1839 he was knighted and made a D.C.L. of During this visit he took with him some of the cement of wool and the first diamond found in the . In 1848 the narrative of his second expedition blished in London, *Journal of an Expedition into rior of Tropical Australia*. In 1851 he was sent rt on the Bathurst gold field, and in 1853 he again England and patented his boomerang propeller for s. He died at his residence at Darling Point, , October 5, 1855.

the above works, Mitchell wrote a book on *Geographical and Descriptive Memoranda*, 1844; an *Introduction to Geography*, and a on of the *Lusiad* of Camoens.

E. Mite (*Acarus*) are minute creatures which large division of the *Arachnida*, distinguished by the absence of any constriction between the cephalo and abdomen. Linnæus included all in the single *Acarus*. They are now divided into several families (containing numerous genera), viz., *Trombidiida* (harvest mites), usually scarlet specks seen running on stones, grass, &c., in hot weather; *Tetranychi*, which, although not bright red, are the red spider of our greenhouses, and are distinguished by feet with knobbed hair; *Bdellidæ*, long-snouted mites with antenniform palpi; *Cheyletidæ* (fig. 1), the so-called book mites, tenacious, predatory little beings, quite uncon nected with book; *Hydrachnidæ*, freshwater mite swimming bees, mostly beautiful creatures of b colours; *Limnesiadæ*, crawling freshwater or mud *Halacaridæ*, chiefly marine; *Gamasidæ*, hard-skinned mites often parasitic on insect, and best known females, and young of both sexes, found on the c during beetle (*Geotrupes stercorarius*); *Ixodidæ*, th ticks, not to be confounded with the sheep tick, &c.

Fig. 1.—*Cheyletus flabe*

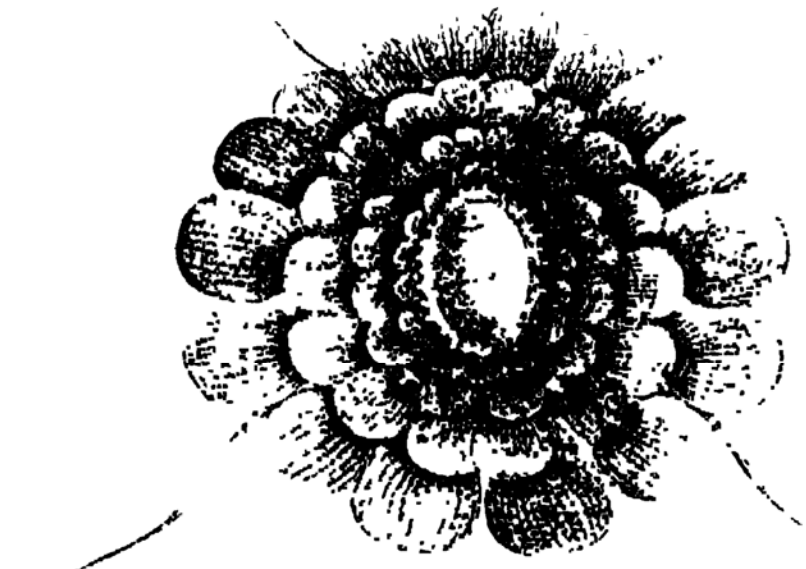

Fig. 2. *Leosoma palmicinctum*, nymph.

are wingless flies; *Oribatidæ*, beetle mites, so calle their resemblance to minute beetles (these are parasitic, they undergo transformations almost as as those of insects, many of the immature forms quaint and beautiful, see fig. 2); *Hydrodromidæ*, bizarr site of the mouse, &c., with peculiar holding *Tyroglyphidæ*, the cheese mites; *Analgidæ*, found feathers of birds; *Sarcoptidæ*, the itch mites; *Arctis* the water bears; *Demodicidæ*, found in the sel follicles of the human nose, &c.; and *Phytoptidæ*, t mites, which attack the leaves of plants, making ti like excrescences.

The sexes are distinct individuals, the reproduc oviparous, the larva is almost always hexapod, thou later stages have eight legs, that answering to the insects is active, and is called the nymph. The br in the first named eleven families is tracheal, the pos the stigmata varying greatly; in the last-named six f it is by the general body surface. No heart or circula the blood is known to exist, the alimentary canal is somewhat on the insect type, but with cæcal prolon to the stomach, the reproductive organs often more crustacean type. There is generally a single ver nerve ganglion above the œsophagus, sending nerve-b to the various parts. The legs have ordinarily

oints, rarely three, the feet are usually terminated
rs or suckers, or both, sometimes by bristles. The
les are generally large, often nest chelate (like a
s claw), sometimes style like piercing organs, and
r forms. The maxillæ vary much: they may be
g or crushing organs, or may coalesce to form a
ry lip; there is usually one pair of maxillary palpi,
ers. Sometimes there is a lingua, and in the
ida a galea. Antennæ are not found.
s are distributed all over the known world. They
een found in Franz Josef's Land and Spitzbergen
the hottest tropical regions, as well as the temperate
Often very similar species come from all parts.
re numerous in amber of the Tertiary epoch.
best-known species are probably those which injure
his works, viz., the itch mite, the cheese mite, the
d harvest-bug, and the red pider. The dog tick
well known.
itch mite (*Sarcoptes scabiei*, fig. 3) is a minute almost
, flattened, colourless creature, with skin covered
avy wrinkles, and a number of transverse pointed
from that of the back by a short, the two front
nd the fourth pair in the male terminated by suckers,
stalks, the two hind
n the female and third
the male having long
, instead. It is para
man beings, the male
oung remain chiefly on
rface of the skin, but
ieult to find, the female
s under the scarf-skin,
the intense itching
ies by the action of
elate mandibles as she
her way. A small
pustule is raised near
the acarus has entered
kin, and other signs
eature is not found in
stule, but at the further

Itch Mite (*Sarcoptes scabiei*).
After Megnin.

a short tunnel which may be half an inch long. The
re laid in the tunnel after the acarus has passed,
atch and multiply rapidly. The disease can be
ly cured; the usual mode is to rub the whole body
ulphur ointment, which is best done after a warm
llow it to remain on all night, and wash off in the
ng. This treatment should be repeated once or twice
rvals of a day or two. Other applications of sulphur,
hurous acid, sulphur vapour baths, &c., are efficacious.
thes which have touched the skin must be disinfected
t. The disease is highly contagious. Most mammals
heir peculiar varieties of itch mite.
cheese mite (*Tyroglyphus siro*) is an elliptical, fat
, colourless acarus with smooth skin and very long
It breeds in thousands in old cheese, flour, grain, &c.,
es much damage. There are numerous allied species
belonging to the genus *Glyciphagus* are elegantly
ented with plumes or leaf-like hairs.
red-spider (*Tetranychus telarius*) attacks the leaves
ats or trees, and is a great pest in greenhouses. It
a slight web on the surface of the leaves, and lives in
nies on the web; it is of a rusty red or brown.
harvest bugs, thought by some writers to be a
, and by them called *Leptus autumnalis*, are simply the
of several species of *Trombidium*. They are predatory,
ll attach themselves temporarily to the human skin,
oduce the violent itching felt on the lower parts of
gs after walking through dry grass in autumn. On
tion with a glass the creature may be seen as a
minute scarlet point. A drop of benzine will probably
rid of the intruder.

The dog tick, like the harvest-bug, is not really par
on mammals, though it attaches itself temporarily
ordinary food may probably be vegetable. (A. D.)

MITFORD, Mary Russell (1786–1855), born at
ford, Hampshire, on the 16th of December 1786,
an honourable place in English literature as the auth
of *Our Village*, a series of sketches of village scen
characters unsurpassed in their kind, and after
century of mutations as true as they had been y
yesterday. Washington Irving was Miss Mitford's
model, but her work is thoroughly original and pecul
the free outflow of a singularly charming character.
short account of her life would be incomplete wit
reference to the scapegrace father who was the ob
her affection, and the Scotch beggar-girl to all that
delightful and characteristic in her writings. Dr. M
first spent his wife's fortune in a few years. Then he
also in a few years the greater part of £20,000 wh
daughter drew on 1797, at the age of forty-two, a pri
lottery, then he lived, for more years, on the
small remnant of his fortune and the proceeds
daughter's literary industry. In the little village of
Mile End, near Reading, in a small cottage whic
Mitford gave way at times before an accumulation
doctor was the daily support and admiration of
looters in the neighbourhood, while his daughter, w
called herself his mamma, and treated him as her lit
from the time when she was herself a little girl, fo
infantine charm in her "tricking," and was the
slave of all his good humour and caprices. The fath
fresh in his daughter the keen delight in nonsen
the lively sympathy with self-willed wayward ardour
and the womanly tolerance of many weaknesses which
many of her heroines of character. The scenes wh
the close attendance on each other's wishes denied
holiday invitations because he could not live with
and worked methodically for him except when she la
her work to read him the political newspapers, ev
wrote from the heart as her brightest portraits
characters as the Talkative Lady, the Tall Man
Jack Brent, Jack Ripley, Tom Cooksley, Lucy Lu
Harriet. Her writings have all the charm of pe
unaffected spontaneous humour, connected with qui
and exquisite literary tact. She died on 10

Mr. Mitford's youthful relations with [illegible]
[illegible] of education we [illegible]
Coleridge in Sept. [illegible] W[illegible]
to be reviewed by Scott in the [illegible]
[illegible] *Edinburgh* [illegible]
[illegible]
Yard, the *[illegible]*
[illegible] tones [illegible] of quaint [illegible]
[illegible] of the [illegible] appointed [illegible]
[illegible] third to [illegible] [illegible] of the [illegible]
[illegible] novel in w[illegible]
[illegible] of 1835. Her [illegible]
in 1870 and [illegible]
for two volumes [illegible]
[illegible]

MITHRADATES, or as it is often written
Mithridates, "given by the god Mithra," a
favourite name of the Pontic kings, in the three
centuries B.C., and was also common in the
neighbouring countries. The dynasty of Pontus
Persian family, claiming descent from the Achæm
and the earliest of them known to history was
under the Persian empire. When that empire was de
Mithradates II. made himself king of Pontus, and
his successors gradually spread their power over

of Cappadocia and Paphlagonia. Several of them rmarried with the Seleucidæ and other Greek royal ilies, and something of the Hellenic civilization was rafted on the native non-Hellenic character of the gdom. The names Mithradates, Pharnaces, and Ariobar- es, all non-Hellenic, alternate in the family. The pro- ce of Phrygia was sold in the most scandalous way by Roman consul Aquillius to Mithradates V., who died bably in 120 B.C. He was succeeded by his son hradates Eupator, sixth of the name, one of those arkable conquerors that arise from time to time in the t. He was a boy when his father died, and for seven lived the wandering life of a hunter pursued by s. His courage, his wonderful bodily strength and , his skill in the use of weapons, in riding, and in the e, his speed of foot, his capacity for eating and drink and at the same time his quick and penetrating llect, his wonderful mastery of twenty-two languages, hese qualities are celebrated by the ancients to a degree ch is almost incredible. With a surface gloss of Greek ation, he united the subtlety, the superstition, and the nate endurance of an Oriental. He was a virtuoso, collected coins, gems, and works of art, he assembled ks, men of letters round him; he gave prizes to the test poets and the best cooks. He spent much of his e in practising magic arts, the interpretation of dreams, other superstitious ceremonies; and it was believed he had so saturated his body with poisons that none ld injure him. He trusted no one: he murdered his rest relations, his mother, his sons, the sister whom he married, to prevent his harem from falling a trophy his enemies, he murdered all his concubines, and his t faithful followers were never safe. He once dis- ared from his palace, no one knew whither, and rned after some months, having wandered over all Asia or in disguise. Except in the pages of romance or the s of the *Thousand and One Nights* it would be difficult nd anything to rival the account given of Mithradates he gravest of historians. These qualities fitted him to e opponent of Roman arms in Asia Minor, to be the mpion of the East in its struggle against the destroying yet crushing power of the West. He resisted the ans for eighteen years, yet we can hardly credit him much real generalship or organizing power. He l collect masses of men and hurl them against the an legions; everything that boundless energy and dless hatred could do he did; but the strength of his tion to the Romans lay in the fact that all the deliber- worst and most cruel time of her war was yet on his side.

collection took place between the Romans and ctor for thirty-two years, though the republic took Bithynia from him in 120 B.C., and several times orted to Sinope in Paphlagonia and Cappadocia ruptures occurred about the time of the Social War hradates encouraged it is said, by envoys from the Italian , to foment disorder in the mainland struggles in Italy. broke out at last on the ostensible cause of disputes t the kingdoms of Bithynia: Mithradates rapidly ran Galatia, Phrygia and Asia, defeated the Roman es, and made a general massacre of the Romans ent in Asia. He despatched large armies into European ce, and his general occupied Athens. But Sulla in ce and Fimbria in Asia defeated his armies in several es, the Greek cities were driven to revolt by his severity, in 84 B.C. he concluded peace, abandoning all his con- s, surrendering seventy ships, and paying a fine of talents. Murena invaded Pontus without any good on in 83, but was defeated in 82. Difficulties con- ly arose between the two adversaries, and in 74 a general war broke out. Mithradates defeated Cott of the Roman consuls, at Chalcedon; but Lucullus w him in several engagements, and drove him finally B.C. to take refuge in Armenia with his son-in-law Tig After two great victories in 69 and 68, Lucullus w concerted by mutiny among his troops and the de his lieutenant Fabius (see vol. xv. p. 56). In 66 superseded by Pompey, who completely defeated Mithradates and Tigranes. The former establishe self in 64 at Panticapaeum, and was planning campaigns against the Romans when his own revolted, and, after vainly trying to poison himse ordered a Gallic mercenary to kill him. So perish greatest enemy that the Romans had to encounter i Minor. His body was sent to Pompey, who buried the royal sepulchre at Sinope.

MITHRAS was a Persian god whose worship over the Roman world during the 2d and 3d cen after Christ. His name is found in the oldest rec the East Aryan races. In the Rig Veda, Mitra, *i.e.* friend, and Varuna, *i.e.*, *Οὐρανός*, are a pair of gods reg associated they denote the heaven of day and the of night. Mithras is therefore by origin the god bright heaven and of day, closely related in concepti and yet expressly distinguished from, the sun. developed Old Persian religion of Zoroaster Mithras re a place, he was not one of the greatest gods, bu first of a triad which, while less pure embodiments divine nature, were more easy for men to comprehen to worships. The seventh month, which bears his nam the sixteenth day of every month were sacred to Mi prayers were offered to him at sunrise, at mid-day at sunset. When the Persians conquered Assyri Babylonia their religion was much affected by the w of these more educated races. The worship of f deities was introduced, that of Persian deities was ch in character, and the gods were represented by i The cultus of Mithras now became far more prominе was identified with the sun, and an elaborate ritua the non-Aryan accompaniment of mysteries was establ This revolution had become before Herodotus (*i.* 131) identify Mithras with the Assyrian goddess Mylitt it became more thorough during the 4th century B.C

It is in this most developed form that we kno cultus of Mithras. The god of light becomes by a translation, which is made in the very oldest Aryan re the god of purity, of moral goodness, of knowledge. goes on in the world as a whole, and in the life o man, a continual struggle between the power of goo the power of evil, Mithras is always engaged in thi test, and his religion teaches all, men and women ali and in the battle. Victory in this battle can be g only by sacrifice and probation, and Mithras is con as always performing the mystic sacrifice through the good will triumph. The human soul, which has separated from the divine nature and has descend earth, can ascend and attain union with God thro process of purification and penance which is taught i mysteries, the sacrifice which is being always offer Mithras makes this ascent and union possible. who were initiated in the mysteries of Mithras had to through a long probation, with scourging, fasting, ordeal by water, and were then admitted as soldiers fig on behalf of Mithras. This was the lowest terre grade, but there were still two others to attain, the and the Lion, each involving further probation, befor soul could rise above the earth. It then ascended t grades of Vulture, Ostrich, and Crow through the r of aether; and then it strove to become pure fire th the grades of Gryphon, of Perses, and of the Sun. F

l attained complete union with the divine nature
the grades of Father Eagle, of Father Falcon, and
ner of Fathers. A holy cave on a hill was the
point in the worship; and the mystic rites involved
g and fasting all night till sunrise brought the
n of light.

worship of Mithras became known to the Romans
the Cilician pirates captured by Pompey about 70
t gained a footing in Rome under Domitian, was
ly established by Trajan about 100 A.D., and by
olus about 190. Finally the mysteries were pro
and the holy cave destroyed in 378. Dedicatory
ions to *Deo Soli Invicto Mithræ*, and votive reliefs
an work, are very common. The usual representa
ows Mithras in the mystic cave performing the
sacrifice; a young man in Oriental costume kneels
e knee on a prostrate bull, grasping the head and
it back with the left hand, while with the right he
s his sword into its neck. A dog, a snake, and a
n drink the blood that flows from the bull's wound
the rock behind Mithras; the figures of the sun
the moon occupy the two sides of the relief.

ajarde, *Recherches sur le Culte de Mithras*.

RE. See Costume, vol. vi. p. 163; and Heraldry,
p. 711.

SCHERLICH, Eilhardt (1794–1863), was born
y 7, 1794, at Neuende near Jever, in the grand-
of Oldenburg, where his father was pastor. He
eated at the gymnasium of Jever under the historian
er. In 1811 he went to Heidelberg, where he
d himself to philology, giving special attention to
sian language. In 1813 he went to Paris, partly
ly, partly with the view of obtaining permission to
French embassy to Persia. The political events of
ut an end to this scheme, and Mitscherlich returned
many. He then set to work on a history of the
es and Kara Chitayens, manuscript materials for
he found in the university library of Göttingen, and
on of which he published in 1815. Still anxious
Persia, he resolved to study medicine in order that
ht enjoy that freedom of travel usually allowed in
st to physicians. He began at Göttingen with the
of chemistry, and this so completely arrested his
on that he gave up the idea of the journey to Persia
e medical profession. In 1818 he went to Berlin,
he worked in the laboratory of Professor Link. He
nalyses of phosphates and phosphites, arseniates and
es, confirming the observations of Berzelius as to
omposition. In the course of these investigations
erved that corresponding phosphates and arseniates
lized in the same form.

was the germ from which grew the theory of
phism. In order to follow out his discovery
erlich set to work to learn crystallography. His
was a fellow student, Gustav Rose, to whose
ting mind and profound knowledge of mineralogy
een due some of the most interesting developments
ustrations of the theory of isomorphism. Having
ed the inclinations of the faces of a vast number of
and artificial crystals, he established the principles
orphism very much as we now hold them.

right that we should remember that Mitscherlich
t the first to notice the fact that two different sub
might have the same crystalline form, or that one
t could partially replace another without great
of form. Romé de l'Isle in 1772 mentions mixed
containing variable proportions of iron and copper,
eblanc in 1802 showed that the crystalline form
s the same although the proportions vary both in
e of these mixed vitriols and in that of mixed
alums. Vauquelin had already, in 1797, prove
alum might contain variable quantities of ammonia w
any corresponding variation of crystalline form.

The authority of Haüy, who laid down as one
principles that each compound has its own crystalline
for a time kept these observations in the backg
Further cases were, however, observed. Wollaston
accurately measured the angles of the rhombo
carbonates, and proved that the forms of these mi
although nearly the same, are not absolutely ide
He showed that a similar close approximation to i
exists in the case of the vitriols. Fuchs in 1815 h
forward his theory of "vicarious constituents."
Laurac proved that a crystal of common alum conti
grow when placed in a solution of ammonia alu
cases of crystallized mixtures were pointed out
French mineralogist Beudant. But notwithstandin
foreshadowings, of which we know, on the evide
Gustav Rose, that Mitscherlich was wholly ignorant
was at the time of which we are now speaking no t
a theory, but merely isolated observations. The th
isomorphism is the work of Mitscherlich. It wa
municated to the Berlin Academy on December 9,

In that year Berzelius paid a visit to Berlin, and
struck with Mitscherlich's ability that he suggested
the minister Altenstein as the most fitting succe
Klaproth in the chair of chemistry in that univers
is not surprising that the idea was not carried o
was only four years since Mitscherlich had begun t
chemistry, he had never lectured, nor had he pu
anything on the subject.

Although Altenstein did not at that time carry
proposal of Berzelius, he was so far impressed by
he obtained for Mitscherlich a Government grant to
him to continue his studies under Berzelius.

In 1820 he went to Stockholm, where he worke
year in Berzelius's laboratory. In 1822 he was app
extraordinary and in 1825 ordinary professor in
In the course of an investigation into the slight diff
discovered by Wollaston in the angles of the rhomb
of the carbonates isomorphous with calc-spar, Mits
observed that the angle in the case of calc-spar vari
the temperature. On extending the inquiry to oth
isotropic crystals he observed a similar variation, a
thus led, in 1825, to the discovery that non-is
crystals, when heated, expand unequally in the direc
dissimilar axes. In the following year he discove
change, produced by change of temperature, in the d
of the optic axes of selenite. The discovery also i
that sulphur can be obtained in two absolutely
crystalline form threw much light on the fact that
minerals calc-spar and aragonite have the same comp
but perfectly different form. Other cases of this p
to which Mitscherlich gave the name of dimorphi
arrived at not long after.

In 1833 he made a series of careful determinat
the vapour-densities of a large number of volatile sub
and proved that Gay Lussac's law as to the prop
by volume in which oxygen, nitrogen, hydroge
chlorine unite with one another hold generally for
elements, and that the simplicity of the relation
volume of the compound to that of the component
also general.

In pure chemistry Mitscherlich's discoveries were
connected with isomorphism. Thus he obtained
acid in 1827, and showed the isomorphism of its sa
the sulphates, and examined with great care the man
and permanganates, showing their isomorphism w
sulphates and with the perchlorates respectively.
did much important work unconnected with this

We may in particular refer to his discovery of ation of benzene to benzoic acid of nitro benzene, a considerable number of the derivatives of benzene. 833 he published his *Lehrbuch der Chemie*, a to a book of chemistry of the most thoroughly d and yet readily scientific kind, from the study of teacher of chemistry may still derive many a Lect He entered in mineralogy led him to the the geology of volcanic regions, and he made to the Ethel with a view to the discovery of of volcanic action He did not, however, publish on the subject, but since his death his notes arranged and published by Dr Roth in the of the Berlin Academy (1860) In December symptoms of heart disease made their appearance, was able to carry on his academical work till 1862 He died at Schonebeck near Berlin on gust 1863

published papers are chiefly to be found in the

VLENE, or Mytilene See Lesbos

PAH (מִצְפֶּה) and Mizpeh (מִצְפֵּה) are Hebrew words place of prospect, or both commanding points s of Palestine usually occupied such positions In the Old Testament we find several places bearing me of "The Mizpah," Mizpeh Sometimes a ming genitive is added "The Mizpeh of Gilead xi 29), "The Mizpeh of Moab" (1 Sam xxii 3). e most famous of these places is that in Gilead noted w Judg x 17) Here Jacob's company was overtaken by the men of Jacob's God and the covenant ended by heaps of stones The narrative of Gen xxxi 45 ff what obscure, and it is not clear from one hand We gather, from it that another name of The Mizpeh was Galeed ed Thus Mizpar Mizpeh, Galeed Gilead Hos v 1 Mizpeh and the height of the pass Josh xviii 26 and Gilead (the height of Gilead) simply The Ramah 2 Kgs xxv 23, 25, are almost proved Enosh to be one pl is it not possible that Ramah Gilead and Mizpeh Gilead may all be nearly identical The place possessed throughout the It was the seat of Gedaliah's government mourning for another probably owing to its being a retreat to ancient ruins almost anarchy the residence of an important official ew Jer xl 6 and a holy or public house on the way Shechem and the house of Obed-edom before Baal-Meon and to which the military revolt of Ishmael son of Nethaniah was carried Mizpah was still a strong place in the Syrian period Josephus Maccabees I Macc iii 46 Jerome knows a place Domus Speculi or Eleutheropolis or Eleutheropolis commonly identified with Tell Sâfi the capital of the Philistines but this cannot be maintained to be made

the prominent bald top of Neby Samwil Mizpeh of the low country of Judah Josh Mizpeh of Moab to be sought under Hermon

EMONICS or contrivances to help the memory, have employed to a more or less systematic form from a arly period Mnemonics (τὰ μνημονικά, ἡ τέχνη μνημονική, Ars Memoriæ) were first cultivated by Greek sophists and philosophers, and are repeatedly referred to by Plato Aristotle In later times the invention was ascribed poet Simonides "perhaps (as Cicero remarks) rather than strength of his memory was fabulous" Cicero, who considerable importance to the art, but more to simplest order as the best help to memory, speaks

Ad Her* III xvi 24 Cicero *De Or* ii 86, mentions this belief commentators (such as

of Carneades (or perhaps Charmades) of Athens and dorus of Scepsis as distinguished examples of the well ordered images to aid the memory. The lat said by Pliny to have carried the art so far *ut nih iisdem verbis redderet auditum*. The Romans value helps as giving facility in public speaking. The n used is described by the author of *Rhet. ad Heren* 24 sqq and by Quintilian (*Inst. Or.*, xi. 1, 2), whose accou however, rather incomplete and obscure. In hi the art had almost ceased to be practised. The Gre Roman system of mnemonics was founded on the mental places and real or pictures The thing to membered was localized in the imagination, and asso with a symbol which concretely represented what desired to retain in the memory, special care being that the symbol should be as vivid, pleasing, and u sive as possible The most usual method was to a large house, of which the apartments, walls, wi statues, furniture &c., were severally associated wit tain name, phrase, event, or ideas, by means of sy pictures And to recall these it was only necessary to over the apartments of the house, till the particular was discovered where they had been deposited by th ination. As the things to be remembered increase houses could be built, each set apart to a certain idea or event, and these houses were again consc into a mnemonic town. In accordance with this s it were desired to fix an historic date in the mem was localized in an imaginary town divided into a number of districts each with ten houses, each hous ten rooms and each room with a hundred quadra memory places partly on the floor, partly on the fou partly on the roof Thus if it were desired to fix memory the date of the invention of printing (14 mercury book, or some other symbol of printing, be placed in the thirty sixth quadrate or memory of the fourth room of the first house of the historic of the town. The success of the method depended on the power of the imagination to give the different rooms, &c., characters the varieties of aspect, and w suppose that it was the effort to frame suitable imag places, invested an adventitious interest to dry detail constituted the real advantage of the system. Exce the rule of mnemonics are referred to by Ma Capella, nothing further is known regarding the p of the art until the 13th century, when the system Romans was revived and a good many treatises published on the subject. Among the voluminou ings of Roger Bacon is a tractate *De Arte Memo* which exists in MS at Oxford. Raymond Lully d special attention to mnemonics in connexion with *generalis* The most important modification of the of the Romans was that invented by Conrad C German poet who, in his *Epitoma in utramque C rhetoricam una cum arte memorativa nova* (1492), inst place made use of the letters of the alphabet. the end of the 15th century Petrus de Ravenna aw such a reputation in Italy by his mnemonic feats was believed by many to be a necromancer. His *Opus Memoriæ*, published at Venice in 1491 in four v went through as many as nine editions, the seventh a me at Cologne in 1608. An impression equally gr produced about the end of the 16th century by L Schenkel, who taught mnemonics in France, Ital Germany, and, although he was denounced as a sorc the university of Louvain, published in 1593 his t *De Memoria* at Douai with the sanction of that cel theological faculty. The most complete account of tem is given in two works by his pupil Martin Somm lished at Venice in 1619. Giordano Bruno, in co

s exposition of the *ars generalis* of Lully, included *ria technica* in his treatise *De Umbris Idearum*.
t the middle of the 17th century Winckelmann made what he called the "most fertile secret" in mne- namely the use of letters with figure- so as to express s by words; and the philosopher Leibnitz adopted abet very similar to that of Winckelmann in con- with his scheme for a form of writing common to all ges. Winckelmann's method was modified and up- ted in regard to many details by Richard Grey, who ed a *Memoria Technica* in 1730. The principal Grey's method is briefly this: "To remember any n history, chronology, geography, &c., a word is , the beginning whereof being the first syllable or s of the thing sought, does, by frequent repetition se draw after it the latter part, which is contrived give the answer. Thus, in history, the Deluge ed in the year before Christ two thousand three d forty-eight; this is signified by the word *Deluk*, nding for Deluge and *tok* for 2348. To retain ng the mnemonical words in the memory they were into memorial lines. The vowels or consonants Grey connected with a particular figure, whereby ily; but in 1806 Feinagle, a monk from Constance, began in Paris to expound a system emonic, one feature of which was to represent the al figures by letters chosen on account of some ity to the figure to be represented or some accidental ion with it. This alphabet was supplemented by licated system of localities, and even with the sam es-ing, by a more vivid and impressive visual char- for want of this are apt to pass from the memory, establishing between ideas of the same group an relation, so that the mention of the one would ing the other. Feinagle, who published a *Nouvelle méthode* at Paris in 1806, came to England in 1811, the following year published *The New Art of y*. A simplified form of Feinagle's method was ed in 1823 by Aimé Paris, and the use of symbolic s was revived in connexion with the latter by a lazwinsky, of whose system an account was pub by J. Bem, under the title *Exposé général de la le Mnémonique Polonaise, perfectionnée à Paris*, Paris. Various other modifications of the systems of gle and Aimé Paris were advocated by subsequent onists, among them being the Phrenotyping or Printing method of Bonnowsky, the Phreno Mnemo of Gouraud, and the Mnemotechnik of Carl Otto. e. The more complicated mnemonic systems have almost into complete disuse; but methods founded on the laws of association have been taught with ncess in Germany by, among others, Kothe, who is thor of *Lehrbuch der Mnemonik*, and *Katechismus dächtnisskunst*, both of which have gone through editions; and in England by Dr Edward Pick, *Memory and the Rational Means of Improving it* so obtained a wide circulation. In certain cases onical devices may be found of considerable service, systems which have aimed at completeness have ound rather to puzzle than aid the memory. The history of mnemonics is that given by J. C. F. von in his *Systematische Anleitung zur Theorie und der Mnemonik*, 1810.

A. See Dysornis

AB. Moab and Ammon (children of Lot) consti long with Edom and Israel (children of Isaac) that of four Hebrew peoples which in early antiquity had from the Syro-Arabian wilderness, and settled on rder of the cultivated country eastward of the great sion which extends from the Gulf of Elath to the Dead Sea, and up the valley of the Jordan. Accord the book of Genesis, they had come out of Mesopo and so were precursors of the larger wave which fo from the same quarter, forming the most southern of the Aramæan immigration into the lands of C and Heth. Whether the Hebrews were originall means is questionable, but it is certain that, b Aramæans, they were distinct from the Canaanite conquerors they were. Such was the relation of and new inhabitants not only in Western Palestin the Israelite occupation, but also and from a much period, in Eastern Palestine, where the aboriginal Amorites (that is, Canaanite) and where the Bne and Moab and the Bne Lot were newly settled i land. The old population did not disappear but conquerors, but continued to exist among them a considerable district, namely, in Gilead, the A even remained unabated, and that formed a gap imperfectly filled up by the Bne Ammon, betwe Hebrew line of migration on the south and th meantime more to the north, a wedge which did no to close until the historical period. From thi they even endeavoured, and with some success afterwards, to recover the territory which ha taken from them in the south. But where they w subject of the Hebrew they constituted the ba population, the man-tool, or the workme and chief. The extent of their influence over the con may be judged from the fact that it was their which gained the upper hand. The Moabite and Ammonite, also the Amorites, spoke the la of Canaan as well as the Israelite. They mus learned it from the Canaanite in the land ea Jordan, prior to the period at which Jacob manag and returned from Egypt. Our knowledge is imperfect as regards other departments of the Ca influence; but in religion it has left a noticeable the cultus of Baal Peor, which was carried on in territory, but was certainly of Canaanite origin.

The assumption that the change of language was brought about by the Israelite in the land which had been that of Canaan rendered intelligible by the fact that the Moabite spoke Canaanitish. But vain to trace accurately the ol Hebrew and Canaanite is the distinction between Phœni Hebrew, no doubt; similar differences existed betw dialect of the Phœnician coast towns and that of the Amorites and Canaanite generally, whose language the borrowed. That the Aramæans of Damascus also allowed pelled to mingle with the Hebrews in the vicinity of wh had taken possession, is probable; but since they spoken by the conquering tribes, they soon lost t direct relation with the mother country of Mesopotamia, a even had greater internal coherence. The designation A usually given in the Old Testament to the original inh of Eastern Palestine, is also extremely uncommon with Canaanite, although not quite so comprehensive. The of the Pre-Israelite peoples which in the Pentateuch is Land of Canaan, figure as Moab in the Land of the A White, however, the former name is bestowed chiefly u portion of the earlier population which had remained unco the latter is given to the portion against which the Israe directed their attack or into whose territory they settled. T place in the mountain district, that to the east and afterwa west of Jordan. For this reason the Amorite, as contra the Canaanites of the coast or of the level country are a race, like the Hebrews themselves, but belonging to an ear past. In the time of the Biblical narrators the Canaanite living here and there in the land, but the Amorite have o where the Israelite now are. This explains the fact that ordinary peaceful circumstances the Canaanites are spoke old inhabitant the Amorite are mentioned as the object whenever war and conquest are spoken of. Sihon and O whom Moses also battles, are kings of the Amorites, in Nu it is with the twelve kings of the Amorite that Joshua ha westward of the Jordan. The Amorite as a race assumes a half-mythical character, and is represented as gi as cedars and strong as oaks.

as Israel was the people of Jehovah, and Ammon
ple of Milcom, Moab was the people of Chemosh
Num. xxi. 29). The kingship of Chemosh was
l as thoroughly national and political in its char-
ut did not on that account exclude the institution
man king which existed in Moab much earlier than
] in the time of Moses the Moabites had a king,
n. titution was even then an old one. The capitals
kingdom were Ar Moab and Kir Moab, south from
en, these were not, however, the constant residences
kings, who continued to live in their native places,
xample, Mesha in Dibon. Doubtless there were
of dynasty, and trace exist of a powerful aristocracy
Moab, 2 Sam. xxiii. 20).

and of the Moabites, the Balka, is bounded north
d southward by Mount Gilead and Wadi l Mu'a,
d and eastward by the Dead Sea and the Wilder-
is divided into two portions by the deep bed of
on, that to the north being the more level (Mishor),
t to the south being more broken up, and consti-
the proper stronghold of the nation. The soil is
ly adapted for sheep farming (2 Kings iii.) and the
of the vine (Isa. xvi.).[1]

ai-torical importance of the Moabites lie wholly in
ontact with Israel, and we have no knowledge of
part from this. After the Israelites had quitted
and passed a nomadic life for about a generation in
ghbourhood of Kadesh, they migrated thence, still
the leader-hip of Moses, into northern Moab, dis-
ing the Amorites, who had made themselves masters
district. The interval from Kadesh to the Arnon
e passed only by a good understanding with Edom,
and Ammon, a proof that the ethnical relationships,
t a later period were expressed only in legend, were
time still living and practical. In all probability
abites called the Israelites to their aid, they were
yet aware that the little pastoral people was des-
ne day to become to them a greater danger than
naanites by whom they were threatened at the
t.[2]

he story of Balaam indicates, the Moabites would
ly have been rid of their enemies after their service
n rendered, but were unable to prevent them from
m the land of Sihon. The migration of the tribes
l into Western Palestine, however, and the dis-olu
their warlike confederation soon afterwards made a
sion of the old frontiers possible. If King Eglon
slate of Benjamin at Jericho, the territory between
and Jordan must also have been subject to him, and
Reuben must even then have lost his land, or at least hi
liberty. It would appear that the Moabites next extende
their attacks to Mount Gilead, giving their support to th
Ammonites, who, during the period of the judges, were it
leading assailants. So close was the connexion betwee
Moab and Ammon that the boundary between them vanishe
for the narrators (Judges xi.).

Gilead was delivered from the Ammonites by Saul, wh
at the same time waged a successful war against Moab; th
fact is lightly touched upon in 1 Sam. xiv. 47, as if thi
were a matter of course. The establishment of the mon
archy necessarily involved Israel in feuds with its neighbour
and kin. The Moabites being the enemies of the Israelit
kingdom, David naturally sent his people for shelter thithe
when he had broken with Saul; the incident is precisel
analogous to what happened when he himself at a late
period took refuge from Saul's persecution in Philistin
territory, and need no explanation from the book of Ruth
As soon as he ceased to be the king's enemy by himse
becoming king, his relations with Moab became precisel
those of his predecessor. The war in which apparentl
accidental circumstances involved him with Hanun ben Nahas
of Ammon really arose out of larger causes, and thus sprea
to Moab and Edom as well. The end of it was that a
the three Hebrew nationalities were incorporated with th
kingdom of Israel: the youngest brother eclipsed and sub
dued his senior, as Balaam had foreseen. Through th
work of Saul and David the political system of Palestin
was altogether changed: the smaller peoples were no longe
a match for Israel, which established a decisive preponde
ance, and transformed what had hitherto been jealousy o
the part of Moab and Ammon as well as of Edom in
bitter hatred; the hatred did not cease even after nothin
but a religious shadow remained of what had once been th
political supremacy of the people of Jehovah.

The struggle with Ammon which David began ultimate
assumed larger dimensions, and brought the Aramaea
also into the field against him. He was successful, indee
against them also, and destroyed their most powerf
kingdom; but after his death they recovered themselve
and pressed steadily on from the borders of the wilderne
towards the sea, at their head were those kings of Damasc
who had established themselves on the ruins of Zoba.
presence of these enemies the already fading distinctio
between the ruling and the subject nationality within t
kingdom of Israel now completely disappeared; and ev
towards the Canaanites outside the relations of the kin
became friendly. It is in one instance expressly stat
that the common danger threatening from the East h
to do with this (2 Sam. viii. 9 *sqq.*). But, conversely,
was natural that Ammon and Moab should make comm
cause with the Aramaeans, such an attitude was suggest
by geographical position and old connexions, but abo
all by their helpless fury against Israel. Both nationalit
must have succeeded in emancipating themselves very so
after David's death, and only now and then was some stro
king of Israel able again to impose the yoke for a time,
upon the Ammonites indeed, but upon Moab. The first to
so was Omri, who garrisoned a number of their towns a
compelled the king to acknowledge Israel's suzerainty
a yearly tribute of sheep, a state of matters which co
tinued until the death of Ahab ben Omri. But when th
brave king fell in battle with the Aramaeans at Ramo
Gilead (about 850 B.C.), Mesha of Dibon, then the ru
of Moab, seized the favourable opportunity to make hi
self and his people independent. In his famous inscripti
he tells how, through the wrath of Chemosh, the land h
fallen into the enemy's power and endured forty years
slavery, and how by the grace of Chemosh the yoke is n
broken and the Israelites ignominiously driven off.

[illegible] seems to have been any difference in this respect
[illegible] and southern portions: instead of Heshbon,
[illegible] the poet Hariri of Tayy, a little before
[illegible] Mafar and Zoar as the chief wine centres (Yakut,
[illegible]

[illegible] are indubitable; it cannot be an invention
Israel [illegible] to locate it in northern Moab, and
[illegible] proper. The only doubtful point
the [illegible] *sqq.* is contemporary evidence
[illegible] correctly not a forgery, but it is a ques-
tion whether it is [illegible] fraction of the kingdom of the
[illegible] Hesbon. [illegible] reference rests entirely upon the words
לבילף אמ[illegible] which could very well be omitted as a mere gloss,
in case the oracle would originally be a taunt-song directed against
Ammon themselves [illegible] because that it is taken by the
[illegible] Nöldeke in *Zeitschr. f. Völker-*
psych., 1884, p. 129 *sqq.*). A [illegible] of the letter of the Amorites
[illegible] of Moab, could [illegible] one of the Edomite vanquish the
[illegible] on the "high" of Moab (Gen. xxxvi. 35); this took place
[illegible] time, as seems to be the fact that between Hadad and
[illegible] of the ancient Edomite monarchy, [illegible] to the period of
[illegible] there were four to nine princes. Certain recollections of a
[illegible] settlement of the Midianites in northern Moab are seen in
[illegible] xxv. 4, 7; xxv. 18.

ole we find only the curt statement that Moab
l against Israel after the death of Ahab (2 Kings i.);
other hand, there is a full narrative of a later attempt
part of Joram ben Ahab to bring Mesha again
bjection—an attempt which promised very well at
nt ultimately failed completely. Joram's invasion
lace not from the north but (probably very unex-
y to the enemy) from the frontier of Edom over
di 'l-Ahsá; he marched through Judah and Edom,
e kings of those countries served as auxiliaries
feated a Moabite army on the frontier, penetrated
e country and laid it waste, he laid siege to the
of Kir Moab so closely as to reduce it to great
But these straits seem to have filled the besieged
desperate courage, for the fortunes of war suddenly
l. The Israelites were compelled to retire home
great wrath (of Jehovah) having come upon them,
a severe disaster having befallen them, which
scribed, but, from the nature of the case, must have
sudden surprise and defeat by the enemy.[1]
the Moabites owed the liberation from Israelite
acy to the battle of Ramah that is, to the
ans we accordingly find them (as well as the
ntes) afterwards always seconding the Aramæan in
nd border warfare against Gilead, in which they
d revenge on the Israelites. With what bitterness
ter in consequence were wont to speak of their
kinsfolk can be gathered from Gen. xix. 30 *sqq.*
e trace of open malice in the story of the patriarchs,
l the more striking as it occurs in a narrative of
Lot is the hero and saint, which therefore in its
form is of Moabite origin, although perhaps it has
older Canaanite nucleus. Of these border wars
n but little, although from casual notices it can be
2 Kings xiii. 20; Amos i. 13, comp. 2 Kings v.
t they were long kept up, although not quite
ruptedly. But when at length the danger from
ramæans was removed for Israel by the inter-
n of the Assyrians, the hour of Moab's subjection
me; Jeroboam II. extended his frontier over the
territory, as far as to the brook of the willows
'l-Ahsá). (Perhaps the song of Num. xxi. 27 *sqq.*
ference to these events.) A vivid picture of the
on and anguish then prevalent in Moab has been
ed to us in the ancient prophecy of Isa. xv., xvi.,
indeed would have greater historical value if we
ble to tell precisely what in it depicts the present,
at is prediction of the future."
utterance of an older prophet was repeated some

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narrative of Mesha in his inscription has, strange to say, not
ently been regarded as parallel with 2 Kings iii., and the con-
been drawn that the Biblical narrative completely inverts the
te of the case, it is difficult to see for what motives, for there
raggadocio in 2 Kings iii. But it is perfectly clear that the
e of 2 Kings iii. presupposes the revolt of Mesha as an old
while, on the other hand, Mesha's story on the stele in the
is a narrative of this very revolt and its immediate consequences,
ordingly to be regarded as parallel with 2 Kings i. 1. Elesha's
in Wadi 'l Ahsá (2 Kings iii. 16) is explained by the locality
means a sandy ground with moist subsoil where, by digging
s, water is always obtainable. The (probably compulsory) par-
on of the king of Edom in Joram's expedition against Moab
haps be brought into connexion with the fact that the Moabites
to lime the bones of a king of Edom (Amos ii. 1).
Isa. xv. xvi. it is presupposed that the attack upon Moab has
ade from the north, at a time when Judah is a comparatively
l kingdom, exercising sovereignty over Edom also, and in a
to afford shelter to the fugitive Moabites, thus not being
war with them. These marks taken together can only apply
period of Jeroboam II. and Uzziah. Hitzig will have it that
ben Amittai wrote Isa. xv. xvi.; but according to 2 Kings xiv.
t prophet preached prosperity to Jeroboam, and not disaster
Moabites.

decennia later by the prophet Isaiah, with the addit
a clause adapting it to his time, to the effect tha
Assyrians would carry out in all its fulness the hi
imperfectly-executed threat. The Assyrians actuall
jugated the Moabites, as well as the other small peop
that region; but the blow was apparently not so gr
Isaiah had predicted. They lay more out of the way
their western neighbours, and perhaps then resista
the scourge of God was not so obstinate as to deman
sharpest measures. What made it all the easier for
to reconcile themselves to the new situation was th
that the Israelites suffered much more severely than
From these then deadly enemies they were henceforth
ever free. They did not on that account, however, g
their old hatred, but merely transferred it from Isr
Judah. The political annihilation of the nation only
sified in Jerusalem the belief in its religious prerogativ
against this belief the hostility of neighbours was a
more keenly than ever. The deepest offence at th
gious exclusiveness of the people of Judah, which
first began to manifest itself, was, as is easily under
taken by their nearest relatives, Edom and Moab,
gave terrible expression to their feeling when the
deans urged them on like unmanned beasts of prey a
the rebellious Jews, and they joined loudly in the g
chorus of malignant joy which was raised over the b
of the temple and the ruin of the holy city.[1]
"Because Moab saith: Behold the house of Ju
like all the other nations, therefore do I open his
he Bne Kedem," says the prophet Ezekiel (xxv. 8
His threat against the Moabites as well as against
Edomites and Ammonites is that they shall fall bef
approach of the desert tribes. Probably in his d
tide of Arabian invasion was already slowly risin
of course it had first to overtake the lands situated
desert border. At all events the Arab immigratio
this quarter began at an earlier date than is
supposed, it continued for centuries, and was so g
that the previously-introduced Aramaizing
could quietly go on alongside of it. The Edomite
way before the pressure of the land-hungry nomad
settled in the desolate country of Judah, the child
Lot, on the other hand, appear to have amalgamate
them,—the Ammonite maintaining their individ
longer than the Moabite, who soon entirely disappe
Israel and Moab had a common origin, and thei
history was similar. The people of Jehovah on t
hand, the people of Chemosh on the other, had th
idea of the Godhead as head of the nation, and
patriotism derived from religious belief a pat
capable of extraordinary efforts, and which has
parallel in the West either in ancient or in modern
The mechanism of the theocracy also had much th
common to both nations: in both the king figures
deity's representative, priests and prophets as the
through whom he makes his communications. In
all this similarity, how different were the ultimat
of the two! The history of the one loses itself ob
and humanely in the sand; that of the other a
eternity. One reason for the difference (which, t
enough, seems to have been felt not by the Israelite
but by the Moabite also) is obvious. Israel re
gentle treatment at the hands of the world, it had
on a continual conflict with foreign influences and

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[1] Zeph. ii. 8 *sqq.*; 2 Kings xxiv. 2, and Jer.
Sqq. ...ed hardly be said that the Moabite
Palestinian peoples when supremacy passed from the
to the Chaldæans, and that, notwithstanding their hatred of
they had no difficulty in seeking alliance with them when
arose on which they could be made useful (Jer. xxvii. 3

; and this perpetual struggle with gods and men
profitless, although the external catastrophe was
de. Moab meantime remained settled on his lees,
s not emptied from vessel to vessel (Jer. xlviii. 11),
ruption not decay were the result. This explana
wever, does not carry us far, for other peoples with
of Israel have yet failed to
r to real importance, but have simply disappeared.
the prophet rendered at a critical time, by
the faith of Israel from the temporal to the eternal
is already been spoken of in the article ISRAEL.
[illegible] Rich and Circourt however
[illegible] south in the connection and the inscription
[illegible] tone of Lenormant ascribed to it, and now in
[illegible] Les Inscr. Himyar. de la Mesopotamie
the wretched character of their ornamentation, sometimes
[illegible] sublime, and do not even form words, much
[illegible] The literature of the ancients to be found in in
[illegible] on the Old Testament itself, and in those on the
[illegible] Moses.

J. W.

MU'ALLAKAT *Al Mu'allakat* is the title of a group
of long Arabic poems, which have come down to
the time before Islam. The name means "the
hung up," the traditional explanation being that
poems were hung up by the Arabs on one of the
at Mecca. The oldest passage known to
which is stated occurs in the *Akd* of the Spanish Arab,
al Rabbihi (A.D. 861-940). Beside the
[illegible] read these: "The Arabs had such an interest in
and valued it so highly, that they took seven long
selected from the ancient poetry, wrote them in gold
Syrian cloth, and hung them up (*'allakat*)
curtains which covered the Ka
golden poem of Amraalkais, 'the golden poem of
The number of the golden poems is seven; they
called 'the suspended' (*al Mu'allakat*). Similar
not to be met with in later Arabic writers. But against
have the testimony of a contemporary of Ibn 'Abd
, the grammarian Nahhas (*circa* A.D. 940), who says
ommentary on the Moallakat: "As to the assertion
ey were hung up on [or in] the Kaba, it is not known
of those who have handed down ancient poems
nations elsewhere is more trustworthy in reporting
so utterly unauthenticated. The customs of the
before Mohammed are pretty accurately known to
have always a mass of information about the affair
or anything like it is found in really good and
authorities. We hear, indeed, of a Meccan hanging
oul of battle on the Ka'ba (Ibn Hisham, ed. Wü
, p. 433). Less credible is the story of an important
of being deposited in that sanctuary, for the lodging
in case of later usages being transferred to pre
times. But at all events this is quite a different
from the hanging up of poetical manuscripts. To
the first appearance of the Mo'allakat from the
we are told in a passage of late origin (De Sacy,
, 2nd ed. p. 20) that they were taken down at the cap
Mecca by the Prophet. But in that case we should
some hint of the occurrence in the enemy-tantal
ohic of the Prophet and in the work on the history
ca, and we find no such thing. That long poems
written at all at that remote period is improbable in
treme. All that we know of the diffusion of Arabic
even up to a time when the art of writing had
far more general than it was before the spread of
point exclusively to *oral* tradition. Moreover, it
e inconceivable that there should have been either a
or a private individual of such acknowledged taste,
or of such influence, as to bring about a consen
opinion in favour of certain poems. Think of the
offence which the canonization of one poet must have
to his rivals and their tribes! It was quite another
for an individual to give his own private estimate
respective merits of two poets who had appealed to
umpire, or for a number of poets to appear at large
ings, such as the fair of 'Okaz, as candidates for the
of honour in the estimation of the throng which li
to their recitation. In short, this legend, so often r
by later Arabs, and still more frequently by Eur
must be entirely rejected. The story is a pure fabr
ted on the name "suspended." The word was ta
t literal sense, and as these poems were undou
prized above all others in after times, the same
was attributed to "the [ancient] Arabs," who wer
posed to have given effect to their verdict in th
already described. A somewhat simpler version
given by Nahhas in the passage already cited, is as fo
"Most of the Arabs were accustomed to meet at 'Ok
recite verses, then it the King was pleased with any
he said. Hang it me, and preserve it among my trea
But, not to mention other difficulties, there was no
all the Arabs, and it is hardly probable that any A
king attended the fair at 'Okaz. The story that the
were written in gold has evidently originated in the
"the golden poems" (literally "the gilded"), a figurat
pression for excellence. We must interpret the desig
"suspended" on the same principle. In all probab
mean (poems) which have been raised, on acco
their value, to a specially honourable position. A
derivative of the same root is *'Ilk*, "precious thing."

The selection of these seven poems can scarcely
been the work of the ancient Arabs at all. It is
more likely that we owe it to one connoisseur of
date. Now Nahhas says expressly in the same pa
"The true view of the matter is this: when Ha
mmad (Hammad the Rhapsodist) saw how litt
cted for poetry, he collected these seven pieces,
people to study them, and said to them: 'These a
[poem] of renown.'" And this agrees with all ou
information. Hammad (who lived in the first thre
ters of the 8th century A.D.) was perhaps of all m
one who knew most Arabic poetry by heart. The
tion of poems was his profession. To such a rha
the task of selection is in every way appropriate;
may be assumed that he is responsible also for the
what fantastic title of "the suspended."

The collection of Hammad appears to have consi
the same seven poems which are found in our
editions, composed respectively by Amraalkais,
Zohair, Labid, 'Antara, 'Amr ibn Kolthûm, and
ibn Hilliza. These are enumerated both by Ibn
Rabbih, and, on the authority of the older philolog
Nahhas; and all subsequent commentators seem to
them. We have, however, evidence of the existe
a very early period, of a slightly different arrang
Two of the foremost authorities in Arabic poetry a
'Obaida and Motaddal, men who for care and a
in preserving the genuine text were far ahead of thei
older, contemporary Hammad. Both of these ins
poem by Nabigha and one by A'shâ in place of t
'Antara and Harith;[3] and, if our informant has ex

[1] Doubts had already been expressed by various schola
Hengstenberg, tried conservative as he was in theology-
challenged it, and since then it has been controverted at
Nöldeke, *Beiträge zur Kenntniss der Poesie der alten Arab*
over, 1864), p. xvii. *sqq.* Our highest authority on Arabi
Professor Ahlwardt, concurs in this conclusion; see his *Bem*
über die Aechtheit der alten arabischen Gedichte (1872), p. 2

[3] The passage is cited by Nöldeke, *Beiträge*, p. xx. *sq.*

[1] *In Nahhas'* C[illegible] *Cogn. des In*
p. vii.

correctly, they also called this modified collection
kat. Mofaddal employs, besides, the names "the
ng [poems]" and "the necklaces." This last be
afterwards a common title for the seven poems.
mparison of songs to strings of pearls is a very apt
m the nature of the Arabic poem, composed as it
eparate loosely-connected parts. Hence it became
ular that even in ordinary prose to speak in rhyth
form is called simply *nazm*, "to string pearls"
dal expressly opposes the view of those who did not
ledge the pre-eminence of the seven poets selected
. This appears to be an attack on Hammad for
ng in his collection the works of two men who for
fame could certainly never enter the lists with
a and Aʿshá. It is *prima facie* more likely that a
riter should have replaced the less famous poets by
who were universally placed in the first rank, than
esa. Perhaps another fact is of some importance
Hammád, a Persian by descent, was a client of the
ribe, Bakr ibn Wail. In the heathen period this
was much at war with the closely related tribe
. Now of all Arabic poems none was more famous
hat in which ʿAmr ibn Kolthum celebrates in
g terms the praises of his tribe Taghlib. It,
re, Hammád's collection embraced this poem, it was
at'eral for him to gratify his patrons the Bakrites
ing alongside of it that of Harith a Bakrite and
porary of ʿAmr where he extols his own tribe and
the Taghlibites with bitter scorn. Such considera
d not affect Abu ʿObaida and Mofaddal
authority of these men has so far prevailed that
ems of their favourites Nabigha and Aʿshá often
in the manuscripts, not indeed instead of those of
and Harith, but after the other seven. Thus we
mes read of *nine* Moʿallakat. The first author in
the writer has observed this is the great philosopher
n Ibn Khaldun (A.D. 1332–1406); he mentions
l of Hárith the far more celebrated ʿAlkama,
er relying on ancient authority, or by an oversight,
not tell. In an excellent collection of forty nine
poems by Abú Zaid al Kora his editor unknown)
dal's seven poets appear in the first class, "the
es;" but Nabigha and Aʿsha are each represented
ifferent piece from that usually reckoned among the
akát. By this editor the name "golden poems,"
as we have seen, sometimes occurs as a synonym of
llakat," is applied to seven quite distinct ones.[1]
uncertainty as to the selection and the titles may
as an additional proof that the "suspension," on the
or anywhere else, is a fable.

lives of these seven (or nine) poets were spread
period of more than a hundred years. The earliest
m, according to the common and probably correct
n, was AMRALKAIS (pronounced also Imroolkais,
ikais, &c.), regarded by many as the most illustrious
bian poets. His exact date cannot be determined
robably the best part of his career fell within the
alf of the 6th century. He was a scion of the royal
of the tribe Kinda, which lost all its power at the
of King Hárith ibn ʿAmr in the year 529.[2] The
royal father, Hojr, by some accounts a son of this
, was killed by Bedouins. The son led an adven
life as a refugee, now with one tribe, now with
r, and appears to have died young. The anecdote
l of him—which, however, are very untrustworthy
ail as well as his poems, imply that the glorious
memory of his house and the hatred it inspired were
comparatively fresh, and therefore recent.

The Moʿallaḳa of ʿAMR hurls defiance against the
of Hira, ʿAmr son of Mundhir, who reigned from
summer of 551 till 568 or 569, and was afterwards
by our poet.[3] This prince is also addressed by Harith
his Moʿallaka. Of TARAFA, who is said to have at
no great age, a few satirical verses have been pre
directed against this same king. This agrees with
fact that a grandson of the Kais ibn Khalid, mentioned
a rich and influential man in Tarafa's Moʿallaka (v.
81), feigned at the time of the battle of Dhu Kar in
the tribe Bakr routed a Persian army. The battle
between A.D. 601 and 616 (Nöldeke, *Tabari*, p. 31

The Moʿallaka of ʿANTARA and those of Zoheir
allusions to the feud of the kindred tribes Abs
Dhobyan. Famous as these contests were their time
be ascertained. But the date of the two poets can be ap
mately determined from other data. Kais, son of Z
composed first a satire and then in the year 630 a
on the Prophet; another son, Bejair, had become
what sooner, to celebrate Mohammed. Nabigha fell
grandfather of the Ahmad ibn Kais who died at Cairo
age in A.D. 686 or 687, he outlived Abdallah ibn Sa
whose brother Isfand was a very old man when he
battle against the Prophet nearly ten years earlier.
communication with Ward, who even the poet Orwa
perhaps have survived the flight of Mohammed to M
From all these indications we may place the
period of both poets in the end of the 6th century.
historical background of ʿAntara Moʿallaka is an
somewhat earlier than that of Zoheir.

To the same period appears to belong the
ʿALKAMA, which, as we have seen, Ibn Khaldun
amongst the Moʿallakat. The poet certainly
of Nahrain, who was one of the most distinguished
Arabic poets. For in the poets contemporary
Moʿallaka, as in numerous others, he celebrates the
above-named Noʿman, king of Hira, who ruled
two last decades of the 6th century. He
mentioned as a contemporary of

The poem of ʿAbid, which Mofaddal places first
Moʿallakat, contains an allusion to the battle of
(under the name "Battle of Hinw
not less famous than Nabigha, lived
in honour of Mohammed and died
630.

Labid is the only one of the
His Moʿallaka, however, like almost all his other
works, belongs to the pre-Islamic period. He
lived till 661 or even later, certainly
what is asserted with
these poets, that he lived to a ripe old age.

We have already mentioned that the
was transmitted not by manuscripts but by
oral tradition. Many pieces probably
may have owed their preservation to their hold
popular memory. But fortunately, there were
men who made it their special business
and reports. The work
The poets themselves
Of
The last representative
Hammad, the man who formed the
list, but he, at the
pp.

[1] See Nöldeke, *Tabari*, pp. 170, 172.

[2] This evidence must be supplemented
come, whose author derives him
to which the downfall of King Noʿman of Hira
p. 317) is spoken of as a not very recent event
of this power is more than doubtful. See Ahlwardt
J. Lyall in the *Academy*, March 1, 1880, p.

[3] See Nöldeke, *Beiträge*, p. xxi., and the catalogue of the Arabic
the British Museum, p. 480 *sqq.*

[4] *Tabari's Geschichte der Perser und Araber . . . übersetzt von*
Nöldeke (Leyden, 1879), p. 171.

apsodist to the critic and scholar. Now, when we r that more than a century in some cases two es elapsed before the poems were fixed by literary ve must be prepared to find that they have not d their original form unaltered. The most-favour- pinion of the rhapsodists would require us to make ce to occasional mistakes; expressions would be anged the order of verses disarranged, passages and probably portions of different poems pieced r. The loose structure of the ancient poems ren- hem peculiarly liable to corruptions of this kind. e fact is that Hammad in particular dealt in the rbitrary fashion with the enormous quantity of which he professed to know thoroughly. He is harged with falsifications of all sort in this depart- Of other Arab and notably of the great philolo alat, "the Rad" it is credibly reported that they n intimate knowledge of the style and language ancient, to pass off whole poems of their own the productions of earlier authors. The worst ories are only too completely confirmed by an ation of such pieces as are still preserved, as is me (especially in Ahlwardt's *Bedeutungen*, already The even Mo'allakat are indeed free from the sus- forgery, but even in them verses are frequently ed in all there are hemistichs and probably all verses which do not belong to them. Some of ave more than one introduction. This is the case th the poem of 'Amr, although, as the finest piece f his very powerful tribe, it must have had a wide ion. The true introduction begins at v. 9, before find another which certainly does not belong to m, and can hardly be the work of the same poet, ved in the desert regions near the lower Euphrates, he Persian dominion; whereas the author of v. 8 of his immediate in several parts of Roman Syria, v. 1 he speaks of drinking wine from a place in n Syria. It is evident that all attempts to restore ginal order, to fill up blanks, or to remove interpola- an only be carried to a certain degree of probability best; there must always be a large subjective ele- judgments on points of the kind. Still less can to discover and rectify the minor changes, mis-inge forms or grammatical forms, which the text may have ne before it was fixed in writing. It may be re- in the connexion that whereas every ancient song has nsmitted through two different grammatical schools, ally appears in two considerably divergent forms, ve been taken down from the lips of separate of secondary importance are the errors due to considerable as these often are, we are, at better able to correct them.

The authors of old Arabian poetry do not exhibit differences in their general manner and to bring to the mind a clear idea of their indivi- Very distinct poetic types emerge, but the great poets present a somewhat monotonous to the western scholar, who indeed can at best have ery imperfect feeling for *nuances* of style in this field. we are thus unable to isolate the various constituent this poetical literature, and pass a critical opinion , we do get from the literature, as a whole, what r greater part than an æsthetic estimate of that particular poet, viz. a poetic picture of the life and activity of that remarkable people which, the endless agitation and endless sameness of its e, and in an extremely inhospitable region, was ng one of the mightiest revolutions in the history world. This collective impression is hardly impaired involuntary alterations made by the rāwīs; nor is it greatly distorted by the forgers of the 2d century of Islam, who were thoroughly familiar with the spirit and style of antiquity, and seldom did violence to them.

The critics of the 2d and 3d centuries A.H. unanimously ranked the poets of the heathen period above those of Islam; and in that verdict we must concur. The older Moslem poets were for the most part mere Epigoni, content, for better or worse, to borrow the style of their pagan predecessors. It is only natural, therefore, that the seven best poems should have been selected from the productions of heathenism. But how these particular seven came to be fixed upon, it is difficult to decide. It is remarkable that people who knew thousands of such poems should have agreed as to the superiority of five, and only differed about two. No doubt the selection was greatly influenced by the widely-established reputation of certain poets, like Imruulkais, Zohair, and Ṭarafa; while in other cases single poems, such as that of 'Amr, stood in high repute for special reasons. Still, even we, with a much narrower range of selection, should hardly pick out these seven as the finest. In all probability our choice would not light on a single one of them. The truth is, our æsthetic ideal is essentially different from that of those old *littérateurs*. And, while we may certainly consider our own taste, formed on the model of the Greeks and the best of the moderns, to be on the whole purer than theirs, we must not forget that they had the advantage of perfect knowledge of the language and the subject-matter, and could thus perceive a multitude of beautiful and delicate touches, which we either miss entirely or realize with laborious effort. The world of the old Arabian poet lay at an infinite remove from ours. His mental horizon was narrow but within that horizon every minute detail was seized and designated with precision. Among the nomads, for example, the smallest point of the horse or camel that the eye can see has its importance; the language has precise and generally understood words for them all, where ours has only technical terms. It is the same with all the physical properties of the animal—its paces, etc. Thus when a poet faithfully described the exterior and the deportment of his camel, that was to his hearers and the same is true of later critics a genuine pleasure, because the description conveyed to them a definite pictorial impression. But we do not understand the details of the picture, or, when at best with all the resources of tradition and natural history we have gained some tolerable comprehension of them, the whole still leaves us indifferent. A camel to us is simply not a poetical object; and even a horse ceases to be æsthetically interesting—except perhaps to a sportsman—when one is asked to go over his points in detail. For this reason we are apt to find a great part of Ṭarafa's Mo'allaka, and many parts of the poems of Imruulkais, viewed as poetry, distasteful rather than interesting. More attractive are the descriptions of the life and habits of wild animals in the desert, such as the wild ass and some species of antelope, which the poets are fond of introducing (see, *e.g.*, the Mo'allaka of Labíd). There are also many vivid sketches from nature to be met with, nature, of course, as seen in the very monotonous Arabian landscape. Monotony, indeed, is a predominant characteristic of this poetry. When one first reads poems where the bard begins by shedding tears over the scarcely perceptible traces of the dwelling of his beloved in years one by, one's sympathy is aroused. But when poem after poem is found to commence with the same scene, and possibly with almost the same words, the emotion is somewhat damped. No doubt such occurrences must really have been very common in the nomad life; nevertheless the suspicion becomes at last irresistible that for the most part all this is pure fiction. Nor can we be sure that the

re always to be taken *au sérieux* when they describe arousals, and other adventures in peace and war, of hey love to boast. They are probably more serious narratives of their love experiences: these are often ghly coloured, and yet are always pervaded by a natural refinement, which is too often wanting in the otic poetry of the Moslems. But there, too, our enjoy s frequently marred by minute and even prosy de ns of the physical charms of the object of affection. lyrical and even the more rhetorical passages of the make in general a deeper impression upon us than riptive portions, to which they owe their dramatic er, and which are often intimately blended with the

When those old Arabs are really moved by love, , or grief, when personal or tribal vanity vents itself oderate boasting, invective, or banter then they chords that thrill our breast. In those passages genuine human feeling is stirred, they also display ater individuality than in the more conventional tions. Especially affecting are the numerous pas complete poems which mourn over the beloved nerated dead. Their sober practical philosophy too, presented in the Mo'allaka of Zohair and in many d's poems, is really impressive

Mo'allakát are highly characteristic specimens of this They exhibit nearly all its merits as well as most defects. Amongst its merits we ought, perhaps, to the unfailing regularity of the verse. That a people nder such extremely simple conditions should have ted a purely quantitative metre, so euphonious and rously adhered to, is a fact worthy of our highest tion. It is one evidence of that sense of measure ed form which is, in other direction also, a marked in the life and speech of the Arabs. The mere fact their verses they give so much attention to elegance ession deserves commendation. Among the defects poetry we must emphasize the loose connexion n the separate parts. We require a poem, like any work of art, to be a compact unity; the Arabs and other Orientals lay all the stress on the detail. In o'allaka of Tarafa, for instance, after the poet has long enough about his beloved, he starts off in this : "But I banish care when it comes near with a" uel of such and such qualities, and then proceeds e a description of his riding camel. Equally abrupt ions occur in almost all these poems, generally more nce in the same poem. In many cases a sort of unity erved by making the different sections represent so scenes from the life of the poet or from the common the Bedouins; but even then there is sometimes factory in the want of real connexion. It does not matters much when the poet keeps up a merely nical transition; as, for example, when he speaks his camel, then with the words "it is as swift as a ss which," &c., passes to a description of that animal. ain proceeds, "or as swift as an ostrich which," &c., r to introduce the ostrich.

loose structure of the poems explains the fact that very early period particular pieces were culled from works and recited by themselves. For the towns of later times this procedure was especially convenien em the wild ass or oryx-antelope had little attraction; the camel they bestowed about as much notice as on our dray-horses and waggons. But the love and he pride and scorn, the fierce lust of revenge and the g grief, the bravery and the gaiety, which breathed h the old Bedouin songs, had an intense fascination m. We see that their attitude towards that poetry some degree approximated to our own. Hence it is me anthologies from the old poetry, made by men of learning and ability, with an eye to contemporary are on the whole much more pleasing to us than th plete poems themselves. This is eminently true excellent collection edited by Abú Tammám, himself siderable poet (first half of the 9th century), und title "Hamása" (Valour). This collection, which, ho embraces many pieces of the Moslem period, is ex fitted to give a European a rather too favourable i ancient Arabic poetry. Whoever wishes really to that poetry and without this knowledge it is imp to understand the Arabs themselves or their langu must betake himself to those which, like the Mo'allak others, have been preserved more or less in their int

The Mo'allakat have been repeatedly printed, separate collectively, both in the West and the East, generally w Arabic commentary. A good commentary by a competent E is a real desideratum. A work of this kind would do more understanding of the poem than any poetical translation must always fail in rendering the delicate concrete expres the Arabs for which we possess neither the idea nor the ma translation must either be a mere paraphrase or else substitu thing utterly worse. (H

MOBILE, a city and port of entry of the United S the capital of Mobile county, and, though not the l the largest city of Alabama, lies 140 miles east o Orleans, on a sandy plain on the west bank of river, one of the arms of the Alabama. The mu boundary includes an area about 6 miles long or 3 m breadth, but, the suburban scattered about the nearer hill, the portion occup the buildings of the city proper is not more than square. In the matter of paving and trade the are generally good, and Government Street esp with its fine oak trees and garden, forms an att promenade. Beside the spacious granite building in 1859 to accommodate the Custom House, the Post and the United States courts the principal edifices Roman Catholic cathedral of the Immaculate Con (1833), Christ Church (Episcopal) (1837), the Cit pital (1830), the United States Marine Hospital (the Providence Infirmary, the conjoint market hou municipal buildings, Barton Academy (occupied high school), and the Alabama Medical College (fo in 1859). About 6 miles out, at Spring Hill, Jesuit College of St Joseph, established by Bishop in 1832. As a commercial centre Mobile is in s speci very favourably situated. It is the only Alabama, the estuary on which it stands is the ou several navigable rivers; and it is the seaward te of the Mobile and Ohio railroad, the Mobile and gomery, and the Grand Trunk. But, on the other it lies 25 miles from the coast, the lagoon like b cut off from the Gulf of Mexico by the narrow isth Mobile Point is extremely shallow, and in 1879 no drawing more than 15 feet could load and unl the harbour with safety. Since 1827, it is true, work have been undertaken to improve the appro the Choctaw Pass and the Dog River Bar, whi formerly a depth of little more than 5 and respectively, were deepened to 17 feet by 188 Mobile will not take rank as a satisfactory ocean p the scheme (operation) for constructing channel more than 20 feet deep right through the been fully carried out. The cost of the new survey being beyond the power both of the city and Stat gress has granted $70,000 for the purpose of w the channel to 200 feet, and deepening it to 25 f private company, established in 1876, has built a water in the bay, and greatly increased the safety harbour. For the years between 1855 and 18 average value of exports and imports was resp

9,266 and $711,420; the following figures for recent ow a considerable decline on the total:

	Export	Import
77	$1,374,171	$864,401
	9,495,306	1,115,112
79	6,219,818	511,678
0	7,188,740	425,019
1	6,695,140	671,252
	665	396,753

ton which form the staple export the falling off is pe cotton trade, 2,308 bales being the average for 1880 to 1 365,915, 392,709, and 295,040 bales the quantities for 0 and 1881. A great deal of what come to the Mobile nt to New Orleans for shipment, partly that it may higher price as "Orleans" cotton, lumber, shingles, d, cotton, hides and wool, and cotton are also important ut do not make in the aggregate so much as half the value otton. Among the local industrial establishment are pommercial mills, cooperages, shipbuilding yards, , and sash and door works. The market gardens of the produce a large quantity of cabbages, potatoes, water tomatoes, &c., for supply the cities of the western and 1870, $411,270, 1880, $171,480, 1881, 1882, $367,191, 1883 (estimated $700,000). Though it has never been a fashionable resort, Mobile had 31,560 the figure for the municipal district in 1880) in 1890, 29,132 (1880), 29,258 (1870), and 32,034 (1870). fied as a port by Lemoyne d'Iberville (le Moyne) in 1702, esteemed to be the capital of the colony of Louisiana till here the seat was transferred to New Orleans. The re by Lemoyne were probably about 90 and above the pre ation, which however appears to have been much exceeded after the flood of 1711. Treaty of Paris, 1763, Mobile and part of Louisiana were to Britain; but in 1780 the fort (now Fort Charlotte) was (by an expedition sent from Cuba) and in 1783 it was recog Spain by treaty with other British possessions on the Gulf of Mexico. Governor William C. C. Claiborne, appointed governor of Louisiana territory, recovered in for Lemoyne on the 16th of April 1813, though the population exceed 2000. It was incorporated as a city. In 1814–15 and the neighbourhood was the scene of important military de operations. The British fleet and troops (1814) were lines of defence erected about the district of West Florida Lawrence, and the capture of Fort Morgan (sometimes spoken of Fort Bowyer, before its recent extension). A municipal Mobile had to struggle with financial difficulties. In 1879 city charter was repealed and a board of commissioners hed for the liquidation of the debt (see § 197–200).

BIUS, AUGUST FERDINAND (1790–1856), astronomer athematician, was born at Schulpforta, November 17, 90. At Leipsic, Gottingen, and Halle he studied r years, ultimately devoting himself to mathematics tronomy. In 1815 he settled at Leipsic as privat- and the next year became extraordinary professor ronomy in connexion with the university. Later director of the university observatory, was elected (1848–49) under his superintendence. ll he was elected ordinary professor of higher and astronomy, a position which he held till 26, 1868. His doctor's dissertation, *Specimen calculationis per plicas*, brought established his reputation as a theoretical Die Hauptsätze der Astronomie* (1836), *Die Lehre von den Kometen* (1843), may be noted st for their perfect mathematical publications. Of special interest, however, are his labours in pure , which began for the most part in Crelle's al from 1827 to 1832. These papers are chiefly nical, many of the leading developments and appli s of the method laid down in his great work, *Der ycentrische Calcul* (Leipsic, 1827), which, as the name s, is based upon the properties of the mean point or of mass. Any point in a plane (or in space) can be ated as the mean point of three (or four) fixed by giving to the proper weights or coefficients. ous principle which leads in the hands of Mobius t revolution is the chief novel feature of the work, a system of homogeneous coordinates. Besides this ever, the work abounds in suggestions and foreshad of some of the most striking discoveries in more times such, for example, as are contained in Gras *Ausdehnungslehre* and Hamilton's *Quaternions*. H be regarded as one of the leaders in the introduc the powerful methods of modern geometry that hav developed so extensively of late by Von Standt, Cr and others.

MOCHA, a town of Yemen on the coast of the R m E. long. 43° 20′, N. lat. 13° 19′. The point of th where Mocha lies appears to have owed early anchorage, for the Muza of the *P (Comm. Or. Mar.* i. 2–3 *sqq.*), a great seat of the R trade in antiquity, seems to be identical with the Muzá (Yakut iv. 680, Niebuhr, *Desc. de l'Arabie*, p a few miles inland from Mocha. Mocha itself is a towns, which rose with the coffee trade into short-lived perity. The French expedition of 1709 found it a some 10,000 inhabitants, and its importance had in half a century later, when Niebuhr visited it. Th trade was then with British India. Lord Valencia i still found the town to present an imposing aspect, two of the minarets and lofty buildings; but the town had sunk to 5000. The internal disorders of and the effort of Mohammed Ali to make the coff again passed through India accelerated its fall, and th is now a mere village. Mocha never produced coff lies indeed on a quite waterless plain; the European Mocha coffee is derived from the shipment of coffe The patron saint, Sheikh Shadali, was, according to the founder of the city and father of the coffee trad

MOCKING BIRD, or Mock Bird (as Charleto and Catesby wrote its name), the *Mimus polyglo* modern ornithologists, and the well-known repres of an American group of birds usually placed am THRUSHES (*q.v.*), *Turdidae*, though often regar forming a distinct section of that Family, diffe having the tarsus scutellate in front, while the Thrushes have it covered by a single horny plat Mockers had inhabited the greater part of the States, being in the north only a summer visitan though breeding yearly in New England, is not there, and migrates to the south in winter, passi on to the Gulf States and Mexico. It appears t numerous on the western side of the Alleghanies, found in suitable localities across the continent Pacific coast, but not farther northward than Wa and is said to be common in Kansas. Audubo that the Mocking-birds which are resident all the ye in Louisiana attack their travelled brethren on the of the latter from the north in autumn. The n the poets, both English and scientific, have been l from the capacity of success fully imitating the cry other birds, to say nothing of other sounds, in add utterance notes of its own which possess a varied ra liquid tube- of tone that are unequalled, according admirers, even by those of the NIGHTINGALE (*q.v.*) opinion may perhaps be correct; but, from the of the only satisfactory judgment can scarcely now need, since a comparison of the voice of one bird can only be made from memory, and t comparison affected by associations of ideas which wo elude a true estimate. To hear either bird at its must be at liberty; and the bringing together of examples, unless it could be done with so many specimens as to ensure an honest trial, would be of litt Plain in plumage, being greyish-brown above a white below, while its quills are dingy black, va with white, there is little about the Mocking-bird's

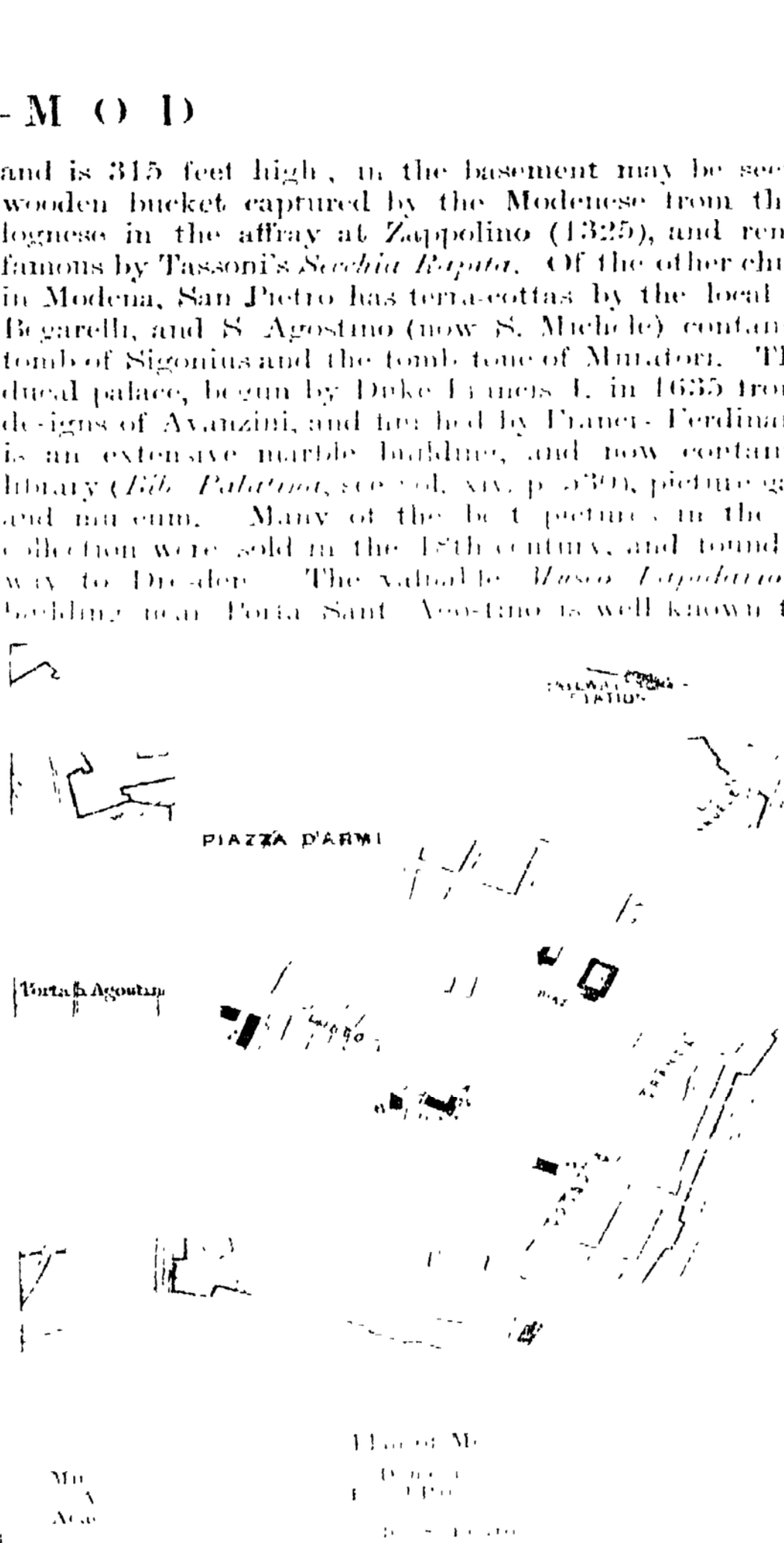
yond its graceful form to recommend it; but the
gesticulations it exhibits are very attractive, and
its European rival in melody is far surpassed, for
k bird mounts aloft in rapid circling flight, and,
g on a conspicuous perch, pours forth his ever
g song to the delight of all listeners; while his
in attendance on his mate are playfully demonstra-
d equally interest the observer. The Mocking bird
over of familiar habits, haunting the neighbourhood
es, and is therefore a general favourite. The nest
d with little regard to concealment, and is not dis
hed by much care in its construction. The
ree to six in number, are of a pale blush green,
d and spotted with light yellowish brown. They,
as the young, are much sought after by snakes, but
rents are often successful in repelling these deadly
s, and are always ready to wage war against any
r on their precincts, be it man, cat, or hawk. Their
various, consisting of berries, seeds, and insects
twelve or fourteen other species of *Mimus* have been
mostly from South America, but *M. gilvus* ranges
to some of the Greater Antilles and *M. lecontei*
, while the Bahamas have a local race in *M. gundlachii*
called Mountain Mocking bird (*Oreoscoptes montanus*)
t very distant from *Mimus*, but, according to Mr Ridgway,
on exclusively the plains overgrown with *Artemisia*
tableland of North America, and not at all in
s, so that it is an instance of one order of birds
ecta allied to *Mimus*, those known as the Thr
s, and belonging to the genus *Harporhynchus*
eight species are found in North Am
like in their habits must be mentioned, but two
re to dwell on the Cat bird (*Galeoscoptes carolinensis*)
y as accomplished an imitator of sounds as its
relative, with at the same time powers of

that, deepening into black-ish brown on the crown and
pervades the whole of its plumage; the lower tail coverts
are of a deep chestnut, excepted under the conspicuous
and though, for some reason or other, far from being
te, it is always welcome when mid-winter may become intimate
n's abodes. It has a much wider range on the American
nt than the Mocking bird, and is one of the few species that
ndered in Bermuda, while on more than one occasion it has
have appeared in Europe.

name Mocking bird, or more frequently Mock Nightingale,
nd occasionally given to some of the Warblers (*Sylviidae*),
lly the Blackcap (*Sylvia atricapilla*), and the Sedge bird
phalus schœnobænus). In India and Australia the name
s sometimes applied to other species.

DENA, one of the principal cities of Northern Italy,
rly the capital of a duchy, and still the chief town
rovince and the seat of an archbishop, is situated in
pen country in the south side of the valley of the Po,
en the Secchia to the west and the Panaro to the east
il it is 31 miles E.S.E. of Parma, 71 W.N.W. of
na, and 37 S. of Mantua. The observatory stands
eet above the level of the sea, in 44° 38′ 52″ N. lat.
0° 55′ 42″ E. long. Dismantled since 1846, and now
y converted into promenades, the fortifications still
the city an irregular pentagonal contour, modified at
orth-west corner by the addition of a citadel also penta

Within this circuit there are various open areas
pacious Piazza d'Armi in front of the citadel, the
gardens in the north-east of the city, the Piazza
le in front of the cathedral, and the Piazza Reale to
uth of the palace. The Emilian Way cross saddlingly
through the heart of the city, from the Bologna Gate in
st to that of Sant' Agostino in the west. Commenced
e countess Matilda in 1099, after the decrees of
ane, and consecrated in 1184, the cathedral (St
nian's) is a low but handsome building, with a lofty
, three eastern apses, and a façade still preserving some
as sculptures of the 12th and 15th centuries. The
ower, named La Ghirlandina from the bronze garland
nding the weathercock, is lined with white marble,



and is 315 feet high; in the basement may be see
wooden bucket captured by the Modenese from th
lognese in the affray at Zappolino (1325), and ren
famous by Tassoni's *Secchia Rapita*. Of the other chu
in Modena, San Pietro has terra-cottas by the local
Begarelli, and S. Agostino (now S. Michele) contain
tomb of Sigonius and the tomb-stone of Muratori. Th
ducal palace, begun by Duke Francis I. in 1635 fro
designs of Avanzini, and terminated by Francis Ferdinan
is an extensive marble building, and now contain
library (*Bibl. Palatina*, see vol. xiv. p. 830), picture g
and museum. Many of the best pictures in the
collection were sold in the 18th century, and found
way to Dresden. The valuable *Museo Lapidario*
building near Porta Sant' Agostino is well known t

classical antiquary through Cavedoni. *Dichiarazione*
antiche iscrizioni Modenesi (1852) and the supplement
Memorie of the Academy vol. ix., &c. The univer
Modena, originally founded in 1683 by Francis
mainly a medical and legal school, but has also a
of physical and mathematical sciences. It has
twenty-five professors and from 200 to 250 stude
library of 90,000 volumes, an observatory, botanic
den, an ethnographical museum, &c. The old a
of the *Dezimato*, dating from 1684, was reste
Francis in 1841, and now forms the flourishing
Academy of Science and Art (*Memorie* since 182
there are besides in the city an Italian Society of
founded by Anton Mario Lorgna, an academy
art, a military college (1859), an important scie
college, and a lyceum and gymnasium, both name
Muratori. In industrial enterprise Modena sh
little activity, silk and linen goods and iron ware
almost the only products of any note. Comm
stimulated by a good position in the railway s
by a canal which opens a water way by the Lag
the Po to the Adriatic. The population of the
32,218 in 1861, and 30,854 in 1871; that of th
mune 50,513 in 1861, and 58,005 in 1881.

The Duchy of Modena, an independent sovereig

to 1859), ultimately extended from the Po to the
rranean, and was bounded N. by Lombardy and the
States, E. by the Papal States and Tuscany, S. by
y, Sardinia, and the Mediterranean, and W. by
a and the duchy of Parma. Its greatest length,
orto Vecchio, on its northern frontier towards Man-
the outlet of the Parmignola torrent, on the Sardinian
was 84½ miles; and its greatest width, from the
Calama, on the Papal and Tuscan frontier, to the
ank of the Enza, on the frontier of Parma, was 37
The area was 2,371 square miles, of which three
were mountainous. In 1855 the population was
). The duchy had six provinces—Modena, Reggio,
lla, Frignano, Garfagnana, Massa Carrara.

na is the ancient Mutina, which it was annexed by the Romans
th the rest of the territory of the Boii. In 183 B.C. Mutina
the seat of a Roman colony. During the civil wars Mutina
held out within its walls against Pompeius in 88 B.C., and
the place was defended by D. Brutus against M. Antony.
century found Mutina in a state of decay, the ravages of
nd the troubles of the Lombard period left it a ruined city
ted land. In the 8th century its exiles founded at a dis-
f miles to the north-west a new city, Citta Gemmiana (still
ted by the village of Cittanova); but about the close of
century Modena was re-founded and refortified by its bishops,
ns. When it began to build its cathedral (1099 A.D.) the
part of the possessions of the countess Matilda of Tuscany,
on in 1184, the edifice was consecrated by Lucius III., it
e community. In the wars between Frederick II. and
IX. it sided with the emperor, though ultimately the papal
as strong enough to introduce confusion into its policy. In
zzo d'Este was recognized as lord of the city, after the
his successor, Azzo VIII. (1308), it resumed its communal
dence, but by 1336 the Este family was again in power
ted a duchy in 1452 in favour of Borso d'Este, and enlarged
ngthened by Hercules II., it became the ducal residence on
rporation of Ferrara with the States of the Church (1598).
d. (1629-163[illegible]) erected the citadel and commenced the palace
as largely embellished by Francis II. Rinaldo (*ob.* 1737)
e driven from his exile by French invasion. To Francis III.
780) the city was indebted for many of its public buildings
s III. (1727-1803) saw his states transformed by the French
Cispadine Republic, and, having refused the proffered
gan and Ottaviano of reclamation by the treaty
Formio, died an exile at Trieste. His only daughter, Maria
, married Ferdinand of Austria (son of Maria Theresa), and
their eldest son, Ferdinand, received back the *State Estense*
was subservient to Austria, reactionary, and despotic. On
eak of the French Revolution of 1830 Francis IV. seemed for
a time to encourage the carte pondire movement in Modena,
sooner had the Austrian army put an end to the insurrection
al Italy than he returned to his previous policy. Francis
nd V., who succeeded in 1846, followed in the same ill-
xample. Obliged to leave the city in 1848, he was restored
Austrians in 1849, ten years later, on 20th August, the
entatives of the Modenese, under the direction of Cavour
clared their territory part of the kingdom of Italy, and
ation was confirmed by the plebiscite of 1860.

of Modena are Pallopius the anatomist, Targioni,
dal tozzi, Sigonius, Tassoni and Corsini the archæologist,
of Zeccara, Tiraboschi and Muratori are associated with
y. Tiraboschi's *Biblioteca Modenese*, 6 vols., contains
of all the literary personages of the duchy.
Modena, 1863, Tiraboschi, *Memorie storiche modenesi*,
Memorie per la storia di Modena, 1793, Oreste Raggi, *Memorie*
Modena, Vedriani, *Modena illustrata*, 1837, Galvani, *Memorie*

DICA, a city of Italy in the province of Syracuse
y, 8 miles from the south coast, on the line of rail
ected in 1872 between Syracuse and Licata. It
ased its communal population from 30,517 in 1861
31 in 1881, and is a well-built and flourishing place.
among the public buildings are the old castle on
, the mediæval convent of the Franciscans, and the
of S. Maria del Carmine (1150) and S. Maria di
this last containing part of the ancient temple
ed by the earthquake of 1693. Modica is the point
hich the remarkable pebble tumuli, tomb and dwelling
f Val d'Ispica are usually visited. An early de-
y of Syracuse, Motyca or Motyca was in it. Cicero's
days a fairly important municipium. In modern
was held as a countship by the dukes of Alba.
Caraffa has written a prolix history of the city, whi
be found in Graevius, *Thes. Ant. et Hist. Ital.*, vol.

MOE, Jorgen Engebretsen (1813-1882), Nor
poet and comparative mythologist, was born at
Sigdal, Ringerike, Norway, on 22d April 1813, and
the university of Christiania as a theological student
age of seventeen. After leaving the university in
acted as tutor in various schools and families, and i
was appointed professor of theology in the Military
of Norway, which post he held until 1853, when he
resident chaplain in his native parish of Sigdal. In
received the living of Bragernes, Drammen; in 18
at Vestre Aker near Christiania; and in 1875 the bi
of Christiansand, where he died on 27th March 188

Moe's first publication was a volume of Norse "songs
of travel," which appeared in 1840; it was followed in
the *Norske Folke-eventyr* (Norwegian Popular Tales), which
collected along with his schoolfellow Asbjornsen. The work
such interest as a contribution to the study of comparative my
that in 1847 he was sent by the Government through Th
and Setersdal to increase his collection of stories. The
enlarged edition, with a preface by Moe, appeared in 18
1851 his *I Brønden væver Tornet* (In the Well and in the
delightful collection of prose stories for children, appeared
was followed in 1852 by a volume of poems entitled *En liden*
(A Little Christmas Present). In 1877 he prepared a
edition of his works in two volumes, the stories he had p
along with Asbjornsen being excluded. Many of the *Folke*
Dunbar Pieces from the Norse) were translated by Sir
Dasent in 1859.

MOESIA (in Greek Mysia, or, to distinguish it fr
country of the same name in Asia, Mysia in Euro
ancient geography the territory immediately to the s
the Danube corresponding in the main to Servia a
garia. It became a Roman province between 27 B
6 A.D., probably about 16 B.C.[1] In the time of T
and Caius the province was under the same govern
Macedonia and Achaia. It was divided by Domiti
two provinces, Mœsia Superior (Servia) and Mœsia
(Bulgaria); and the same emperor completed th
military road along the line of the Danube, increas
strength of the Roman forces in the country, and,
conquest of Dacia, saved it from the inroads by w
had been harassed from the time of Tiberius. The
invaded Mœsia in 250 A.D., and at last, in 395, a
of them, afterwards known as Mœsogoths, obtain
mission to settle in the province. The Slavonia
Bulgarians appear in the 7th century.

The boundary between Upper and Lower Mœsia was not
a. Ptolemy (iii. 9, 10) states, by the river Cebrus or
(Cibritz or Zibrin), but a may be inferred from an inscriptio
(*Inscr. Lat.*, vol. iii. 2 *additamenta*), lay between Almu
and Ratiaria (Artchar). Upper Mœsia, or, as it was often
Mœsia Prima, contained Singidunum (Belgrade), head
of Leg. IV. Flavia and in the 3d century a colonia; Vim
also of the headquarters of Leg. VII. Claud., and designate
time Pannoniæ quam Ulpiam, but more usually colonia (a rank h
out by coordinate), Bononia (Widin); Ratiaria, which, on
of Dacia, became the headquarters of Leg. XIII. gemi
remained a large town till it was destroyed by Attila; Re
Mastaki Le Pecha Palenkay, which has furnished inscriptions
me to be identified Ulpiana; and Naissus (Nissa or Ni
birthplace of Constantine the Great. Lower Mœsia (Mœsia I
contained Oescus (Colonia Ulpia, mod. Gigen), headquarte
legio V. Macedonica; Nova (Sistova), at a lat
camp of Leg. I. Ital. and afterwards chief seat of Theodo
of the Goths; Nicopolis ad Istrum (Nikup), really on the
Vantra, a memorial of Trajan's victory over the Dacians;
Rustchuk), Varna (Nicopoli on the Osma), Dorostorum (S
Odessus (Varna), Tomi (Kustendje), Troesmis (Iglitza).

See Roesler, *Romanische Studien*, 1871; Pötzner, *Gesch. der Völ*
Völkerwanderung, i.-ii., pp. 2-161, Hahn, in *Oesterr. K. Ak. der Wiss.*, Ph
Vienna, 1861, p. 278.

MOFFAT, a health resort of some note in Scot
situated in Upper Annandale, Dumfriesshire, occupy

[1] See A. W. Zumpt, *Commentat. Epigraph.*, ii. 253 *sq.*

ble position at the base of the Gallow Hill, 63 miles Edinburgh, and 42 miles from Carlisle by railway. pa, which is 1¼ miles above the town (525 feet sea-level), is sulphureous with some saline ingre- and is used in gout, rheumatism, and dyspepsia. tion (1881) 2161; in the season about 4000.

FFAT, Robert, D.D. (1795-1883), African mission- as born at Ormiston, Haddingtonshire, Scotland, ecember 1795, of humble parentage. Moffat learne ft of gardening, but in 1814 offered himself to the n Missionary Society, who, in 1816, sent him out to Africa. After spending a year in Namaqua Land, he powerful and dreaded chief Africaner, whom he ted, Moffat returned to Cape Town in 1819, and l Miss Mary Smith, a remarkable woman and most wife. In 1820 Moffat and his wife left the Cape oceeded to Griqua Town, and ultimately settled at an, among the Bechuana tribes lying to the west of al river. Here he worked as a missionary till 1870, e reluctantly returned finally to his native land. He frequent journeys into the neighbouring regions, a- th as the Matabele country, to the south of the si. The results of these journeys he communicated Royal Geographical Society (*Journ. R. G. S.*, xxv. and *Proc.* ii.), and when in England in 1842 he ed his well-known *Missionary Labours and Scenes th Africa*. Single-handed he translated the whole Bible into Bechuana. While solicitous to turn the to Christian belief and practice, Moffat was perhaps t to take a broad view of the missionary function, realize the importance of influencing the savage to the arts of civilization. He himself was builder, ter, smith, gardener, farmer, all in one, and by pre nd example he succeeded in turning a horde of irsty savages into a "people appreciating and ting the arts and habits of civilized life, with a language of their own." Now we find more or less anized communities extending from Kuruman to e Zambesi. Moffat met with incredible discourage nd dangers at first, which he overcame by his strong determination, and genial humour. It was largely him that the work of Livingstone, his son-in-law, e direction which it did. On his return to England, received a testimonial of about £6000. He died gh, near Tunbridge Wells, 9th Aug. 1883.

Scenes and Services in South Africa, the Story of Moffat's ary Labours, London, 1876; and publications of the London ary and the B. and F. Bible Societies.

GADOR, or Suerah (Berber *Tasaût*), the most rn seaport town on the Atlantic coast of Morocco, e capital of the province of Haha, stands from 10 feet above high water on a projecting ridge of cal s sandstone in 31° 30′ N. lat. and 10° 14′ W. long. tain states of wind and sea it is turned almost int nd, and a sea-wall protects the road to Safli. T are regular and, for a Moorish town, broad and clean. n the walls there are three distinct divisions, the s old and new with the government buildings, to rth-west the outer town with its spacious marke centre; and at the north-west corner the Mellah, ws' quarter. In the citadels the houses are fairly and considerable attention is paid to sanitary matters. is brought from the Kseb, about 1½ miles to the by an aqueduct. The prosperity of Mogador is due commerce; only a few gardens break the barren f the immediate vicinity. The harbour or roadstead, apparently protected by the island and quarantine of Mogador, is extremely dangerous during west uth-west winds. Trade is carried on mainly with illes, London, Gibraltar, and the Canaries, the prin cipal exports being almonds, goat-skins, gums, oli and ostrich feathers, and the principal imports cotton (half of the total) and tea. The average value of ports for the five years 1877 1881 was about £210,0 imports rather less. Attention has been frequently d to the value of Mogador as a health resort, especi consumptive patients. The climate is remarkably s mean temperature of the hottest month 71·06, of month 58·69. The annual rainfall is only 10 or 12 and the rainy days of winter and spring about 28. sirocco is but rarely felt. The population is about (7000 Jews, about 150 foreigners). Jews, Prote and Roman Catholics have religious edifices in the t

A place called Mogador is marked in the East Portion of t ventrum Library, and the map in Hondius's *Novus Mundus* sh island of Mogador *I. Domegatoor*, but the origin of the preser is much more recent. Mogador was founded by Sultan Moh and completed in 1770. The town received from the Mo name of Suerah (little pictured) which the Portuguese called the shrine of Sidi Mogadul, which lies towards the south h to the village of Diabat, and forms a striking landmark for In 1844 the citadel was bombarded by the French.

MOGHILEF, a north-western government or pr of the Russian empire, situated on the upper D between the provinces of Vitebsk and Smolensk north and east, Tchernigoff and Minsk on the sout west. In the north it is occupied by the water-shed separates the basins of the Dwina and the Dniep undulating tract from 650 to 900 feet above the se and covered nearly everywhere with forests. This shed slopes gently to the south, that is, to the v the Dnieper, which enters the province from the east and flows west and afterwards due south. southern part of the province is flat and has much in common with the Polyesie of the province of Minsk however, more habitable, the marshes being less ext

The province is covered in the Tertiary formation, D sandstone appears in the north, and Carboniferous lime ston east. The soil is mostly out clay-shale clay and potters not uncommon, and peat bogs, with a few patches of earth. The climate is cold and wet, the average yearly t ture at the Gorki meteorological observatory being 10 (11·2 in January and 63·8 in July), cold nights in sum often the cause of bad crops. The province has about 1, inhabitants (947,695 in 1870, mostly White Russians cent. belonging to the Greek Church, Jews are numerous cent.), Poles, belonging mostly to the nobility, make on cent. of the population. Agriculture is the chief occu nearly one half the surface of the province crop, but, except after unusually good harvests, corn is mostly by the navigable channel of the Dnieper and Sos are many distilleries on the estates of landowners, and wh is exported. The hemp cultivated is important, hemp and seed oil are exported to Libau. The province has some iron mill, a few iron and copper works, and minor manufactures.

The province of Mohilef is divided into eleven districts the chief town. Mohilef (46,500 inhabitants), Chausy (Chaikof 2900, Gorki (3,000 Gorki, formerly the se agricultural institute (Cohen, Krasnoi (7000), Mstislavl (Orsha 5350, Rogachef (2,0, Surazh Bykhof (3,700), and (2,500). Of these the other municipal towns are inhabi (13,000 inhabitants), Dubrovka (7000 Krichef (4000).

The province was inhabited in the 10th century by the and Radimichi. In the 11th century it became part of L and afterwards of Poland. Russia annexed it in 1772.

Mogilef on the Dnieper, a town of Russia, of the province of the same name, is situated on bank of the Dnieper 10 miles south of the Orsha of the railway between Moscow and Warsaw. A along the Dnieper will soon bring Mogilef into communication with these capitals.

Mogilef is mentioned for the first time in the 14th as a dependency of the Vitebsk or of the Smolensk pro At the beginning of the 15th century it was the property of the Polish kings. But it was successively p etted by Russians, who attacked it six times dur 16th century, or by Cossacks, who plundered it three ti the 17th century its inhabitants who belonged to the Greek suffered much from the persecutions of the Latin

…ered to Russia, but in 1661 the Russian garrison was …d by the inhabitants. In the 18th century it was taken …times by Poles and by Swedes, and in 1708 Peter I. …t to be almost razed by fire. It was annexed to Russia in …1340,000 inhabitants two-thirds are Jews and the remainder …Russians and Poles 2500). Its manufactures are …unimportant, but one branch of trade, namely, the prepa… …, has maintained itself for many centuries. The … …in the hands of Jews: corn, alcohol, and … from the south, while skins and manufactured … …mainly by Germans, are sent to the …provinces.

MOGILEV-ON-THE-DNIESTER (*Mohilev*), a district town …ia, situated in the province of Podolia, on the left … the Dniester, 87 miles east-south-east of Kamenetz-…, and 13 miles from the Zhmerinka railway junc… It has 18,200 inhabitants, nearly one half of whom …s; the remainder are Little Russians, Poles (1500), …w Armenians. The Little Russian inhabitants of … carry on agriculture, gardening, wine, and mul… culture. The Jews and Armenians are engaged in … trade with Galicia, to which they send corn, wines, … and timber. Coal is brought down from Galicia, as well as … interior, to which they send manufactured wares … from Austria.

…ill, named by Cossacks of the Monastyrian hetmanate Mohile… …ded by Count Potocki from the end of the 16th century … it remained on the way from Moldavia to the Ukraine … a settlement of Poles, it developed rapidly. For more … years it was the property of the Cossack hetmans, the Poles, and the … It remained in the hands of the Poles, and was annexed … in 1793. The Crown property of Mohilev-Podolski …

MOGILA, PETER (1596–1647), metropolitan of … …, belonged to a noble Wallachian family, … born about the year 1596. He studied for some … the university of Paris, and first became a monk … He was the author of a *Catechism* (Kieff, 1645), … other works, but is principally celebrated for … *Orthodox Confession*, drawn up at his instance by the … low Lot of Kieff, approved at a provincial synod … 3, and accepted by the patriarchs of Constantinople, … Alexandria, and Antioch in 1642–3, and by … of Jerusalem in 1672. See GREEK CHURCH, … p. 158.

…are numerous editions of the *Confession* in Russian; it has … …ted in Greek and Latin by Panagiotes Nicusios (Amsterdam 1662; …nann (Leipsic 1690) and by Lomonosov (Jena 1743), and … German translation by Erich (Frankfort 1727).

MOGUL, or MUGHAL, معل, the Arabic and Persian … the word Mongol, usually applied to the Mongol … in India. See INDIA, vol. xii. p. 793 *sqq.*

MOHACS, a market town in the Trans-Danubian county … Hungary, stands on the right bank of the west … the Danube, 25 miles east-south-east of Pecs (Funf… …), with which it is connected by railway, 45° 58′ N. … 37′ E. Here … At Mohacs there are several churches … belonging, both to the Roman Catholics and … to the summer palace of the bishop of … an old castle, and a station for steamers … on the Danube, by which means a considerable … and the agricultural produce of the … is carried on with Budapest and Vienna. … from Siklos, the coal mines, and the town is an … coal depot of the Danubian Steam Navigation … The population in 1880 was 12,017 (Magyars … and Germans).

…great battle took place in the vicinity of the town, mark… …ment and decisive defeat of the Turkish dominion in Hungary. … 29th August 1526, the Hungarian army under Louis … annihilated by the Ottoman forces led by Soliman the … (see vol. xii. p. 566). In the second (12th August) … Austrians under Charles of Lorraine gained a great and … victory over the Turks, whose power was afterwards still … by Prince Eugene of Savoy.

MOHAIR is the woolly hair of a variety of the co… or domestic goat inhabiting the regions of Asiatic T… of which Angora is the centre, whence the animal is … as the Angora Goat (see GOAT, vol. x. p. 708). … hair has been known and used as a textile material … East from the most remote periods; but neither the … goat nor its wool was known in Western Europe … 1655, the animal was described by the naturalist T… tort. That textures of mohair were in use in E… early in the 18th century is obvious from Pope's allus…

> "Arm'd when she goes her friend in deep despair,
> Observes how much a chintz exceeds mohair."

Owing, however, to the jealous restrictions of the T… power, it was not till 1820 that mohair became a … article of import into the United Kingdom. In th… a few bales came into the market; but so little w… material appreciated that it only realized 10d. per … 1870 average mohair fleece was selling at five tim… price. From the small beginning of 1820 the i… gradually waxed, and the trade received a very co… ble impetus through the introduction in 1836, by … Salt, of the analogous fibre alpaca. The increasing d… for and value of mohair early stimulated endeavo… acclimatize the Angora goat in other regions; … European attempts have failed, owing to humid a… genial climates. In 1849 a flock was taken by D… Davis to the United States of America, and sinc… time many fresh drafts have been obtained and dist… to Virginia and various Southern States, and to Ca… and Oregon in the west. In these high and dry … the goat thrives, and the flocks in the Western … now number many thousands. The Angora goat h… been introduced into the Cape of Good Hope with … success. The first importation of mohair from the … made in 1862, amounted to 1036 lb; and now abo… tenth of the total British supply is received fro… source. Mohair has also been received in Englan… goats reared successfully in Fiji, where they were … troduced in 1874, and there are also thriving fl… Australia.

The trade in mohair between Asia Minor and western E… controlled in Constantinople. There upwards of twenty … of fleeces are distinguished according to the localities of th… duction, the richest and most lustrous qualities being pro… hilly and forest regions, while the fleeces from the open p… comparatively kempy, coarse, and cottony. From the La… district on the eastern borders of Asiatic Turkey a distr… inferior variety of wool is obtained. It is known in comm… Van mohair, and counts, to the extent of about 70 per cent., … wool slightly streaked with black, with 30 per cent. of colo… and black wool. At Konieh in the south, also, an inferior … known as Petoloms is produced, 80 per cent. of which is bl… d and the remainder white. The average weight of an … ost fleece is from 5 to 6 lb. The finest quality of wool is … om the first clip, which is made in the second year of the … She-goats yield the best wool, after which come wether … the ram gives the coarsest fleeces. Angora mohair is a … white lustrous fibre elastic and wiry in character, and d… felting properties. It attains the length of four or five inc… the long fibre is mixed with an undergrowth of shorter woo… in the spinning process is combed out as "noils" for separ… It is a material of enormous durability, and, owing to its ten… elasticity, it is especially fitted for working into long piled … as plush and imitation furs, or for use in braids and b… and boot and other laces. It is largely used for making … velvet or furniture plush for the upholstering of railway c… & … trade centred at Amiens. In the making of imitati… ons and imitation beaver, otter, chinchilla, and other f… for carriages generally, mohair is extensively employed. … stuffs of mixed mohair and alpaca, cotton, or silk … manufactured; but with changes in fashion such materials … stantly changing in style, composition, and name. Mohai… used for making certain qualities of lace, and an imitation o… feather for use in trimming has been made from the fibr… Imports of mohair into the United Kingdom during 1882 a… to 10,859,771 lb, valued at £1,433,584, a quantity largely i… of the imports of any previous year.

MESOPOTAMIA.

MOHAMMEDAN EMPIRE

English Miles

MOHAMMEDANISM

UNDER this head is given the history of Mohammed and his successors to the fall of the Eastern Caliphate, with a sketch of the institutions and civilization of the Moslem empire and an account of the Koran. The later history must be sought under the names of individual countries, dynasties. What falls to be said of the social and religious aspect of Islam in modern time will be given under the two great divisions of SUNNIS and SHI'ITES.

PART I. MOHAMMED AND THE FIRST FOUR CALIPHS.

MOHAMMED[1] or MAHOMET, the founder of Islam, first appears in the full light of history with his Flight to Medina (The Hijra), A.D. 622, and the date, not that of his birth, has been intimately chosen as the epoch of the Moslem Era. The best attested tradition places his first appearance as a prophet in Mecca some twelve years earlier (*circa* 610). He was then forty years old; the forty must be taken as a rounded number but as such is doubtless trustworthy. Thus the birth of Mohammed falls about 570 A.D.—it is not to have been in the year when Abraha, the Abyssinian viceroy of Yemen, led the expedition against Mecca, mentioned in the Koran when the Arabs first saw the elephant and first suffered from smallpox.[2]

At the time of Mohammed's birth and youth other events seemed less likely than that the Arabs should presently make their triumphal entrance into the history of the world as victors over the Greeks and Persians. Nowhere in the Peninsula was there an independent state of any considerable power and importance. At the beginning of the 6th century indeed the princes of Kinda had attempted to form a national kingdom, uniting in particular the tribes of central Arabia; but the kingdom was nothing more than an epic prelude to the true history of the Arabs, which begins with Islam. After the fall of the Himyarite dynasty, the old anarchy reigned supreme among the nomads of the Nejd and the Hijaz; in all other quarters Greek or Persian influence predominated, extending from the frontier deep into the interior by the aid of two vassal states, the kingdom of the Ghassanids in the Hauran under Greek suzerainty, and that of the Lakhmids in Hira and Anbar under the Persian empire. The antagonism between Byzantium and Ctesiphon was reflected in the feud of the Arab lordships[3]; but indeed the rivalry of Greek and Persian exercised its influence even on the distant South of the Peninsula. Urged on by the Greeks, the Abyssinians had overthrown the Christian hegemony of the Himyarites, the sunken remnant of the ancient might of the Sabæans (A.D. 526), the Persians had helped a native prince again to expel the Christians (*circa* 570), and since then the Persians had retained a footing in the land. Toward the close of the 6th century, their direct and indirect influence in Arabia greatly surpassed that of the Greeks, and since the Kindite dead fallen before the Lord of Hira, it extended right down to the Nejd into Yemen.[4]

In the Hijaz and western Nejd, the district from which Islam and the Arab empire took their beginnings, Greek and Persian influences and Ghassanid and Lakhmid rule had not made themselves felt. The nomad tribes, and the few urban communities that existed there lived their own life entirely under Arab forms, after the manner of their father-city Mecca, which the Banu Khuzaa had formed a settlement round the Ka'ba, the sanctuary of a number of tribes destined to be associated with Mecca but belonging to that district. The Ka'ba was annually observed on the day before the full moon of the month Dhu'l Hijja at Mecca and at 'Arafa and Kozah, the vicinity, presented scenes of attraction for all inhabitants of the Hijaz, and grew into a great fair, at which the Meccans sold to the Bedouins the goods they imported from Syria. Feast and fair gave the city the prosperity which it shared with other cities which, like Mecca, had the advantage of lying near the meeting-place of the great natural road to Yemen—that from the north where the Red Sea coast, and that from the north-east following the line of the mountains that traverse the Nejd.

By these trading journeys the Koraish had acquired knowledge of the world, especially of the Graco-Syrian world; the relative superiority of their culture raised them not only above the Bedouins, but above the agricultural population of such a city as Medina; the art of reading and writing was pretty widely diffused among them.[5] The Koraish within the city were the Banu Kathir and Lo'ayy, those in the surrounding country Banu 'Abd Manaf and Sahm; the town-men proper were again subdivided into Makhzum and Nofal; the latter were the new-comers, who withdrew from the old settlers by the more recent of the other Arabian towns, as Taif and Hira. The community was a mere confederation of near kindred; separate quarters occupied by its own quarter, there was no private property, towards each had no civil duty. Only for hostile attack in the general interest were they held together under the leadership of the Koraish who dwelt in the quarter nearest the Ka'ba, the Hashimites (the house of 'Abd al-Muttalib), the 'Abd Shams (the house of Umayya), and the Nofal (the house of Abd al-'Uzza, afterwards called Umayya).[6] Each quarter had its own chief, the Hashimite (the house of 'Abd al-Muttalib), the 'Abd Shams (the house of Umayya), and the Nofal (the house of Abd al-'Uzza, afterwards called Umayya).[7

Mohammed [illegible] Abdallah b. 'Abdalmottalib, did not live to see the fourth, and in mother's [illegible] died while he was still a child. Mohammed was then cared for by his grandfather, 'Abdalmottalib, and after his death by his eldest paternal uncle, Abu Talib b. 'Abdalmottalib. He was [illegible] not rich, but shared the hard lot of a numerous and very poor family, he [illegible] as a shepherd [illegible] to the desert [illegible] to all [illegible] a natural development [illegible].

[illegible] Abu Talib, the [illegible] Mohammed, or the [illegible] he was [illegible] to [illegible] [illegible] [illegible]

ents", men who strive to free themselves from ... d not constitute a regular sect, and had no fixed ... nd organized views. They had, no doubt, inter... with one another, but were not a close society, they ... more of their own souls than of propaganda: only ... they seem to have been more numerous. They ... polytheism and acknowledged Allah, but not ... intellectual ground as or ground of conviction ... the one God was with them identical with pos... tion (*Islam*) to him was, their monotheism was not ... lined to the ... of a personality and of a command ... et, it stood opposed to the worship of ... , and was an impulse to upright and moral life. ... They were not theorists, but ... the ... voices of Law and Gospel were to them ... that lived again in the ... They felt on the whole ... ated toward the ... ed forms of the ... ... on, they rather ought after some new form ... ... tached themselves to ... and ... mmed, it would appear from ... ... limits through a series of ... who was one of the ... ...

"Read! in the name of thy Lord, who created, created man from a drop. Read! for thy Lord is the Most High who hath taught by the pen, hath taught to man what he knew not. Nay truly man walketh in error, when he deems that he suffices for himself, to thy Lord they must all return."

What is here recorded is the commencement, not of Mohammed's knowledge, but of his prophet-ship. That the latter was one to a vision experienced by him on a night of the month Ramadan (cxcvii. 1, xcvi. 1-5) is

he vision was connected by the traditional conception of revelation and prophecy which Mohammed had learned to accept. But, of course, uncertain whether the words in which the angel called the Prophet are really contained in xcvi. Certainly the [illegible] very early, and it contents are, indeed the best expression of the essential idea of Islam. Man live on context with himself, but he must one day return to his Creator and Lord, and give account to him. This [illegible] the most vital principle of the whole faith of Islam, the formal principle of the very process of doctrine of revelation in writing, copied from the heavenly book.

When the angel left him [illegible] the tradition runs on Mohammed came to Khadija and recounted the occurrence to her in much distress. He thought that he was possessed. But she however comforted him, and convinced him that the belief that he had received a revelation and was called as a messenger of God. Yet he doubt returned when the revelation broke in the revelation, and they reached a climax in height. He was often on the point of [illegible] death by casting himself down from Mount Hira. It is usually assumed that the [illegible] of angels lasted from two to three years. Then the angel [illegible] to have suddenly appeared a second time, he came to Khadija in great excitement and said, "Wrap me up! wrap me up!" This, it must be explained, was done when in bed in the women's and on this occasion often the matter, the revelation came during an attack. The [illegible] down and [illegible] commune with the deity. "O thou enveloped one! henceforth there was no [illegible] and no doubt, the revelations followed with [illegible] and the Prophet was fired of his vocation.

That Mohammed did pass through many doubts and much distress before he reached the [illegible] was believed (in xcvii. 3), but the [illegible] development of the doctrine of the [illegible] or interval of from two to three years between the first and second revelation, before a later stage of tradition. It appears that it was [illegible] to dispose of the controversy whether Mohammed [illegible] a prophet in Mecca for ten or for twelve years. Perhaps, too, it was designed to solve another [illegible] whether cxvii. or cxi. was the beginning of the revelation—a question that [illegible] to the [illegible] claims of each. The tradition [illegible] by the [illegible] that Mohammed in the first three years of his mission did not appear in public, but only called [illegible] and the [illegible] Allah in private circles. But, he [illegible] the [illegible] own house, in the Khatim, he [illegible]

[illegible] Ibn Hisham, p. [illegible]
[illegible]
We will [illegible]
[illegible]
[illegible]
[

notworthy that the sharp negations of monotheism as ac-
pressed pronounces only by degrees. It was in his under-
ation against the cold mockery with which he was met
he had long wished to have by revelation from God
"These are the sublime Quranic," whose interces-
be hoped for." The addition were urged and
by the unconditional the credit and when Mod-
the all the and with the word, " and pro-
he was in the terrible point himself first in other
on the e who refused to hear the word of the
shed, applying the old to the address and the
sent with -ed in direct that it was
ne as to add the moral. The old not to
the Meccans, e possibly at all the as it
ground What Mohammed attacked ed really and
table were them help there, the was pe
ead, and the in tribe. The and when
tened was help we the prophet the pe of
owed to be upon it, but they had not yet
Mohammed was not instructed to the
ever, he other was to be the
pproach Mat Tabib the Prophet
o have in be and
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[1] The authorities for this are Ibn Sa'd, the secretary of Wâkidi, to whom we owe the preservation of Wâkidi's material, but the Meccan, and especially Tabari; comp. Muir, ii. 150 *sqq.* The common

MOHAMMEDANISM

--What think ye of al-Lat and al-'Ozzâ, and of M
third with them?" the devil put words in his mout
he had long wished to have by revelation from G
"These are the sublime Qurânic," whose intercess
be hoped for." The addition were urged and
by the unconditional the credit and when Mod
the all the and with the word, " and pro
he was in the terrible point himself first in other
on the e who refused to hear the word of the
shed, applying the old to the address and the
sent with -ed in direct that it was
ne as to add the moral. The old not to
the Meccans, e possibly at all the as it
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table were them help there, the was pe
ead, and the in tribe. The and when
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way. But the Meccans, from the way in which he had
[illegible] God's word and afterwards
[illegible] of reading, did not hesitate to
[illegible] the whole of his boasted revelation
[illegible] To them cold and
[illegible] the Prophet had nothing to oppose save
[illegible]
[illegible] to the Medinan proceedings at the puncture
[illegible] for their
[illegible] which were well
[illegible] the Meccans. Mohammed and his Hanefs
[illegible] left the city by night, wounded by the
[illegible] at which the [illegible] succeeded treat.
[illegible] Abd-el-Uzza, the [illegible] tragedy of the
[illegible] Medina, and in order to become somebody in
[illegible] he adopted [illegible] Meccan
[illegible] the [illegible] which
[illegible] Quraish were the only two
[illegible] and neither of them [illegible]
[illegible] from [illegible] which were [illegible]
[illegible] very marked man.

[illegible] Koran proofs
[illegible] by the other

directly

[illegible] that the
Meccans [illegible]
The [illegible] he had [illegible]
[illegible] He was determined to
[illegible] and the [illegible]
[illegible] Apostle, and
he [illegible] [illegible] people
came by degrees [illegible] The chief sons
[illegible] Mecca, the children [illegible]
power [illegible] [illegible] he [illegible] the accession
of his [illegible] [illegible] He [illegible]
[illegible] [illegible] [illegible]
[illegible] [illegible] [illegible] the Meccans [illegible]
[illegible] Nadhr [illegible] [illegible] the
[illegible] [illegible] [illegible] [illegible]
[illegible] [illegible] [illegible] [illegible]
[illegible] [illegible] [illegible] [illegible]

radition has it that he found comfort in the fact that at
ast the Jinnis listened to him as by the way he chanted
e Koran in the sacred grove of Nakhla.[1] In the present
ircumstances it was now impossible for him to return into
e town, after having openly announced his intention of
aking with it and joining another community. He did
t venture to do so until, after long thought and negotiat
had assured himself of the protection of a leading citizen
of Mecca by 'Ath. Notwithstanding all that had happened,
resolved, two months after the death of Khadija, to enter
on a second marriage with Sauda bint Zam'a, the widow
an Abyssinian emigrant.

Chance soon afterwards brought to pass what some
ought (on his journey to Tayif) had failed to accomplish
ter having given up the Meccan Mohammed was wont
seek interviews with the Arabs who came to Mecca
ajjumu Dhu'l Majaz and 'Okaz for the purpose of trade
nt in the fairs and feasts, and to preach to them. On
e such occasion, in the third year before the Hijra
p. 619 620), he fell in with a number of men from
Medina, who to his delight did not run like those
nally the case but showed both aptitude to understand
d willingness to receive his doctrine. For all this they
d been previously prepared [by the disciples] who
me with the numerous Jews who lived among them
th them in their towns and neighbourhood, and by the
nnections which they had with the Northern and
rth-eastern Arabs of the tenth. Hanifism was especially
idely diffused among them, and at the same time there
re movements of expectation of a new Prophet
en of an Arabian Messiah who would bring to Mecca
e the proper call for Mohammed to step on to the stage
at he owed such a discovery to account of. He entered
to closer relations with the pilgrims who had come from
ence, and asked them to try to find out whether
as any likelihood of his being received in their town.
ey promised to do so, and to let him hear from them in
e following year.

At the pilgrim feast of next year, accordingly, twelve
tizens of Medina had a meeting with Mohammed, and
ve him their pledge to have no god but Allah, to with
old their hands from what was not their own, to the for
eation, not to kill new-born infants, to limit lusts, and
obey God's messenger as far as was fairly to be asked of
his is the so-called First Homage on the 'Akaba. The
lve men now returned, as propagandists of Islam, to
eir homes with the injunction to let the matter bear
the success of their efforts at the same place on the
llowing year. One of the Meccan Moslim, Mus'ab b.
Umair, was sent along with or after them, in order to teach
e people of Medina to read the Koran, and instruct them
the doctrines and practices of Islam.

Islam spread very quickly on the new soil. It is easy
understand how his joy strengthened the Prophet's
irit to try a higher flight. As a symptom of his exalted
ame we might well regard his famous night journey to
erusalem (sur. xvii. 1; vi. 2), if we could be sure that it

[1] Sur. xlvi. 28; lxxii. 1. On the unpolemical character of the
e date of this occurrence see Nöldeke, *op. cit.*, p. 101.

[2] Muir (ii. 181 *sq.*) assumes, with good reason, that he had already
one so during the time when he was living in the shadow of Abu Talib's
d assigns to this period the story that Abu Lahab followed him in
s in order to counteract his preaching, and so forth among the
heat.

[3] Sprenger (ii. 526) identifies this meeting with the first, which tra
tion distinguishes from it and places a year earlier. He is probably
ght.

[4] Afterwards this was called the women's oath. It is a noteworthy
ummary of the features by which Islam is distinguished from
eathenism.

[5] On the 'Akaba compare *Wakidi*, pp. 117, 197, 429. It was a
ation between 'Arafa and Mina.

belonged to this period.[6] The prophecy about the final
triumph of the Romans over the Persians (contained in
sur. xxx. 1–7) might very well pass for an expression
of even a remnance of victory, at the time he still had
feeling of solidarity with the Christians. But this prophecy
(the only one contained in the Koran) [illegible] would
appear to a much later date.[7]

At the Meccan festival in the last week before the Hegira
(in March 622) there presented themselves among the pil
grims from Medina seventy-three men and two women who
had been previously converted. Both by night after the day
the brother they had arranged with the Prophet
to the effect that Mus'ab [illegible]
death had become known to the Meccans
present. The [illegible] of the
Medina, which Muhammed [illegible]
pledge to [illegible] Meccan
other matters. But [illegible]
Prophet, engaged [illegible]
other matters. But [illegible]
necessary efforts and [illegible]
ears. A few days [illegible]
Muhammed and to [illegible]
emigrate. In the first month of the following year of the

[illegible] Flight (April 622) the emigrants [illegible] within two
months some 150 persons had reached Medina. Abu
Bekr alone and 'Ali remained behind in Mecca.

Muhammed himself remained in the house in Mecca in the
company of Abu Bekr and 'Ali. His reason for doing so
is to be sought in the connexion of the following events. The explan
tion offered of the Prophet's action by the Meccans
has a motive in every respect [illegible] which he secretly
withdrew from with Abu Bekr [illegible] two or three days the
two fled [illegible] in a cave of Mount Thaur
south from Mecca, till the pursuit should have pas
over. Then they took the northward road
and arrived [illegible] on the 12th or 16th of Rabi' of the
first year of the Hijra. Meanwhile 'Ali remained [illegible]

[illegible] Muir, [illegible] 127 sq. [illegible]
[illegible] Nöldeke, *Z.D.M.G.* xl. p. 162. The [illegible]
[illegible] generally [illegible]
[illegible] that [illegible]
[illegible] Mecca [illegible]
and on the [illegible] decree (*Qoran*, p. 101, 2
a manner which [illegible] to make the pil
[illegible].

[7] Ibn Hisham, pp. 315 sq., 439 sq.

[8] The 12th of Rabi', according to Ibn Ishaq, the Prophet's birt
day, the day of his arrival in Medina, and the day of his death.
is certain that he died at mid-day on Monday the 12th of Rabi',

days longer in Mecca, for the purpose, it is alleged, of restoring to its own all the property which had been entrusted for safe keeping to the Prophet. The Koraish left him entirely unmolested, and threw no obstacle in the way when at last he also took his departure.

With the Flight to Medina a new period in the life of Mohammed dawns. Great a revolution in the circumstances of any man. Had he remained in Mecca he would in the best event have died for his doctrine, and its triumph would not have come until after his death. The Hijra brought it about that the founder of a new religion lived also to see it completely established. That in his case was united all that in Christendom is separated by the enormous interval between Christ and Constantine. He knew how to unite Islam and the state, founding the Arabian empire. That the new standpoint for the religious reformer under these circumstances was peculiarly difficult soon became apparent. It soon became the duty of its leader sometimes, for almost from the first it became mixed up with the duties of practical administration. In addition to the task of securing the capability of development which attached to all true religion, Mohammed received a special heritage from Mohammed the hope which it had never ceased to entertain. It ought not however to be overlooked that the want of orderly and political traditions was partly due to the Arabian origin.

Mohammed in the first months took up his quarters in the outlying village of Kuba, where a great part of his most zealous adherents had their houses, and had already built a mosque. It was not until after some days had passed, and his host's family had given the first reception, that he removed to the city itself, which at that time bore the name of Yathrib. All were anxious to have him precede, that none might feel themselves slighted, he left the decision to the camel on which he rode. It sank down in an open space on the quarter of the Banu Najjar, which he accordingly selected as the site of the mosque and of his own house. At first the land quarters, or even months in the house of Abu Ayyub, within this interval the mosque was finished, which was to serve at once as the place of religious gathering and as the common hall. Over it was the Prophet's private dwelling, of the last of his wives, according to order of which he lived. At that time it consisted only of the sanctuary already mentioned, but soon increased in size, the youthful Arabs, the daughters of his friend Abubekr, who acquired great influence over their young husband, the lofty enclosure built round it, the row of huts for the poorer brethren of the Koreish who had emigrated with him, and the dwellings for the people of Medina.

... situated on a west-ward part of the Arabian ... ed to the Wadi Kanat. It ... an ... ...

Mohammed thus laid the foundations of his position in a manner precisely similar to that which Moses (Exod. xviii.) is said to have followed; and just as the Torah grew out of the decisions of Moses, so did the Sunna out of those of Mohammed. It was perhaps in judicial and regulative activity, which he continued quietly to carry on to the very end of his life, that his vocation chiefly lay. At all events his work in this direction was extremely beneficial, if only because he was the creator of law and justice where previously there had been nothing but violence, chance, or at best voluntary arrangement. But the content of his legislation also (if it can be called by such a name) marked a distinct advance upon what had been the previous use and wont in Arabia. In particular, he made it his special care to set a fence round the right of property, and to protect and raise the place of woman in marriage. Blood revenge he retained indeed, but completely altered its character by reserving to himself the right of permitting it; in other words, the right of capital sentence. It need not be said that in many ways he availed himself of that which already existed, whether in the form of Arab usage or of Jewish law; he followed the latter, in particular, in his laws relating to marriage.

The new situation of affairs inevitably brought it about that religion was made a mere servant in the work of forming a commonwealth. Never has this service been better performed; never has it been rendered with greater adroitness as a means towards this end. In Mecca, Islam had originally been nothing more than the individual conviction of Mohammed; it was only after severe struggles that he went so far as to preach it, and even his preaching had no other aim than to create individual conviction in others. What he said was of the simplest description: that people ought to believe in God and in judgement to come, that men ought to live their lives soberly and not waste them in follies, that one ought not to be high-minded or covetous, and so on. A community arose, it is true, even in Mecca, and was confirmed by the persecutions. There also religious meetings were held and sacred prayers; but everything was still in a very timid and rudimentary stage: religion retained its inward character. It was not until the first two years after the Flight that it gradually lost this, and became, if not exclusively, yet to a very large extent, a mere drill-system for the community.[1] No good but the one God (lá iláh illa lláh) was the entire sum of their dogmatic, and less importance was attached to belief in it than to profession of it. It was the watchword and battle-cry. The prayers[2] took the form of military exercises; they were imitated with the greatest precision by the congregation, after the example of the Imam. The mosque was, in fact, the great exercising-ground of Islam. It was there that the Moslems acquired the *esprit de corps* and rigid discipline which distinguished their armies.

Next to the monotheistic confession (tauhíd) and to prayer (salát) came almsgiving (zakat, sadaka) as a third important means by which Mohammed awakened and brought into action among his followers the feeling of fellowship. The alms by and by grew to be a sort of tithe, which afterwards became the basis of the Moslem fiscal system and so at the same time the material foundation of the Moslem state. Religion received so practical a development that of alms nothing but the name remained, and the convenient notion that the taxes had to be paid to God.

Just in proportion to the closeness of the union into which Islam brought its followers did its exclusiveness towards them that were without increase. If in Mecca Mohammed in his relations to the other monotheistic religions had observed the principle, "he that is not against me is for me," in Medina his rule was "he that is not for me is against me." As circumstances were, he had to do just mainly with the Jews. Without any intention on their part, they had helped to prepare the ground for him in Medina: he had great hopes from them, and at first treated them on no different footing from that of the Arab tribes which recognized him. But as his relation with the Jews and Khazraj consolidated, those which he had with the Jews became less close. The conjunction of religious with political authority, the development of civil polity out of religion, of the king but from the prophetic function, was precisely what they objected to. On the other hand, while the old polity of Medina broken up and disorganized as it was, had no difficulty in tolerating foreign elements within its limits, the new political system created by Islam changed the situation, and rendered it necessary that these should be either assimilated or expelled.

Mohammed's hostility to the Jews found expression, in the first instance, theoretically rather than practically, and especially in the care with which he now differentiated certain important religious usages which he had taken over from Judaism, so that they became distinguishing marks between Islam and Mosaism. Thus, for example, he altered the direction of prayer (kibla), which formerly used to be toward Jerusalem, so that it now was towards Mecca; and for the fast on the 10th of Tishri ('Ashura) he substituted that of the month of Ramadan.[3] In appointing Friday as the principal day of public worship, he may also possibly have had some polemical reference to the Jewish Sabbath. Of these alterations the greatest in positive importance is the transference of the kibla to Mecca. It symbolizes the completion of the Arabian process which went on step by step with the changes Islam underwent from being an individual to become a political religion. In substituting the Meccan Ka'ba for the sanctuary at Jerusalem, Mohammed did not merely bid farewell to Judaism and assert his independence of it, what he chiefly did was to make a concession to heathenism, and bring about a nationalization of Islam, for the purpose of welding together the Arab tribes (Kabáil) into one community. Of similar significance was the substitution of the feast of sacrifice (Aid al-dohá) on the day of the Meccan festival. The Moslems were to observe the latter as much as possible, even if they could not be actually present on the spot.

Thus we have the two chief precepts of Islam: (1) Confession of the unity of God, (2) stated prayer, (3) almsgiving, (4) the fast of Ramadan, (5) observance of the festival of Mecca. Capable of having deeper meaning

[illegible] the fact of uniting the Arab politically, [illegible] the Jews had no such effect. [illegible] contrary, the original feud and hatred in which [illegible] did greatly to the advantage of the Moslems. [illegible] recognition of Mohammed's supremacy as a fact but [illegible] title therefore to examine from his prophetic office

[1] This is to be understood as applying to the system as a whole. Of course, there are always individuals who break through it; but the historical power of Islam rests upon the system. To the system also belongs the spiritual jargon which Mohammed introduced. It was no longer permissible to say "Good morning!" Um sabahtan, the phrase now ran, "Peace be with thee!" and on every occasion pious forms of speech were demanded. Characteristic of the puritanism of the system is the prohibition of wine and of gaming, first issued in the years immediately following the Flight, and the contempt for poetry.

[2] They were five in number—at sunrise, noon, afternoon, sunset, and late evening. Each prayer consisted originally of two, afterwards of four, prostrations. The chief weekly public service (jom'a), with sermon, was held on Friday at mid-day.

[3] Compare the well-known second sura, [illegible] week on Judaism.

[4] A connection with the Christian fast is [illegible] possible that Christian influence may have [illegible] of the fasts, but it cannot have anything to do with the [illegible] Ramadan; for in the first year after the Flight, Ramadan fell not Spring but in December.

ttached to them, but no criterion also, even in a merely
xternal observance, they were an excellent instrumentality
or producing that *esprit de corps*, that obedience to Allah
nd his messenger, which constituted the strength of the
Moslem system. I pt till that time blood relationship had
all relation in
pon such a foundation it was impossible to rai
ommunity, either, for blood dissociates as much as it
Rut now, wherein consisted upon the removal
of the great obstacle in building the social structure,
ossible by breaking up the old organization, in order to
ecast the thus disintegrated element into a new and
uch more stable system. The very heart of men were
hanged, the ancestry of the old religion hopelessly lost
ith the decease of Abu Talib brother would have lain brother
and Mohammed wished it. The best Moslem was he who
as the most resolute in separating from the old and
ttaching himself to the new. Mohammed gave preference
o active natures over it they occasionally kicked over the
ace, to contemplative piety proceeding from him only the
ure of word. Over the wretched rule of a matte
ode of trouble the old sacredness of blood came back
ampered, the object were united by the bond of
ood. Every Moslem was now a Moslem's brother, and,
matter of course, took his part against every non-
Moslem. Outside of Islam there was no other law nor
afety. Allah alone was powerful, and he protected those
nly who acknowledged his sole sovereignty.

The Companions (Mohagirun), who along with the Prophet
ad fled from Mecca were the kernel and the nucleus of
he community. It was made all the easier for them to
ive effect to the fundamental principle, that citizenship
n Medina depended not on family but on faith, because the
ative Moslems (Ansar, "the Defenders") were themselves
Aus and Khazraj reconciled one another by their mutual
nmity. Mohammed seems at first to have cherished the
esign not only of entirely disowning relationship with
on Mecca, but also of destroying as much as possible,
within Islam, the distinction of blood, by means of the
ommon faith. He even declared between emigrant and
ndividual citizens of Medina relationship of brotherhood,
which also involved heritage. But he soon abandoned the
ame, and expressly recognized the validity and sacredness
sunna Islama, of the old right of family and inheritance
Sura viii. 76). Thus he retained from carelessness not to
ut full logical consequence the theoretical principle of
qualization, but on practical ground permitted the old
rder of society to continue. Meanwhile a great period, he
ad conceded to relation-ship and the ties of blood far
more rights than were compatible with Islam and the
ould find the foundations of the violent quarrel which
ore the community, more particularly in the time of the
Omayyad. Similarly it might be said that communism
as gradually involved in the principles of Islam, but it
s characteristic that from the first the aims were less em
loyed to the equalization of society, than for transferring
the hands of the ruling power. It frequently happens that
religion receives its final expression also in the form of
ocial polity, but it is remarkable to observe how Islam
nalyzed the religious heaven from the first for a positive re
rganization of society, and neutralized the destructive
endency which that heaven is wont to show in political
affairs. It did not indeed succeed in totally destroying the
adical tendency, as the history of the caliphate shows.
But, on the whole, the equality before God which Islam
eaches interfered hardly at all with the subordination of
men to their human leaders. Both were demanded by
eligion, both were taken seriously and each was found,
in practice, reconcilable with the other.

That this new and drastic principle, thrown into the
chaos of existing relations, must have exercised a migh
power both of attraction and repulsion is obvious. Mo
than one naive expression bears witness to the astonis
ment with which the Arabs regarded the strange spir
which animated the community of the Moslems: the fir
ess with which they held together, the absolute and wi
ng obedience which they gave to their leaders, the rec
lessness with which they disregarded everything that befo
Islam, or outside of it, was looked upon as holy. Son
nature felt themselves attracted by these peculiaritie
especially if on other grounds they felt little difficulty
severing themselves from their old connexions; but, on t
whole, feeling of antipathy prevailed. Even in Medi
itself the antipathy was widespread. The so-called hyp
crites (monafikun) were either only half attached to t
Prophet or to their innermost hearts unfavourably dispose
they were kept from overt action partly by the absence
a decided opinion, partly by the terrorism which the co
vinced Moslems exercised. The reproach of hypocri
brought against them means chiefly that they did n
manifest a full acceptance of the new political relation
They could not reconcile themselves to the position
became never a word to say in their own town, and
being compelled to obey the Prophet from Mecca and the
who had come with him. For a time the danger w
imminent that all Medina (the Emigrants of course e
cepted) might be infected with hypocrisy, if one may c
it hypocrisy when for a moment nature and blood assert
themselves against religious discipline and burst its bon
The younger portion of the community, however, was
the whole enthusiastic for Mohammed; the hypocri
were for the most part older men, especially heads
families, who could not at sufficient to put up with the loss
political influence which they were suffering. As chief
their number Ibn Obayy is always named, the forem
man of Medina, whom the Khazraj had thought of crow
some days before matters were so fundamentally chang
by Islam. Mohammed's attitude towards him and t
hypocrites in general was that of connivance, - thorough
appropriate here, where political rather than religious affa
were involved, and the question was one less of princi
than of power.

The foundation of the state upon the feeling of fellows
generated by religion, was without question the Proph
greatest achievement: the community of Medina was
tool, its heroic faith the force, by means of which Isl
attained the result which figure so largely in the histo
of the world[1]. Moslem tradition, however, does not stop
inquire what it was that constituted the inward strength
Islam, but goes on at once to relate what were its outw
manifestations. Its information on the subject of the per
of Mohammed's sojourn in Medina is given under the title
"the campaigns (maghazi) of the apostle of God." W
a few of the smaller tribes in the neighbourhood of Med
(Dhamra, Mozaina, Ghifar, Aslam), and with the Khoza
Mohammed maintained relations of peace and amit
benevolent neutrality gradually grew into alliance, a
loyally union with the commonwealth of Medina. I
towards all the rest of Arabia his very principles pla
him in an attitude of war. Ever since Islam from be
a religion had become a kingdom, he was compelled
vindicate, by means of war against unbelievers, its cla
to supremacy; the conflict of principles had to be sett
by the sword, the sole sovereignty of Allah demonstra

[1] The credit of being the founder of the Moslem state cannot
transferred to 'Omar, but must be left with Mohammed. It was
'Omar who created that feeling of oneness which enabled him, for
example, suddenly to recall a general like Khalid from his career of vic
without exciting a murmur. The miracle is the "primitive cell"
Medina, not the fact that in course of time success gave it the forc
an avalanche.

y force to the rebels who showed unwillingnes- to accept
. More literally than Christ could Mohammed say of
imself that he was come not to bring peace but a sword.
slam was a standing declaration of war against idolaters
The nearest object against which to direct the holy war
jihâd) was presented by the Meccan- Against them first
id Mohammed bring into operation the new principle, that
is faith and not blood that separates and unites
ording to Arab notions it was a kind of high treason on
s part to leave his native town in order to join a foreign
ciety; on the part of the people of Medina it was an
t of hostility to Mecca to receive him among them
The Meccan would have been fully justified on their side
taking arms against the Moslem but they refrained
ing too much at their ease, and hesitating to do from
atricidal war It was the Moslem who took the initia
ive; aggression was in their blood Mohammed
an with utilizing the favourable position of Medina, on
mountain-spur near the great highway from Yemen to
ria, to intercept the Meccan caravans On six he
ent forth only the Emigrants to take part in the expedi
ion, as the people of Medina had pledged themselves to
efend him only in the event of his being attacked in
owever, they also joined him What first induced them
o do so was the prospect of booty afterwards it was im
ossible to separate them selves from the fortunes of
lements which had been quietly going on within the
mmble of Islam

The first plunder was taken in the month Rajab, year 2
Autumn 623), in which enormous interest was at once seen the
dvantage arising from the chance of conquest brought
bout by the new religion, for in Rajab tent and plun
ering raid were held to be unlawful Returning upon the
eredity of this month a caravan of Koreish was returning
om Syria laden with leather, wine, and raisins But
is did not prevent Mohammed from sending out a band
f Emigrants to stop the caravan at Nakhla, between
Taif and Mecca; his orders to this effect were given in a
ocument which was not to be unsealed until two days
fter the departure of the expedition. The plan was carried
ut, and the surprise was all the more successful, because
he robbers gave themselves the outward semblance of
ilgrims; one Meccan was killed in the struggle. But
he perfidy with which in this instance Mohammed's ad
anced religious views enabled him to utilize for his own
dvantage the pious custom of the heathen roused in
Medina itself such a storm of disapproval, that he found
himself compelled to disavow his own deed In Moham
medan tradition, the contents of the murderous document
in which he ordered the surprise are usually falsified

The Koraish still remained quiet, another outrage had
et to come. In Ramadan VII 2 (December 623), the
eturn of their great Syrian caravan was expected, and
Mohammed resolved to lie in wait for it at Bedr, a favour
te watering-place and camping ground northward from
Medina. For this purpose he set out thither in person
long with 308 men, but the leader of the caravan, the
Omayyad Abu Sofyan, got word of the plan and sent a
messenger to Mecca with a request for speedy help Con
ern about their money and goods at last drove the Koreish
o arms; a very short interval found them, 900 strong, on
he road to Bedr. By the way they received intelligence
hat the caravan had made a circuit to the west of Bedr,
nd was already in safety. Nevertheless they resolved, at
he instance of the Makhzumite Abu Jahl, for the sake of
heir honour, to continue their march When the Moslem
first got touch of them at Bedr, they took them for the
caravan; their surprise on discovering the truth may be
magined. But, kept firm by the courage of their leader,
hey resolved to face the superior numbers of the enemy.
On the morning of Friday, the 17th of Ramadan, the
encounter took place. A number of duels were fought in
the front, which were mostly decided in favour of the
Moslem. The Meccans at last gave up the fight, strik
speaking for no other cause than that they did not see
reason for carrying it on They were reluctant to shed
the blood of their kinsmen, they were awestruck in pre
sence of the gloomy determination of their adversaries
who did know what they were fighting for, and were
absolutely ready for the last consequence After a number
the noblest and oldest of the Koreish, including Abu
Jahl, had fallen, those who remained took to flight
The numbers of the dead are said to have been a great
that of the prisoners Two of the latter, whom he p
sonally hated, Mohammed caused to be put to death
Ukbah Abu Mu'ait and Nadr b. al Harith W
the latter named had previously, from the Prophet in prison
hence, the direction which he used to make use of
friend of his absence the Moslem to be entertained
treated hence termed, at Nadr's request That the Koran
taken these persons there had not been put to death
him, a Blood-feud to which the apostle replied w
I do not demand but I would gladly plead from th
for I have his maid ascend at the old tobacco
remainder prisoner he was released on payment by th
Emigrants of a heavy ransom But Mohammed is said
have afterwards regretted himself for having allow
considerations of wealth to keep him back from
ing them all to death as they deserved

The battle of Bedr not only the most celebrated
battle in the memory of Moslem it was really also
great historical importance It helped enormously
strengthen Mohammed's position The next forward
operation to be undertaken Medina was impossible, fam
which had hitherto withdrawn themselves from his
ence were so thereby fully roused by some attempts
carried out in obedience to his order, that they went
to Islam He was now in a position to proceed to bri
up the antagonism of the Jews In the first instance,
addressed himself to the weak Banu Kainuka demand
their acceptance of Islam on their refusal, he took
earliest opportunity that offered itself to declare war a
them After a fortnight's siege they were compelled to sur
der, and they might congratulate themselves that their
only, Ibn Obay was able to persuade the Prophet into par
their lives, and consented instead to banish them from Medina Soon afterward other blows were str

In the larger sense of the word, by means of which Moh
med put an end to the existence of the Jews whom he h
met, such as Ka'b b. al Ashraf and Abu Sofyan's
fate of fear to which the rest were reduced may rea
be imagined, they came to the Prophet and begged
to be protected. [illegible] another day these had fo
somewhat public expression in all sort of witticisms
contrite caviare, they were now at least modest and q
and kept more hatred to themselves.

The Meccans were very deeply impressed by
defeat inflicted on them by the Moslem They soon le
that the slow [illegible] exhausted and they took energeti
measures to [illegible] campaign After a year de
their preparations were now complete, and their a

[illegible] Mohammed Muhammad
elder [illegible] Hamza
[illegible] and replaced [illegible]
[illegible] [illegible]
[illegible] Mohammed [illegible]
[illegible] [illegible]
[illegible] [illegible]
[illegible]

Abábísh) assembled, they set out under the command of Abú Sofyán, and without any check reached Medina, where they pitched their camp to the north-east of the city, in the green corn-field by Mount Ohod. In Medina the elders were for awaiting the attack on the town and defending themselves within it, but the young men burned the Prophet into the determination to meet the enemy without the gates, the resolution once come to he persevered in even after those who had urged him to it had changed their mind. On the morning of Saturday, the 6th of Shawwál, A.H. 3 (Jan. Feb. 625), the armies met. At first the battle seemed to be going once more in favour of the Moslems; one after another the standard-bearers and champions of the enemy fell, the whole host wavered, and even the camp was gained. But here their lust for plunder did them an evil turn. Mohammed had covered his left flank against the Meccan horsemen by a number of bowmen, whom he had ordered on no account to leave their post. But as soon as they saw that the enemy's camp was taken, they threw off all discipline, and determined to have their share of what was going. It thus became possible for the Meccan cavalry to fall upon the Moslem rear, and snatch back the victory that had already been won. In the confusion which now ensued Mohammed himself was wounded in the face, and for some time lay senseless on the ground. Among the Islám was spread the rumour, Hamza b. 'Abdalmuttalib, "the lion of God", had been cut out and carried to Abú Sofyán's wife, Hind bint 'Otba, whose father had been killed by Hamza at Bedr. But the Meccans did not know how to follow up their triumph. Instead of at once attacking Medina, where, to be sure, a second struggle with Ibn Obay, who with his following had not taken part in the battle at Ohod, would have been necessary, they contented themselves with the honours of their victory, and took the road home, after having summoned the Moslems to a repetition in the following year of the duel at Bedr. Mohammed ever put forth a short distance on the following day (as far as to Hamrá al-Asad, of course only for the sake of appearance, that the Arabs might not suppose him to have been dictated by his defeat.

Nothing came of the proposed meeting at Bedr, the Meccans failing to put in an appearance. The principal event of A.H. 4 was the expulsion of the Banú Nadír, the most distinguished and powerful Jewish family in Medina (Summer 625). Mohammed, under some pretext, had already broken with them and ordered their departure within ten days, on pain of death. Relying upon the support of Ibn Obay, they resolved to resist, and strengthened a stone within their walls; but the ally they had counted on proved a broken reed, and they were soon compelled to surrender. They were permitted to withdraw, taking along with them all their movable property except their arms. With music and roll of drum the women on camels, they marched through the street of Medina, on their way to Khaibar, where they had property. The land the Prophet appropriated to himself, but the income derived from it could be employed to meet the numerous claims that were made upon him. He seems also to have handed over some of it to the Emigrants, who stated that they had acquired no property in land in Medina.

Meanwhile, the Banú Nadír were not idle in Khaibar, but left no stone unturned to annihilate their mortal enemy. They succeeded in securing about an alliance of the Koraish and the great Bedouin tribes of Solaim and Ghatafán for the suppression of Islám. In the month Dhú 'l-ka'da, A.H. 5 (March 627), the three armies set out, 10,000 strong, under the command of Abú Sofyán. Mohammed received word of this through the Khoza'a who secretly played into his hands, and on this occasion he resolved, not as formerly to offer battle on the open field, but to make preparation for a siege. For the most part the houses of the town were built so close to one another as to make a continuous wall; at the north-west corner only was there a wide open space, through which an enemy could easily effect an entrance. Here Mohammed with the advice and direction of the Persian freedman Salmán, drew a ditch, behind which he entrenched himself with the Moslems, the hill of Sal'[1] protecting their rear. This ditch, which has become famous, and has even given its name to the entire campaign (the War of the Ditch), fully served its purpose. The enemy with their cavalry perseveringly directed their attack on this spot, but were constantly repelled by the vigilant and courageous defence of the town. They at last gave up all hope of reaching their end in this way, unless a simultaneous attack were to succeed in another quarter. To assist them in this, they endeavoured to stir up the Koraiza, the last autonomous family of Jews still remaining in Medina, having their settlement in the south-east of the town. The Nadírite Huyayy b. Akhtab, the most zealous promoter of the alliance against Mohammed, undertook charge of the negotiations, and succeeded at last in persuading their prince, Ka'b b. Asad, to break his pact of neutrality with the Moslems. But nothing came of it. The Jews doubted the perseverance of the Koraish and their allies; they had their fears lest, if the struggle proved a protracted one, the besiegers might withdraw and leave them to their fate. They accordingly demanded hostages in security against such an event, being otherwise determined not to break up all hope of reconciliation with Mohammed by entering the contest. This attitude, in turn, aroused suspicion on the part of the besiegers, whom it was not difficult to convince that the Jews were demanding hostages of them for the purpose of handing them over to Mohammed, and so making their peace with him. All this crippled their activities still more than did the failure of their own attacks upon the fosse. The season also was against them; the weather was windy, the nights extremely cold, and, worst of all, the field yielded nothing. From this cause the chief sufferers were the Bedouins, who had brought no forage for their camels and horses. Mohammed, who appears to have been kept well informed of their mood, judged it expedient to open negotiations with them. These were soon broken off indeed, but the mere fact that the Ghatafán had even entered upon them was enough to create mutual suspicion amongst the allies. One stormy night the Meccans suddenly raised the siege, after it had lasted fourteen days, and returned home; they were followed by the Ghatafán and Solaim. It was with no small joy that the Moslems on the following morning discovered the departure of the enemy; it would have been impossible for them to have held out much longer, exhausted as they were, not less by cold and hunger, than by the fatigues of constantly mounting guard. As soon as Mohammed had given them permission to leave the camp beside the hill of Sal', they dispersed with the greatest alacrity to their homes.

Mohammed, however, did not allow them much time to recruit. Hardly had they reached their abodes, when he again called them to arms against the treacherous Koraiza. The unlucky Jews had been given over to the sword by the withdrawal of the allies; a siege of fourteen days compelled them to surrender unconditionally. The me

[1] The sympathy shown by many scholars for Ibn Obay, who is weakness degenerated into fatuity, [illegible]

[1] Now the citadel, it would seem.

ere driven in chains to the house of Osáma b. Zaid, hence on the following morning Mohammed caused them to be brought one by one to the market place of Medina, nd there executed. This continued till late in the even ng. They were six or seven hundred in number, and mong them was the Nadrite Hoyay b. Akhtab the uthor of the War of the Fosse, who had left the Meccan o join his fortunes with those of the Korayza. By ccepting Islam these men could have saved their lives, ut they preferred death. No more magnificent martyrdom known to history. The women and children were old nto slavery, one young woman only, Banana, suffered the enalty of death for having broken the head of a Moslem ith a millstone during the siege. With joyous heart and miling face she went to meet her death, never forgotten y 'Aisha, with whom she was when her name was called. he Prophet selected for himself the fair Rehana, and arried her, after having caused her to become a convert o Islam.

The War of the Fosse was the last attack made by the oraish upon Medina. Mohammed now began to take the ffensive towards Mecca. The first act about with xtreme diplomacy, utilizing the festival, and the truce of od subsisting at the time of the festival, for the purpose f paying a visit to his native town. Although a novice l in winning to his side the neighbouring troops of edouins, it was nevertheless with a considerable following 1500 men) that in Dhú l-Ka'da VI. (March 628) he set ut on his journey. In a dream he had had the Key of he Ka'ba delivered to him, on the strength of this fe ollowers believed firmly in the success of the expedition. ut the Koraish were determined that the pretext of pil rimage should not avail their adversary. They summoned heir allies and formed a camp to the north of their town or the purpose of preventing the entrance of the Moslems. Mohammed was forced to halt at Hodeibiya on the border f the sacred territory, and it was not even that by fair peeches he sought to obtain permission to make the ircuit of the Ka'ba. He felt himself too weak to force is way, and accordingly preferred to treat. While the nvoys were passing to and fro, there suddenly arose an larm in the Moslem camp, they apprehended a sudden ct of treachery on the part of the Meccans. It was on his occasion that the famous Homage under the Tree took lace, when Mohammed pledged his followers by striking ands that they would stand by him and go to death for is sake. Some of the Koraish agents witnessed the scene, nd were immensely impressed by it, such an enthusiastic bedience as Mohammed received, such an ascendency over he minds of men as he exercised, they had never before onceived to be possible, and on their return they urged heir people in the strongest way not to permit matters to ome to extremities. The Koraish accordingly judged it est to offer a bargain with Mohammed, the terms being hat for this year he was to withdraw, so that the Arabs ight not say that he had forced an entrance, but that on he following year he was to return and be permitted to emain three days within the sacred territory for the urpose of sacrifice. After some discussion Mohammed ccepted this proposal, although zealous Moslems detected discreditable shortcoming in matters of faith, in so far as t involved turning back within sight of the Ka'ba without eing allowed to accomplish the sacred circuit. When the greement was to be committed to writing, Mohammed ictated the words: "In the name of Allah, the merciful Rahmán";[2] but the Meccan plenipotentiary, Sohail b Amr, declared that he knew nothing about Rahman, and insisted upon the customary formula "In thy name, Allá homma!" The Moslems murmured, but Mohammed yielded. He then went on to dictate: "This is the treaty f peace between the apostle of God" . . . Sohail anew protested; to acknowledge Mohammed as the apostle of God, would be to declare himself his follower; the de putation ought to be simply Mohammed b. 'Abdallah. The Moslems murmured louder than before, and refused to consent to the change. The head of the two tribes of Medina, Ousid b. Hodair and Sa'd b. 'Obáda, held the hand of the scribe and declared that "Mohammed the apostle of God" must be written, or the word must de cede. The Meccan representative whispered to one another words of amazement at the spirit displayed by these men. But Mohammed made a sign to the zealots to hold their peace, and again gave way (cp. xxvii. 110). The writing which now took shape ran as follows:

"In the name O God! This is the treaty of peace concluded by Mohammed b. Abdallah and Sohail b. Amr. They have agreed to allow them arms for ten years. During this time each party shall be safe and their hands shall be withheld from doing damage to the other; no secret damage shall be inflicted, but pure faith and honour prevail between us. Whosoever wishes to enter into a treaty and covenant with Mohammed can do so, and whosoever wishes to enter into treaty and covenant with the Koraish can do so. But if a Koraish come without permission to Mohammed, he shall be delivered up; but, on the other hand, one of Mohammed's people coming to the Koraish he shall not be delivered up. This year Mohammed with his men must withdraw from us, but he must be now one month in Yathrib and remain for three days with us without other weapons than those of a traveller, the sword remaining in their sheaths."

The first result of the treaty was that the Khoza'a declared for alliance with Mohammed, while, on the other hand, the Bekr b. Kinana joined themselves to the Koraish.

To compensate his followers for the apparent fruitlessness of the expedition, Mohammed immediately after their return led them out against the rich Jewish oasis of Khaiba (northward from Medina), whither the Banú Nadir had migrated, and from which place they had unceasingly stirred up opposition against the Prophet. Hitherto he had contented himself with putting out of the way by means of assassination, one of their leading men who seemed to him to be particularly dangerous, such as Abú Rafi' and Yosair b. Razim,[3] but now he resorted to wholesale measures. In Moharram VII. (May 628), he made his appearance before Khaiber with a powerful army, in the plunder only those who had taken part in the expedition of Hodaibiya were to have, but many other beside accompanied them. The Jews, although aware of the hostility of Mohammed's intentions, were nevertheless taken completely by surprise; when one morning they saw him and his troops encamped before their stronghold. One of their leaders had given them the excellent advice not to shut themselves up by famine in their quarters, but to construct a common camp in the field, otherwise they were likely to have the fate of their co-religionists in Medina. But they replied that their stronghold were of a different sort, perched on impregnable summits, and they remained shut up within them. They had neither discipline nor order, courage nor devotion. As they were wanting in community of feeling, so also were they lacking in leader. Their head man, Salam b. Mishkam, lay on a sick bed, his place was by no means supplied by Kinána b. Abi l-Hokaik. When they suddenly became aware that they had been completely abandoned by their Arab allies, the Ghatafan, their heart utterly failed them. When besieged in any of their citadels, they hardly ever waited

[1] Nöldeke, *Tabari*, p. 303, note 1; *Vakidi*, p. 18.

[2] Rahmán is a name of God which Mohammed had taken from the Jews and used with special preference.

[3] The "etc." is remarkable, and sounds as if the treaty had been dictated by the Meccans.

[4] *Vakidi*, pp. 170, 239.

o be stormed, but after one or two sorties evacuated it nd withdrew to another, where the same story was re peated. Three citadel after citadel fell into the hands of he Moslems, each of which had something to do with he name or with well-nigh superhuman. From Al-Natat he town withdrew to Al Shikk, and at last nothing was eft to [illegible] Al Kathiba (with Al Watih and Sulalim)[1]. There [illegible] manned shut up and tilled with fear without [illegible] formerly, made [illegible] bats and [illegible] ector the citadel. After one time they asked for [illegible] obtained it on the footing that they returned [illegible] wives and children, and one garment each but [illegible] up all their property, the penalty of concealment [illegible] being death. Kinana b. Abu'l Hakik was cruelly put to death after he had buried the removed jewels of his family; thus at the same time [illegible] hand one with Safiya but Hoyay was left free for Mohammed.

He married with the daughter of the Imam' was and [illegible] the proposed marriage. Safiya felt no repulsion towards the man who had caused the death of her father Hoyay and of her husband Kinana. She readily accommodated herself to the situation. Mere worthy was the honeymoon of another Jewess, Zeynab, who made the attempt to poison the executioner of her people and atoned for the violence by her death. The attempt was unsuccessful, but Mohammed believed that even in his last illness he could trace the effects of the poison.

Simultaneously with Khaibar [illegible] Jews to hus band and cattle, vineyard and Wadi Kura, where also there were [illegible] Jews. The plunder was very considerable [illegible] and [illegible] moveable. It was gathered together [illegible] the booty, the proceeds were to [illegible] Mohammed ordered very strictly that no one should be permitted to plunder for himself. The [illegible] Muhajirun [illegible] Ansar [illegible] Most valuable [illegible] were [illegible] and [illegible] time came to remain at a distance in the [illegible] of the Jews. Half of the produce had to be paid [illegible] The [illegible] of the pool fell to the [illegible] of the Prophet, a fifth of the movable [illegible] and [illegible] portion. He consequently had [illegible] and [illegible] material to [illegible] them, not only for the enrichment of his [illegible] but also for [illegible] over to his able [illegible] which were more accessible to payment than to preaching.

The peace of Hodaibiya, with the [illegible] of Khaibar, close the first period of Mohammed's life at Medina. Hitherto, it merely contained the latent elements of the War of the Ditch and [illegible] Henceforth Mohammed's [illegible] became apparent, and [illegible] the advantages [illegible] with him. "No victory of Islam," Muir was wont to say, "has more importance than the [illegible] of Hodaibiya, for more are always [illegible] ning them [illegible] and [illegible] there first [illegible] a wall of partition between the Moslems and [illegible] more they never spoke to each other, when [illegible] they began to fight. Subsequently both [illegible] and mutual confidence took [illegible] man of even moderate intelligence who heard [illegible] pointed it, in the twenty-two months during which [illegible] the number of converts [illegible] throughout the whole of the previous period; the [illegible] in all directions among the Arabs.

As a religion Islam did not attract the Arabs; they had no inclination to pray, read the Koran, and give alms. Of this they had given sufficient evidence by their perennial feuds with Mohammed, and by the murder of divers of his missionaries who were sent to teach them the faith.' We can hardly believe that a new spirit now suddenly possessed them. Their change of attitude was merely due to the impressing effect of the rising might of Islam. They began to respect the Moslems, who, in spite of their small number, could defy a whole world, because they were of one mind, and did not ask what the world thought. They saw that, in the great conflict between Mecca and Medina, in which as actors or as spectators they had all participated, the victory inclined more and more to the side of Medina, that force could accomplish nothing against faith. The prestige of Mecca was shaken by the War of the Ditch, and was not restored by the treaty of Hodaibiya, in which the Koraish waived Mohammed's with the open hand, and at the same time permitted him to return next year. Islam had stretched out its neck had consolidated itself into indestructible existence, at now fought for victory. There was, moreover, another argument in favour of the new religion, to which the Arabs were very sensible, the rich booty, to wit, which the Moslems acquired by their continual forays. There is no question that the material success of Islam was the chief force that attracted new adherents.

The treaty of Hodaibiya gave a breathing space to the two combatants, and of this the prophet reaped the whole advantage. The truce, which lasted for almost two years, brought to the Meccans an almost unbroken series of humiliations and losses. Contrary to all expectation, the provision made in their favour by which Mohammed bound himself to send back each of them coming as a deserter to him became their majority, turned to their hurt, so that they had to ask Mohammed to have it changed. Still more serious for them was the desertion of three eminent men, Khalid b. al Walid, 'Amr b. al 'As, and 'Othmán b. Talha, whom the Prophet received with open arms. Never were they looked on with shame and concealed indignation when the Prophet, availing himself of his stipulated right, entered the city with 2000 men and performed the sacred ceremonies (Omrat al Kada, March 629). Still they were afraid to break with him again, and did not even venture to [illegible] the murder of Ibn Sunaina, the Khoza'a, who lived in the neighbourhood. "When they put one foot forward they draw the other back, they are convinced that Mohammed will win." So much was the impression the Koraish made on the Bedouin, who have a very keen instinct in matters of the sort. They had lost confidence in themselves; they knew that the fight was not fought out, but they dared not venture to bring it to a decision.

Against them will the decision came. The Banú Bekr fell upon Mohammed's friends, the Khoza'a, and were supported by some of their Koraish-shite allies. The Kho-

[1] Such were the names of the three separate quarters of Khaibar, each one made up of a complex of houses and citadels.

[illegible] p. 153-155; (Ibn Ma'una and al Bajl'), and the genuineness of the letter, see p. 230 *sqq.*

Abu Basir fled to Mohammed to Medina; the Meccans demanded his surrender. He was given up, in spite of his passionate appeals, to the two messengers sent to fetch him. But on the way one of them and slew him with his own sword; the other fled back to Medina in horror. Abú Basir followed him. Mohammed had now done enough to satisfy the Meccans; however, when the messenger refused the charge of so dangerous a person, and Mohammed permit the latter to go off where he pleased, [illegible] him to [illegible] with the Moslems. Accordingly Abu Basir took up his position on the coast road of the Syrian caravans, and became the leader of other Moslem fugitives from Mecca, who quickly gathered round him. They intercepted all caravans, divided the prey, and slew the men. Abu Basir's robberies at length induced the Meccans to ask Mohammed by letter to allow him to join his community, and put an end to the mischief.—*Tabari*, p. 261; Ibn Hishám

tes complained to the Prophet, who eagerly seized the retext for war. In vain did the Meccans send Abu Sofyán to Medina to renew the truce; they could not move the Prophet from his purpose. In Ramadan, A.H. 8 January 630), he moved against Mecca with an army of 0,000 men. With the Emigrants and the Defenders were mustered the Aslam, Ghifar, Mozaina, Johaina, and Ashja'; the Solaim and the Khozá'a joined them on the way. The Bedouins were drawn by the hope of booty he Fazárite 'Oyaina was sorely vexed that he had left h Ghatafan at home, not knowing what was in store for Mohammed at first kept the aim of his expedition secret Some of the Meccan nobles must however have known it; Makhrama b. Naufal, for example and the Prophet uncle, 'Abbás, did not await the capture of the city, but deserted to the enemy while he was still distant Abu Sofyan, in particular, must have been in the secret it appears that at Medina he received the promise that the holy city should be spared if it yielded peaceably and that he pledged himself to do his best to place it in the hands of the Prophet.[1] But before the people were necessary to keep up the appearance of a struggle an inevitable submission to the unforeseen dictates of The same comedy was repeated afterwards at Mecca he heathen treated with the Prophet without consulting the Thakafites, and then contrived that the result of their policy should appear to be forced by the events of war. The Moslems were on the border of the holy land before the Meccans suspected their approach. Their cavalry eight 10,000 lines were drawn up to intercept to the north west of the holy city. Its wells destroyed, Mecca fastened to the hostile camp. He returned with the news that the Moslems were at the that any resistance could effect nothing; nearly three wise counselled surrender. Mohammed had promised security to those who remained in their houses or threw away their weapons. The terrified Meccans had hardly any other course open to them than to follow this advice. And now the Moslems entered the city from several sides at once, meeting only at one point with an easily quelled resistance. Mohammed insisted that there should be no violence; he pledged the captains to avoid all bloodshed. Ten persons only were put to the ban, not of the whole half were subsequently pardoned. He took all pains to preserve the sanctity of Mecca unimpaired, confirmed the rights and privileges therewith connected, and made it plain that the old cultus should not be [illegible] under Islam. The ceremonies were retained, save only that he abolished all idols, both the domestic wood found in every house and the images in and round the Ka'ba. But every sanctuary outside of Mecca was destroyed, except such as had a part in the celebration of the Feast, and so stood in connexion with the Ka'ba itself. That the Meccan worship gained a new and unique importance Mohammed's reform did for Mecca what Josiah did for Jerusalem.[2]

The last step towards that identification of the Ka'ba with Islam, which made it the religious centre of the Moslem world, was not taken till the following year, when the famous Renunciation (Barâ'a) of Sura ix forbade the heathen to share in the Feast, which was henceforth to be strictly Moslem ordinance, and at the same time abrogated the peace of the holy months. A year later (Dhu l Hijja, A.H. 10, March 632) he himself celebrated the Feast for the first time in the orthodox fashion, introducing certain modifications on the traditional practice and

[1] The tradition indeed is silent, but Muir (iv. 120) is justified in drawing this inference from the course of events.

[2] Snouck Hurgronje, *Het Mekkaansche Feest*, Leyden, 1880

reducing certain varieties of use to uniform rule. In this he professed to re-establish the true ancient u purged of heretical deviations from the example Abraham. At the same time he remodelled the Calend forbidding the occasional interpolation of a month as arbitrary and human invention, and establishing the l lunar year of twelve lunations.

We return to the capture of Mecca. The submis[illegible]ion the Koreish was followed by that of their nomad brethr and allies. But the neighbouring Hawazin, to whe belonged also the Thakafite inhabitants of Taif, assembl for battle with the Moslems. They encamped in Aut between Taif and Mecca. Mohammed advanced against them, and battle was joined in the valley of Honain. T Moslems were broken by the first flights of the foe fou[illegible] round the Prophet himself was in danger till the Khazr rallied round him, checked the onset of the Hawazin, an at length turned them to flight. A vast booty rewarde the victors, for the Hawazin had brought all their hou and non-combatants with them and placed them in th rear that they might feel what they were fighting for Mohammed caused the prey to be conveyed to the [illegible] Ji'rana out of the northern border of the Haram a litt way off the great valley that descends from Taif, he hi next proceeded on to Taif itself. Here however he found his objects made of more stubborn stuff; a month's siege bowl of cream that was set before him, either the co tent ran out. Mohammed therefore broke up the siege and marched to Ji'rana to deal with the booty. He h decreed this step in the hope that the Hawazin would [illegible] tempted to embrace Islam in order to recover the females and cattle. But as they still [illegible] and [illegible] had to yield to the pressure of the situation and [illegible] pool. When at last too late the [illegible] appeared to take over their convoy from the [illegible] now to give up their lead and contest them the [illegible] their wives and children were restored to the[illegible] through the mediation of the Prophet with the [illegible] ation. The leaders too read contempt of [illegible] for wh they gave up the Divine Word and [illegible] captives booty. Although [illegible] went in the distribution of booty more than had been the share of the convert those who [illegible] to the [illegible] noble of Mecca who had not been in the battle, but [illegible] Mohammed decreed to consist to be [illegible] camels.

The fall of Mecca exercised powerfully on the futu development of Islam. Year the [illegible] came the [illegible] of the Moslem over t Koreish shaped itself into a demonstration of the Koran over the Moslems. For this the Prophet himself was blame. In making Mecca the holy city of Islam, he w ostensibly moved by religious motives, but in reali Mohammed seldom had nothing to do with t heathenish usages at the Ka'ba and the Great Feast. represent Abraham as the founder of the ritual was mere a pious fraud. What Mohammed actually ought was recommend Islam to Arabic prejudices by incorporatin the fragments of heathen use and at the same time be w influenced by his local patriotism. Henceforth the local feeling became quite the main point of his conduc his attitude to the Koreish was determined entirely b the spirit of clear-sighted [illegible]. Hence the extraordinary val he set on the conciliation of their chief, and [illegible] impression that he cared more for the [illegible] for the co version of all the rest of the world. He beat them that they already had; he gave them in addition whatev they asked, if only they would be his good friends. Abu Sofyán was a great man already, but Mohammed has[illegible]

[1] Among them were relatives of the Prophet's foster-mother, Halima

to raise his power by giving him rule over a broad tract southward from Mecca. He used every means to make their conversion easy to the Koraish, and to convince them that they were losing little and gaining much. They had the sense to realize this and act accordingly; they were soon the best of Moslems, and that for the best practical reasons.

The men of Medina, as was natural, felt themselves to be in a special degree by the plotting of the Koraish. All they had done all and sacrificed all for the Prophet were theirs now to reap the fruit of their labours.[1] Had they by years of struggle made Mohammed Lord of Mecca, only that they might surrender in favour of Mecca the place they had hitherto held? Did he indeed seem to know so much more than mere service to the Faith? The Defenders had good ground for discontent, but Mohammed appeased them easily enough. He reminded them of their fellowship together in the great days of the past, of all that he had done for them and they for him, he promised that their town should still be his residence, and so the political capital of Islam (Madinat al-Islam). Then all the men wept till their beards were wet and said "O apostle of God, we are content with our share and lot."

The Defenders murmured at the preference shown to the Koraish, because they deemed preference for themselves. But already there were movements of an opposition from principle which deemed it a falling away from Islam to give any heed to kinship instead of to faith. It is related that the beginnings of the Khárijite (Dissenters) go back to the distribution of booty in Wádí'l-Jiránah. Certain it is that a worldly bias, which had indeed been introduced into Islam long before, then first became visible to every eye. Certain it is that Mohammed then sowed the seed of the deep dissensions that rent his followers after his death, of the struggle between religious democracy, such as Islam demanded, and the national aristocracy, which alone was really fit to hold rule in Arabia. It was Mohammed who placed the helm in the hands of the Koraish and opened the way to sovereignty for Abú Sofyán and his house, the Omayyads. If the Khárijite Dhú'l Khowaiṣira protested against the Prophet himself at Jiránah, the feeling that moved him was quite sound.

The last years of the Prophet were like the ingathering of a harvest laboriously reaped. The conquest of Mecca, so great was the impression it produced, was called "the conquest," as if it contained in it all other. From every side, in the next two years, the sheikhs streamed to Medina to open negotiations for the acceptance of Islam by their tribes; if they did not come spontaneously Mohammed sent to them. A change of heart on the part of the Arabs had no more share in these than in former conversions. It cost them no struggle to cast away their idols, the mirror and the sanctuaries fell quietly enough. Heathenism was a dead thing; superstitions could be transplanted into Islam. The unique sovereignty of Allah was clearly evidenced in the fact that no might could withstand him. It is safe to affirm that the accessions to Islam were due to political more than religious impulses, and meant adherence to the state of Medina rather than to new doctrines. The power to which that unity had grown acted as a force of attraction upon the Arab; and their submission was not the mere effect of fear, but expressed also that sense of the necessity for peace and order, which had led to the foundation of states in the two previous centuries. Thus it becomes intelligible that from every side by a sort of natural necessity, the masses of Arabian society were drawn towards the centre of attraction at Medina, and that the Prophet received the homage of distant tribes which he could not have influenced directly. The Christian tribes were not behind the rest, they were Arabs first and Christians after. Only the Christians of Najrán remained true to their faith; so did the Jews in all parts, and the Magians in the province of Bahrain.[2] The last named, as idolaters, ought not in strictness to have been tolerated in a Moslem state, but practical considerations broke through theory, and the men of system had to accept the inconsistency with the best grace they could.

The articles of submission were (1) the performance of the five daily prayers, or at least the proclamation of the times of prayer by the Muedhdhin; (2) the payment of the alms tax; (3) the acceptance of the Moslem Law, which was introduced by qualified delegates from Medina. Otherwise things remained as they were; Mohammed was careful not to meddle with tribal affairs, and strengthened the existing aristocracy wherever he could do so. The change of faith was effected by treaty; the populace was not consulted and the whole negotiations were directed by the Elders and Chiefs. For, in fact, purely political interests were involved.

A single case, about which our information is exceptionally full, will suffice in illustration. The Hawázin joined Mohammed after the battle of Honain, and had preached the duty of holy warfare against their kinsmen the Thakafites of Taif, who were still heathens. They made raids on the cattle pastured without the city, and made captives of those who ventured abroad. The Thakafites were exposed, alone and helpless, to the advances of Islam; they dared not stir a foot beyond their walls. The heads of the city found the situation untenable, and resolved to do homage to the Prophet for the sake of peace. Ten ambassadors proceeded to Medina, and negotiation began as to the conditions of the conversion of Thakif. The envoys desired that fornication, usury, and wine drinking should be permitted to them; this Mohammed refused (Qur. xxii. 231; ii. 278; v. 92); and they consented to yield the point when it was explained that indispensable as these three practices might seem, the other Moslems had learned to give them up. There was more difficulty about the Rabba or Goddess of Taif (Lat). The ambassadors begged that, as a concession to the foolish multitude, they might retain her for three years. When they found Mohammed resolute, they came down successively to two years, one year, and a month. Even this was refused, Mohammed's sole concession was that they should not be obliged to destroy their goddess with their own hands. The deputation returned, and had nearly reached Taif, when 'Abdyalil counselled the others to make as if they had broken off the negotiation, and not to discuss the conclusion of the pact till the Thakif showed their stomach for battle with Mohammed. With faces covered, like men who have no good news, they rode into the town and first paid the customary visit to the temple of the Rabba. Then they told their tribesmen the conditions of the treaty, declared them intolerable, and reviled Mohammed as a hard and arrogant man. "And so," they concluded, "prepare for war, lay in provisions for two years. Mohammed will surely not maintain the siege longer than to see to protect your stronghold, and lose no time." The Thakafites at first agreed to this; but in a few days they lost courage, and bade the negotiators return and accept the conditions. These then confessed the truth

[1] *Wakidi*, p. 377. Ibn Hisham, p. 881.

[2] Non-Moslem subjects were made to pay an arbitrary capitation or income tax.

[3] The expenditure of this tax was regulated in the case of certain tribes by special treaty.

nd added that Mohammed's emissaries would presently ppear to destroy the Rabba. The destruction took place ecordingly, to the terror of the women and children, but ithout a single man raising his hand

The pilgrimage undertaken by Mohammed in the year 0 (March 632) was like a very triumph. All Arabia, part from the vassals of Persia and Greece, lay at his feet. The greatest success of his life had been effected by sheer oral force without a stroke of the sword. But Arabia o longer sufficed him; he had wider aims. In his last ears he began to extend the holy war against the Greek Even on his return from Hodaibiya, he began to direct nvoys to several foreign potentates, with letters demand ng their adhesion to Islam. One of the envoys was eized and beheaded in the Belka (the ancient Moab). Hence sprang the first campaign against the Greeks, or he Arabs who were subject to the Greek empire. The rmy directed against them was, however, entirely defeated t Mu'ta (Autumn 629), Khalid succeeded with difficulty n rallying and leading back the broken remnant of the ost. Next summer the Nabatæans who visited the mar et of Medina spread a rumour that the Emperor Heraclius was collecting a vast force to attack the Moslems, and Mohammed set forth to meet him at the head of 30,000 men, but got no farther than Tebuk, on the southern borders of ancient Edom, when the rumours were found to be false. The expedition, however, was not altogether fruitless, as it led to the submission of several small Jewish and Christian communities in the north of the Peninsula. Mohammed equipped a new expedition against the Greeks on his return from his "farewell pilgrimage," and it was just ready to start when he died, on Monday 8th June 632.

In forming an estimate of one who has exercised so unexampled an influence on the history of the world, we shall do well to bear in mind the hint of Gibbon, that "some reverence is surely due to the name of heroes and the religion of nations." The grounds on which Mohammed may be condemned are partly found in his private life. Although on the whole, even after he had become ruler of all Arabia, he maintained the original poverty and simplicity of his establishment, never setting store by money and estate, eating and drinking and soft clothing, strictly continued to fast and watch and pray after his first call to them, and that, too, plainly out of a heartfelt need and without any ostentation, he nevertheless in one point at least claimed for himself supreme authority as prophet to make provision for the flesh. He claimed to be personally exempt from those restrictions in regard to the female sex which lay upon all other Moslems, and, as is well known, he made very extensive application of this fundamental principle. This fact is quite rightly urged against him as a reproach; even pious Moslems have been scandalised by it. At the same time it is unnecessary to judge him on this account more harshly than we do Charlemagne, the most Christian king of the Franks, in any case we must not apply the standards of the present day to the circumstances of old Arabia. Of much weightier and indeed of crushing character is the accusation, that he did not really believe himself to be a prophet, but merely of set purpose played the part of one. For the first years of his activity indeed this charge is not now any longer maintained; it is universally granted that at that period his enthusiasm was genuine and real. But in Medina, we are told, he used his prophetic character simply as a pretext for the establishment of his power. It seems to the present writer that into this opinion there enter modern notions as to the separation between religion and the civil magistracy, which ought to be carefully kept out of sight. By any other instrumentality than that of a prophet it would hardly have been possible to found the state of Medina: religion was the soul of the community. The founding of a religion and the forming of a state were not connected in so merely external a way as is usually supposed, on the contrary, the one was the natural and necessary consequence of the other. This must certainly be conceded, that, if we are to make any distinctions at all, Islam was far less rich in religious meanings than in social forces. The Koran is Mohammed's weakest performance, the weight of his historical importance lies in his work at Medina and not in that at Mecca. And it is a fact that the politician in him outgrew the prophet more and more, and that in many cases where he assumed spiritual motives he merely did so to give a fair appearance to acts that emanated from secular need. In this respect it appears to us particularly objectionable that he gave out as revelations of God and placed in the Koran all sorts of regulations and orders of the day, which proceeded simply from his own deliberations or even in part were suggested to him by advisers from outside. At the same time the element of self-deception is not excluded even here. He took for a message sent down from heaven everything which in his cataleptic fits passed through his mind, however clear enough he at agreement with his own previously clear best thought. It was pardonable that he went on with the idea after he had once grasped it, that he blew upon the coal when the flame threatened to die out. It is easy to free him from the reproach of perfidy and cruel vindictiveness. The surprise of Nakhla in the month Rajab (ordered by him, though he afterwards repudiated it), the treatment of a nation which he maltreated, the execution of the 600 Jews at the close of the War of the Ditch, border, the Prophet heavily and inherently explain the wide-spread antipathy in which he is held. Yet even in this respect it is well not to forget the motives, already cited of Chrysostom, He pressed the man of vast aims who find it most difficult to keep the beaten path.

After the death of Mohammed arose the question who was to be his "representative" (Khalifa, Caliph). The choice lay with the community of Medina, as this was understood; but whom were they to choose? The natives of Medina believed themselves to be now one more matter in their own hands, and wished to promote one of themselves. But the Emigrants asserted their superior claims, and with success, having brought into the town a considerable number of outside Moslems, enough to overawe the men of Medina, who besides were still divided into two parties. The Emigrants' leading spirit was Omar; he did not however, come himself to be proposed to himself but to Abubekr, the friend and father-in-law of the Prophet.

The affair would not have come off so smoothly, had not the opportune decease of the Arabian pretenders put a stop to the onward schism which threatened. Islam suddenly found itself once more knitted to the community of Medina only Mecca and Taif remained true. The Bedouins were willing enough to place Medina, but less willing to pay taxes to their detention, as might have been expected was a political movement. Nowhere was it a revolt from Islam, for here religion, political society and the religious are identical. A peculiar consideration to Mohammed was involved in the fact that the leaders of the rebellion in the various districts did not pose as princes and kings, but as prophets, as the secret of Islam's success appeared to be.

Abubekr proved himself quite equal to the perilous situation. In the first place, he allowed the expedition against the Greeks, already arranged by Mohammed, quietly to set out, limiting himself for the time to the defence of Medina. On the return of the army he proceeded

[1] Compare Muir, iv. 263.

[2] See Nöldeke, *Beiträge zur Kenntniss der Poesie der alten Araber* (1864), i. 89 *sq.*

ttack the rebels. The holy spirit of Islam kept the men
f Medina together, and inflamed them to a death-defying
eal for the latter while, on the other side, the Arabs as a
hole had no other bond of union and no better source of
nspiration than a confused paganism. As was to be expected,
hey were worsted in seven small flying columns of the
Moslems, sent out in various directions, failed to quell
he revolt. Those who submitted were forthwith received
nd pardoned; those who persisted in rebellion were
ompletely crushed. The majority, accordingly converted,
he apostates were extirpated. In Yamama only was
here a stand to struggle. The Banu Hanifa under their
hief Moseilama fought bravely, but here also Islam

[illegible] Islam in Arabia was
[illegible] to say, brought about by the distribution already
he holy war against the heathen country which Mohammed
ad already organized was the best means for maintaining
he new religion popular among the Arabs, for maintaining
ce by means of the sword the worship of Allah, opposi-
nity was at the same time attended by increasing
ooty. The next movement was of course Islam, but
o many were induced to join it by more other than
heroic motives. Now was the Islamic principle the most
ecessary one which the Arabian chiefs had overlooked
ince and according to former times every attempt to
Sodomize had settled on the borders of the wilderness.
The best test may perhaps be seen in the case of the ever
much desired possession of the old Satrapan kingdom
Mesopotamia, the most Arabian kingdom of
the ancient Hierarchical organization, the western and eastern
borderland of [illegible] the more prized to Moslem
conquest as [illegible] coveted goal, not only on account
thereof was subject to [illegible] and Persian Pahlawi time to
the Greek, the [illegible] of the Arabian accepted the
xtension of the war to exceed the limits of Arabia to a
struggle with the two great powers.

After the pacification of Middle and North Eastern
Arabia, Khalid by Abubekr's order or the
Caliph to the conquest of the Euphrates on the lower
Euphrates. The more he was instructed to [illegible] where
o-ordinate but distinct from [illegible] the
summer of 633, as from 20th August 633 to the
attle on the Hieromax (Yarmuk) was fought, the
he Emperor Heraclius hurriedly [illegible]
hemselves, the Christian hemisphere would decidedly have
ken only an isolated case in the history of the

these limits annexation was practicable and natural, a
repetition indeed of what had often previously occurred.
The kingdoms of Ghassán and Hira, advanced posts
hitherto, now became the headquarters of the Arabs; the
new empire had its centres on the one hand at Damascus,
on the other hand at Cufa and Basra the two newly
founded cities in the region of old Babylonia. The
capital of Islam continued indeed for a while to be Medina,
but soon the Hijaz and the whole of Arabia proper lay
quite on the out[illegible]ert of affairs.

It is striking to notice how easily the native population
of the conquered district exclusively or prevailingly
Christian, adapted themselves to the new rule. Their
nationality had been broken long ago; but intrinsically
it was more closely allied to the Arabian than to the
Greek or Persian. Their religious sympathy with the
West was certainly impaired by dogmatic controversies;
from Islam they might at any rate hope for toleration
even though their views were not in accordance with the
theology of the Emperor of the day. The lapse of the
masses from Christendom to Islam, however, which took
place during the first century after the conquest, is only to
be accounted for by the fact that in reality they had no
inward relation to the gospel at all. They changed their
creed in order to acquire the rights and privileges of
Moslem citizens. In no case were they compelled to do
so, on the contrary, the Omayyad Caliphs saw with dis-
pleasure the determining process of the poll tax derived
from their Christian subjects.

It would have been a great advantage for the solidity
of the Arabian empire if it had confined itself within the
limits of the old Semitic land with perhaps the addition
of Egypt. But the Persians were not so ready as the
Greeks to give up the contest, they did not rest until the
Moslems had subjugated the whole of the Sasanid empire.
The most important event in the protracted war which led
to the conquest of Iran, was the battle of Nehawend in
641, the most obstinate resistance was offered by Persis
proper, and especially by the capital, Istakhr (Persepolis).
In the end all the provinces and somewhat autonomous
provinces of the Sasanid empire fell, one after the other,
into the hands of the Moslems, and the young Shahanshah

to ruin, where he came to a miserable end.[1] But in more
than one case the work of conquest had to be done over
again, as we have to see the Iranians learned to accept the
position. Unlike the Christians of Western Asia, the
had a vivacious feeling of national pride, based upon
historic memories and especially upon a church having
connection of the closest kind with the state. Internal
disturbances of a religious and political character and
external disasters had long ago shattered the empire of
the Sasanid indeed, but the Iranians had not yet lost
their patriotism. They were fighting, in fact, against the
despised and hated Arabs, in defence of their holiest pos-
sessions, their nationality, and their faith. They were
subjugated, but their subjection was only outward. The
commonwealth of Islam never succeeded in assimilating
them as the Syrian Christians were assimilated. Even
when in process of time they did accept the religion of
the Prophet they leavened it thoroughly with their own
peculiar leaven, and, especially, deprived it of the practical
political and national character which it had assumed after
the Flight to Medina. To the Arabian state they were
always a thorn in the flesh, it was they who helped most
largely to break up its internal order, and it was from
them also that it at last received its outward deathblow.

[1] De Goeje, *Mémoire sur la Conquête de la Syrie*, 2nd ed., No. 3, Leyden, 1864; Noldeke, *Z. D. M. G.*, 1875, p. [illegible]; Baladhori, 137.

[2] See H. Zotenberg in *Journal Asiatique*, 1874, [illegible]. The date is perhaps some year too late.

[1] The accounts differ, see Baladhori, 305. The chronology of the conquests, as is well known, is in many points uncertain.

[1] Baladh., 315 *sq.*, Tabari, i. 1068.

The fall of the Omayyads was their work, and with the Omayyads fell the Arabian empire. The course of Islam's political history during its first centuries is denoted by the removal of the capital from Damascus to Cufa, and from Cufa to Baghdad, the latter occupying, approximately, the site of the ancient Ctesiphon.

But we must return to the period of Abubekr. He died after a short reign, on 23d August 634, and as a matter of course was succeeded by 'Omar. To 'Omar's ten years' Caliphate belongs for the most part the great conquests. He himself did not take the field, but remained in Medina; he never, however, suffered the reins to slip from his powerful hand. The influence of his personality and the Moslem community of feeling. His political genius is shown by the circumstance that he endeavoured to limit the indefinite extension of Moslem conquest, and to maintain and strengthen the national Arabian character of the commonwealth of Islam; also by his making it his foremost task to promote law and order in its internal affairs. The saying with which he began his reign will never grow antiquated. "By God, he that would be over you must be in my sight the strongest, until I have wrested from him his rights, but him that is strong I will have as the weakest, until he complies with the law." It would be impossible to give a better general definition of the function of the State. After the administrative apparatus he directed his organizing activity, as the circumstances demanded, chiefly towards matters relating to the regulation of taxation in the conquered territories and the application of the vast resources which poured in to the treasury at Medina. It must not be brought forward as a personal reproach, that in dealing with the Arabs he followed the principle that the Moslems were the born rulers and leaders of all the rest of the world. But he lost his life by his death for the fault of having overlooked a Persian slave, driven to desperation by abuse and threats, who stabbed him in the mosque at Medina. He died in the beginning of November 644.

Before his death 'Omar had nominated six of the leading Emigrants who should choose the Caliph from among themselves: 'Othman, 'Ali, Zobair, Talha, Sa'd b. Abi Wakkas, and 'Abd al Rahman b. 'Auf. The last named declined to be a candidate, and decided the election in favour of 'Othman b. Affan. Under this weak overlord the government of Islam fell entirely into the hands of the Koraish nobility. We have already seen that Mohammed himself prepared the way for this transference; Abubekr and 'Omar followed suit; the Emigrants were unanimous among themselves in thinking that the precedence and leadership belonged to them as of right. Thanks to the energy of Omar, they were successful in appropriating to themselves the succession to the Prophet. They indeed rested the claim they put forward on the undeniable priority of their services to the faith, but they also appealed to their blood relationship with the Prophet, as a legitimation of their right to the inheritance; and the ties of blood connected them with the Koraish in general. In point of fact they felt a greater solidarity with these than, for example, with the natives of Medina; nature had not been expelled by faith.[3] The supremacy of the Emigrants naturally furnished the means of transition to the supremacy of the Meccan aristocracy. 'Othman did all in his power to press forward this development of affairs. He belonged to the foremost family of Mecca, the Omayyads, and as he should favour his relations and the Koraish [illegible] in every possible way, seemed to him a matter of course. Every position of influence and emolument was [illegible] to these, they themselves heartily called the imperial province of Irak the garden of Koraish. In truth, the entire empire [illegible] Nor was it unreasonable that from the [illegible] of Islam the best advantages should be reaped by those who had it the world. So it were beyond all doubt the patricians of Mecca and after them those of Taif; people like Khalid al Walid, 'Amr b. al 'As, 'Abdallah b. Sa'd, Sa'id b. Al 'As, Marwan b. Al Hakam, and, above all, Abu Sufyan with his son Mo'awiya the governor of Syria.

Against the ruinous tide of worldliness an opposition arose, however, now here now there, to appear. It was led by what may be called the ascetical nobility of Islam, which distinguished from the hereditary nobility of Mecca, may also be designated as the nobility of merit, and which [illegible] the "Defenders" and the pervades of the Koran, and who bear themselves to the [illegible] of the Koraish but by means with the intention of allowing merit [illegible] thereby enhanced. The opposition was headed by Zobair, Talha, both [illegible] and [illegible] and a disappointed candidate [illegible] their tendency was [illegible] purely [illegible] fear of God [illegible] reliance but power and position [illegible] They party was a minority [illegible] zeal party, who saw with displeasure [illegible] best places in the community [illegible] and actually done nothing [illegible] themselves to [illegible] the twelve [illegible] had borne the brunt [illegible] But the majority were [illegible] view, who [illegible] person, that the [illegible] place. Everywhere in the provinces against the Caliphate [illegible] 'Othman's country [illegible] were and strong adherents. [illegible] energetic in [illegible] the deposition of 'Othman [illegible] [illegible] province as well as [illegible] seemed to give [illegible] there were [illegible] Mecca.

The malcontents [illegible] hand they came from the provinces 'Othman into [illegible] India and Oman to the [illegible] before the [illegible] two troops at hand. He reproached the malcontents [illegible] but as soon as they had gone he let matters take their old course. Thus three years went on [illegible] In the following year (655) the leaders of the rebels came once more from Egypt and Iraq to Medina with a more extensive following, and the Caliph accepted his former plan of making promises which he did not intend to keep. But the rebels sought him [illegible] fulfilment by which of his word, and now demanded his [illegible] action, he regained him as his own [illegible]

[1] He sought to make the whole nation a great host of God, the Arabs were to be soldiers and nothing else. They were forbidden to acquire landed estates in the conquered countries; all land was either made state property or was restored to the old owners subject to a perpetual tribute which provided tax on a splendid scale for the army.

[2] Noldeke, *Tabari*, 216. To 'Omar also is due the establishment of the Era of the Flight.

[3] Even in the list of the slain at the battle of Honain the Emigrants are enumerated along with the Meccans and Koraish, and distinguished from the men of Medina.

[4] It was [illegible] opposition of the party that afterwards [illegible] the Omayyads. The movement triumphed [illegible] 'Othman to the throne. But, that the party [illegible] not for principle but for personal advantage was apparent in the [illegible] Zobair and Talha [illegible] the followers of 'Ali.

defended by a few faithful subjects. As he would not yield, they at last took the building by storm and put him to death, an old man of eighty. His death in the act of maintaining his rights was of the greatest service to his house and a corresponding disadvantage to the enemy.

Controversy now arose among the leaders of the opposition as to the inheritance. The mass of the mutineers summoned 'Ali to the Caliphate, and compelled even Talha and Zobeir to do him homage. But soon the two, along with 'Aïsha, the mother of the faithful, who had an old grudge against 'Ali, succeeded in making their escape to Mekka, where at Basra they raised the standard of rebellion. Ali in point of fact had no real right to the succession, and moreover was actuated not by piety but by ambition and the desire of power, so that men of penetration, even although they condemned 'Othman's method of government, yet refused to recognize his successor. The new Caliph, however, found means of disposing of their opposition, and at the battle of the Camel, fought at Basra in November 656, Talha and Zobeir were slain, and 'Aïsha taken prisoner.

But even so 'Ali had not secured peace. With the murder of 'Othman the dynastic principle gained the twofold advantage of a legitimate cry—that of vengeance for the blood of the persecuted Caliph—and of a victim who could champion the Syrian governor Mo'awiya. Mo'awiya was not inclined to recognize 'Ali, and the latter did not venture to depose him. To have done so would have been useless, for Mo'awiya's position in Syria was impregnable. The kernel of his subjects consisted of genuine Arabs, not only in race and manners, alone with Islam, but also old settlers who, through contact with the Roman empire and the Christian church, had taken on a measure of civilization. Though the Ghassanids these latter had become habituated to monarchical government and loyal obedience, and for a long time much better order had prevailed among them than elsewhere in Arabia. Syria was the proper goal for the rise of an Arabian kingdom, and Mo'awiya was just the man to make use of the situation. He exhibited 'Othman's blood-stained garment in the mosque at Damascus, and incited the Syrians to revengefulness.

'Ali's position in Cufa was much less advantageous. The population of 'Irak was already mixed up with foreign elements; it fluctuated greatly, and was largely composed of fresh immigrants. Islam had not its headquarters here; Cufa and Basra were the home of the sect and of the adventurer, the centres of religious and political movement. This movement it was that had raised 'Ali to the Caliphate, but yet it did not really take any personal interest in him. Religion proved for him a much less trustworthy and more dangerous ally than the conservative and secular feeling of Syria for the Omayyads. Mo'awiya could either act or refrain from acting as he chose, and in either case of the obedience of his people. 'Ali on the other hand, was unable to convert either case for the principle ascribed on his banner into a reason for his position. It was necessary that he should accommodate himself to the wishes of his supporters, and at the same time it was impossible, for these wishes were inconsistent. They compelled him suddenly to bread on the battle of Siffin, which he was on the point of gaining over Mo'awiya, because the Syrians fastened copies of the Koran to their lances to denote that not the sword but the word of God should decide the contest (end of July 657). But in yielding to the will of the majority he aroused the displeasure of the minority, the genuine zealots, who in Mo'awiya were seeing the enemy of Islam, and who regarded 'Ali's entering into negotiations with him as a denial of the faith. When the negotiations failed and war was resumed, the Kharijites refused to follow 'Ali's army, and he had to turn his arms in the first instance against them. He succeeded in disposing of them without difficulty, but in his success he lost the soul of his following. For they were the true champions of the theocratic principle; through their elimination it became clear that the struggle had in no sense anything to do with the cause of God. 'Ali's defeat was a foregone conclusion; once religious enthusiasm had failed him; the secular resources at the disposal of his adversaries were far superior. Fortunately for him he was murdered (on 24th of January 661), thereby posthumously attaining a unique importance in the eyes of a large part of the Mohammedan world (Shi'a) which he had never possessed during his life. His son Hasan made peace with Mo'awiya.

The Kharijites are the most interesting feature of this phase of Islam. In the name of religion they raised their protest against allowing the whole great spiritual movement to issue in a secular and political result, in the establishment within the conquered territories of an Arabian Lineodom, a kingdom which diametrically contradicted the theocratic ideal. Islam was then on the point of making its peace with the world, not without a certain apostasy from its original principles, for which Mohammed himself had paved the way. Life was no more dominated by religion, but came to terms with it and parted company. The development was favoured by the government, which desired before all things to have peace. Orthodoxy arose, and thereby religion was tamed and directed to every dangerous element, strictly speaking, became a compromise, according to which the letter of the precept was correctly followed, in order that, in everything besides, a man might obey his own inclinations. The conditions under which any one might make sure of heaven were on the one hand the performance of "good works" as had a special church merit assigned to them, on the other hand, faith in the absolute sovereignty of God even over the wills of men. About morals God showed little concern—the usual view of orthodox shamanism. This was by no means the original standpoint of Islam, although the transition from it was made at an early stage, and by the Prophet himself. Originally Islam—as religious resignation—was only the complement of pious effort; a man set himself about even the hardest and apparently purposeless tasks, because he believed the issue to be entirely in the hand of God. But now all this was reversed, a man acted according to humour, because his destiny had nothing to do with his inherent qualities, but was dependent entirely on Allah's caprice. The Kharijites protested not merely against the dynastic principle and the rule of the Omayyads, but also against orthodoxy; they disputed the doctrine of predestination and the proposition that a grievous sinner could yet be a good Moslem, because they did not understand how to divorce religion from practice. To some degree they call to mind the Montanists, but their opposition was much more energetic in its expression.[1]

Sources.—For the history of Mohammed these are—(1) the Koran, (2) the theological historical tradition or Hadith. The latter is chronologically arranged in the biographies, of which those of Ibn Ishak and of Wakidi are the oldest and most important. Ibn Ishak's work in its complete form is now to be found only in Ibn Hishām's revision (ed. Wustenfeld), but large and numerous fragments of the original are given by Tabari (ed. de Goeje). Of Wakidi's *Kitab al Maghazi*, *i.e.* the history of Mohammed in Medina, is still extant (abridged German translation by Wellhausen, 1882); his collections for the earlier period are known to us through the work of Ibn Sa'd his secretary (*Tabakat*

[1] On the further development of Islam compare Houtsma, *De Strijd over het Dogma*, Leyden, 1875.

unedited). The Hadîth is set forth more systematically, according to subjects, in the great collections of tradition by Mâlik b. Anas, Bokhârî, Moslim, etc. (Bûlak editions). A subsidiary authority is the humanistic tradition of the Odaba, with which the poetry may be reckoned. The principal collections of this class are the *Kitâb al-Aghânî* (Bûlak edition) and the *Kâmil* (ed. Wright). For the period after Mohammed the most important work is the *Chronicle* of Tabarî (Leyden edition); the history of the conquest is treated briefly after the best authorities by Baladhorî (ed. De Goeje, 1866).

Literature.—The genuine tradition of the Arab with reference to their prophet was first introduced into Europe by the French beginning with Gagnier and ending with the valuable work of Caussin de Perceval. Weil and, after him, Noldeke especially, have the merit of having shown how to use the Koran in conjunction with the Arab tradition as a main source. Of modern biographies the most important are those of Muir and Sprenger; research has not yet got beyond them, although there is room for this. For the history of the Caliphs, the standard book is still the well-known work of Weil (although since it was published considerable additions have been made to our knowledge of the sources, especially to the labours of Dozy, De Goeje and other Dutch). Hitherto the main object has been to arrange together the material for this department of research, and a comprehensive treatment of the entire subject has not yet been accomplished. Still reference may be made in this connection to Dozy, *Histoire de l'Islamisme*, and A. von Kremer, *Geschichte der herrschenden Ideen des Islams* (*Kulturgeschichte des Orients unter den Khalifen*). (J. W.)

PART II. THE EASTERN CALIPHATE.

SECT. I. THE OMAYYADS.

1. In commencing the history of the Omayyad dynasty we must first recur to the causes which brought about the triumph of this family, and which led at once to the removal of Damascus for Medina as the seat of the Caliphate, an event which led to profound changes in the Moslem empire and exercised a considerable influence on its development. In the same way, at a later date, the transfer of the Caliphate from Damascus to Bagdad marked the accession of a new family to the supreme power, and gave Islam a new direction.

In the time of Mohammed the Arab were divided into an infinite number of tribes, some settled, other nomadic, which were constantly at war with each other. The Prophet united them into one body, but he could not entirely eradicate the hatred which had existed for ages between tribe and tribe. Thus the people of Mecca and those of Medina hated each other because the former were a branch of the race of Ma'add, the great ancestor of the tribes of the North,[1] while the latter belonged to the Yemenite race, or that of the South. The conquest of Mecca by Mohammed and his allies of Medina only exasperated this hatred, and the nobles of the Koraish swore to take revenge on the Yemenite, as soon as they should be able to do so. One of the most violent opponents of the Prophet had been, as we have seen, the father of that very Mo'âwiya who founded the Omayyad dynasty, Abu Sofyan, grandson of Omayya, the leader of the Meccan at the battle at Ohod; and it is related that his wife Hind, having found Hamza, Mohammed's uncle, among the dead, cut open his body, and tore out and devoured his liver. We have also seen how Abû Sofyân ultimately made his submission and embraced Islam, but only under compulsion. His son Mo'âwiya became, it is true, one of Mohammed's secretaries; but we know that his faith was never very strong, and that he always made his religion subordinate to the interests of his family. Even in his youth, he had conceived the project of recovering the supreme power for his own race, and it has been related above how the inner conflicts of Islam under the Caliphates of 'Othmân and 'Alî carried him forwards towards this goal.

Mo'âwiya might, no doubt, have marched to the help of 'Othmân with an army of Syrians, but the preservation of the Caliph, his relative, would not have served the purposes of his burning ambition, and we may say without hesitation that it was with secret joy that the prefect of Damascus heard of the fatal result of the plot against 'Othmân. The Syrians were entirely devoted to Mo'âwiya. Polite, amiable, and generous, he had gained the goodwill of all the Arabs of Syria, for whom Islam had remained a dead letter, and who, continuing Bedouins at heart, shared the feelings of their chief against the new aristocracy of Medina. Consequently, when 'Alî, the successful candidate, summoned Mo'âwiya for the last time to acknowledge him, and when Mo'âwiya, a cultivated man of the world, had read the message of Damascus, asked them what they replied that it was his part to command, and theirs to obey and to act. The enthusiasm of the Syrians was great, and Mo'âwiya having ordered a levy *en masse* within three days a very able-bodied man had joined the standard. Syria alone supplied Mo'âwiya with more troops than all the rest of the provinces put together had furnished to 'Alî, who is said to have addressed his soldiers with these bitter words: "I would gladly exchange ten of you for one of Mo'âwiya's soldiers." Then he added an allusion to the savage action of Hind, Mo'âwiya's mother, on the field of battle at Ohod: "By God! he will win the victory, the son of the liver-eater!"

'Alî's gloomy anticipations were fulfilled, but it was by stratagem that Mo'âwiya gained his victory. The battle of Siffin, the abortive negotiations that followed, and the withdrawal of the Kharijites have been already spoken of. The negotiations ended in the conference of Dumat-al-Jandal, a small place situated between Syria and Arabia, about seven days' journey from Damascus and three from Medina. Here in Ramadan, A.H. 37 (A.D. 658), Abu Mûsa and 'Amr ibn al-'As (the former conqueror of Egypt) appeared as arbitrators for 'Alî and Mo'âwiya respectively, and the summons of the latter induced Abû Mûsa to pronounce both pretenders deprived of what rights either might have to the Caliphate, and to say that it now rested with the Moslems to make a new choice. 'Amr, who was only waiting for the declaration to execute his turn, stood up and said to the Arabs who were crowding round the platform: "O people, ye have heard what Abû Mûsa says. He has himself renounced the claims of his candidate. I also agree to the deprivation of 'Alî, but I proclaim my master Mo'âwiya Caliph." Abu Mûsa cried out against this treachery, but no one would listen to him, and he fled for refuge to Mecca, where he ultimately recognised the claims of Mo'âwiya, even in 'Alî's lifetime. The event marks the commencement of the Omayyad dynasty. 'Amr went in triumph to Damascus, where the Syrians took the oath of fidelity to Mo'âwiya.

In 'Irak, on the other hand, with the exception of the Kharijites, all the people remained faithful to the memory of 'Alî who mounting the pulpit at Cufa, summoned the army to the field and fixed their rendezvous at Nokheila, a small place not far from the city. The Kharijites had taken refuge at Nahrowan, and 'Alî decided at once to attack them there, before marching against the Syrians. At his arrival most of the rebel dispersed, and only fifteen to eighteen hundred fanatics, who remained, threw themselves on the enemy and allowed themselves to be slaughtered to the last man. Thus rid of the Kharijites, 'Alî now prepared to direct his march towards Syria, but his soldiers refused to move, and declared their intention of returning

[1] The Ma'addites are also often called Modarites and Kaisites, after their ancestors Modar and Kais.

est at Cufa. Compelled to inaction, 'Alí returned to
Cufa, while Mo'awiya gave his attention to securing the
at the provinces. At the beginning of A.H. 38
A.D. 658-659, Egypt was lost to 'Alí. 'Amr b. al-'As
was reconquered by Mo'awiya, and marched without
delay, at the head of five thousand men, against 'Alí's
successor, Mohammed, son of the late Caliph, Abúbekr.
The governor appointed by 'Alí to the help of
Mohammed was poisoned at Kolzom by the prefect of
the place, a Omayyad under secret orders from Mo'awiya, and
his troops retraced their steps. Meanwhile in Egypt
all a partisan of the Omayyad, Mo'awiya b. Hodaij,
who was at the head of six thousand fighting men, had
declared against Mohammed and driven him from Fostat.
On his arrival in Egypt, 'Amr effected a junction with
Mo'awiya b. Hodaij, and the unfortunate Mohammed
was taken by his adversaries, fell into the hands of Ibn
Hodaij, who put him to death.

While Egypt was thus being lost to 'Alí, commotions
were excited in Arabia by a partisan of the Omayyads.
These were, however, put down by the governor of that
city, Ziyad. This man was Mo'awiya's own brother, but
illegitimate, and not having been acknowledged by his
father, Abu Sofyan, he had revenged himself by embracing the
party of 'Alí. Ziyad was renowned among the Arabs
for his eloquence, his prudence, and his courage. At a
later period, Mo'awiya seemed bent over to his cause by
publicly acknowledging him as his brother. At the time
we are speaking of, however, a faithful friend of 'Alí, and a
supporter of his cause, Mohammed, son of the late Caliph, Abúbekr.
The governor appointed by 'Alí to the help of
Mohammed was poisoned at Kolzom by the prefect of
the place, a Omayyad,

liph was not moved; threats prevailed over the
y of the people of 'Iráḳ, and Moʿawiya repaired to
n person, at the head of an army, to intimidate the
nts of Mecca and Medina. As may be supposed,
cipal fomenters of the resistance in Arabia were
s of the first Caliphs, 'Abd al Raḥman the son of
r, 'Abdallah the son of 'Omar, and Hosain the
Alí; for, by submitting, they would have renounced
of being themselves chosen by the people. Another
ḥ, son of that Zobair who had been among the
idates nominated at the death of 'Omar for the
of the Moslems, was also one of the warmest
nts of the pretensions of Moʿawiya. All the efforts
Caliph to win over these personages to his side
proved vain, he ordered them to be brought into
sque at Mecca, each between two soldiers; then,
mounted the pulpit, he called on the by-standers to
oath of allegiance to his son, adding that 'Abd
man, Hosain, and the two 'Abdallahs would refuse no
n. They, in their terror, did not utter a word, and
mbly took the oath. Then Moʿawiya, without con-
himself further about the malcontents, returned to
ns.

thus occupied at home, Moʿawiya did not neglect
affairs. 'Amr b. al 'Aṣ, governor of Egypt, died
A.D. 663-664), and was followed by several pretend
ssion, under one of whom the general Moʿawiya
undertook several expeditions into the province
ca. In the year 50 (A.D. 670) he advanced as
'Aqaqa, now Sus, near which city he laid the
ions of the celebrated Kairawan, and even went
Sabaratha, a town situated near the sea-shore, and
to the island of Crete. The emperor, Constantine
l sent thither thirty thousand Greeks who were
and compelled to re-embark in haste. Moʿawiya re-
eturned to Egypt after his victory and the Caliph
sidered the position of the Moslems in Africa so
that he separated that province from Egypt, and
d as governor of Africa 'Oḳba b. Nafi', who pro-
y established Kairawan, in a plain situated at a
stance from the first encampment of Moʿawiya b.
According to some historians, the new city was
ed A.H. 55 (A.D. 674-675).

East the successes of the Moslems were still more
. Ziyad, brother of Moʿawiya, as soon as he was
ed governor of 'Iraḳ and Persia, sent an army into
n. It advanced as far as the Oxus, crossed that
nd returned loaded with booty taken from the
ng Turkish tribes of Trans-oxiana. Bokhara was
l by a son of Ziyad, and Saʿíd, son of the Caliph
n, whom Moʿawiya had made governor of Khoraʿsan,
l against Samarkand, A.H. 56 (A.D. 675-676);
generals penetrated as far as the Indus, and over-
l conquered Múltan, Kabulistan, Mokran, and

e North the Moslems were not less fortunate in
tacks on the Byzantine empire. Moʿawiya, while
ly governor of Syria, had gained possession of
, and had sent a fleet against Cyprus, which, in
tion with that of the governor of Egypt, had
the conquest of that island. Encouraged by the
f this expedition, he gave the order for new incur-
the Mediterranean. His fleet of twelve hundred
invested the islands of Cos, Crete, and Rhodes.
ous Colossus of Rhodes was broken to pieces, and
l that the bronze of which it was made was bought
w of Emesa, and formed a load for nine hundred
hty camels. The Arabs even dared to threaten
tinople, which owed its safety only to the Greek
Yazíd, the son of Moʿáwiya, took part in these
expeditions, but with no great ardour; and in the year 5
(A.D. 677-678) Moʿawiya concluded a thirty years' peace
with Constantine IV. Two years later, he died at Dama-
cus, after a reign of nearly twenty years. He had been
governor of Syria for the same length of time. Before his
death, he sent for his son Yazíd, and having pointed out
how he had smoothed down all difficulties for him, he
advised him to pay no effort to preserve the attachment
of the Syrians. He urged him also to keep a close watch
on the actions of Hosain b. 'Alí, and of the other pre-
tenders who had refused to take the oath of allegiance to
him, but he added that, should they rebel, Yazíd ought
to treat them with clemency, and not to forget their illus-
trious origin. By failing to act upon this wise advice
Yazíd rendered irreconcilable that formidable schism which
even at the present day, till divides the Moslem world,
and which, at all period, has been a cause of calamity to
Islam.

Yazíd had not his father's consummate diplomatic
talent of playing off one party against another, he became
more cautious on forming a pretty complete idea of consol-
idating the stability of his empire. During his short reign
he committed three actions for which Moslem never
pardoned him, namely, the murder of Hosain, son of 'Alí
and grandson of the Prophet, the pillage of Medina, and
the taking of the Kaʿba, the venerated temple of Mecca.
crimes which were not redeemed in the eyes of the people
by a few fortunate expeditions on the part of his generals.

Immediately on ascending the throne, in the month
Rajab A.H. 60 (April A.D. 680), Yazíd sent a circular to all
his prefects, with an official announcement of his father's
death, and an order to administer the oath of allegiance to
their respective subjects. In particular, he charged the
new prefect whom he appointed to Medina, his own cousin
Walíd b. 'Oḳba, to take off the head of Hosain son of
'Alí, 'Abd al Raḥman son of Abú Bakr, 'Abdallah son of
'Omar, and 'Abdallah son of Zobair, if they should refuse
to acknowledge him. Terrified at such a command,
Walíd did not dare to act with promptitude against Hosain and
'Abdallah b. Zobair, both of whom refused to take the
oath, but allowed them to escape to Mecca. Yazíd
immediately deprived him of his office, and appointed in
his place 'Amr b. Saʿíd, already governor of Mecca. One
in the Holy City, 'Abdallah b. Zobair threw himself in
such perfect safety that he began to intrigue with the
Meccans, to have himself proclaimed Caliph in Arabia.
At Cufa the news of the flight of Hosain produced great
agitation among the partizans of the family of 'Alí, who
were numerous there, and they sent several addresses to
the grandson of the Prophet urging him to take refuge
with them, and promising to have him proclaimed Caliph
in 'Iraḳ. Hosain, who knew the fickleness of the people
of 'Iraḳ, hesitated to yield to their entreaties, but the
Zobair, who was desirous to get rid at all costs of so
formidable a rival, persuaded him that he ought to go
and put himself at the head of the people of 'Iraḳ, and
enter on an open struggle with Yazíd. Hosain began by
sending his cousin Moslim b. 'Aḳíl to Cufa, and from him
he learned that many of the inhabitants of that city
appeared really devoted to support him. The prefect of
Cufa, Noʿmán b. Bashír, though apprized of the approach
of the prince, did not choose to make them known to Yazíd,
as he was reluctant to act with severity against the grand-
son of the Prophet. Information, however, reached the
Caliph, who deprived Noʿmán of his office, and ordered

[1] Sabora b. Ziyad invaded Seistan, and returned to Bassora with immense booty to Merv. In Africa 'Oḳba b. Nafi' marched to the Atlantic coast; the Mediterranean so far as Tangiers on the Straits of Gibraltar; and fell not in an ambuscade laid by the Berbers, who killed him and took Kairawan.

Obaid Alláh, son of the famous Ziyád, and then governor of Basra, to give up the post there to his brother 'Othmán, and to repair in person to Cúfa, in order to watch the partisans of 'Alí in that city. 'Obaid Allah obeyed, entered Cúfa, and ascending the pulpit the very day after his arrival proudly announced his firm intention of putting to death any one who should rebel. Moslim b. 'Akíl was given up by a traitor and executed. Meanwhile Hosain, on receiving the communications despatched, had already set out from Mecca with all his family, and had reached Kadisiya, a place situated only fifteen parasangs[1] from Cúfa and noised for the defeat sustained there by the Persians under the Caliphate of 'Omar, when he received the vexatious tidings. He wished to retrace his steps immediately, but the friends of Moslim dissuaded him from doing so for revenge, and representing to him that doubtless he had only to show himself under the walls of Cúfa to be received with enthusiasm by its inhabitants. Hosain accordingly pursued his journey towards Cúfa. But 'Obaid Allah, who was watching all his movements, sent four thousand horsemen, devoted to the Omayyad cause, to meet him, with orders to bring Hosain before him either alive or dead. The commander of the horsemen was 'Omar b. Sa'd,[2] to whom 'Obaid Allah had promised the government of Medina as a reward, if his expedition should succeed. The Omayyads met Hosain in the plain of Kerbela, opposite to Cúfa, before he had reached the Euphrates, and surrounded him. 'Omar b. Sa'd himself brought out Hosain and summoned him to surrender. Hosain declared himself ready to renounce his pretensions, provided he were allowed to return to Mecca with his followers, or were even sent to Damascus. When 'Obaid Allah was informed of this proposal, he simply repeated his former order to bring Hosain to Cúfa, dead or alive, and, learning the defection of 'Omar b. Sa'd, he sent out other troops under the orders of a certain Shimr. On the 9th of Moharram in the year 61 (9th October A.D. 680), Shimr reached Kerbela, and summoned Hosain afresh to surrender at discretion. Hosain preferred to die sword in hand, and on the following day, after a desperate struggle, he was cut down with all his followers. His head was sent off and carried to Cúfa, and then sent to Damascus. His body was not buried till the following day. Only the women of his family were spared, and one of his sons, these were taken by Yazíd's order to Medina, where the sight of their mourning and the tale of their sufferings caused a profound sensation. The horror and grief of the partisans of 'Alí's family were great. Hence the names of Yazíd, 'Obaid Allah, and Shimr, have been held accursed ever since by the Shí'ites. They observe the 10th of Moharram as a day of public mourning. Among the Persians, stages are erected in public places on that day, and plays are acted, representing the misfortune of the family of 'Alí.[3] The Omayyads themselves were loud in their reprobation of this impious massacre, and all Moslems without distinction of party, considered it a most foul act.

At Mecca the news was received with a decree of indignation of which 'Abdallah b. Zobair took advantage to assume the title of Caliph. Arriving A.H. 60, the new prefect of Medina had tried to secure his person. He had sent against him a force of two thousand men, at whose head was placed a brother of the pseudo-Caliph himself, called 'Amr, who, having been accused by 'Abdalláh of maintaining a guilty intercourse with one of his wives, had become his bitter enemy. 'Abdalláh collected an army, and placed it under the orders of 'Abdalláh b. Safwán, who completely defeated the Omayyad troops. The brother of the pseudo-Caliph was taken and put to death. At the news of this defeat, Yazíd swore that Ibn Zobair should never appear before him but as a prisoner in chains. He dismissed the new prefect of Medina, and nominated Walíd b. 'Otba, who, in the year 61, went to Mecca to try to seize 'Abdallah b. Zobair. The latter, in derision, wrote to Yazíd: "Walíd is a mad man, who will ruin everything by his folly; send in his place another governor to repair the wrongs he has done." Yazíd thought that 'Abdallah meant these words as a step towards reconciliation, hastened to deprive Walíd of his office; appointed 'Othman b. Mohammed in his place, and even sent envoys to Ibn Zobair. He, however, would not listen to them. He thought he could reckon upon the devotion of the people of Mecca, and further hoped that Medina itself would declare against Yazíd. This, in fact, took place in the year 63 (A.D. 682-683). The people of Medina, having been roused by a certain 'Abdallah b. Hanzala, who had had a near view of Yazíd at the court of Damascus, and had been scandalised by the profligacy of his life, revolted, drove the governor and all the Omayyads out of Medina, and proclaimed the dethronement of Yazíd. The Caliphate was even offered by some to 'Alí, that one of the sons of Hosain who had escaped the massacre of Kerbela; but 'Alí wisely refused it. At the news of this revolt Yazíd first sent an ambassador to Medina. This step proving fruitless, he next collected an army of from ten to twelve thousand Syrians, and entrusted their command to Moslim b. 'Okba, who passed, and with good reason, for a man who would recoil from nothing. This general, though weighed down by age and sickness, marched against Medina, took it, after a battle known as the day of Harra[4] (26th Dhu l-Hijja 63, 26th August 683), and gave up the city for three days to massacre and pillage. Torrents of blood flowed, and hence Moslim b. 'Okba received the surname of *Mosrif* (the Prodigal). On the fourth day, Moslim repaired to the mosque, and received the oath of allegiance from all those of the citizens of Medina who had not been able to make their escape. The news reached Mecca a few days later, and fell like a thunderstroke on Ibn Zobair and his adherents, who prepared for war, expecting from day to day to see Moslim appear before the walls of their city. He had, in fact, started for Mecca immediately after the conquest of Medina; but he died on the road, and the command was taken by Hosain b. Nomair. The Omayyad army arrived before Mecca a month after the capture of Medina, and found Ibn Zobair ready to defend it. A number of the citizens of Medina had come to the aid of the Holy City, as well as many Kharijites and Shí'ites, at the head of whom was a certain Mokhtár b. Abí 'Obaid, who subsequently played a very important part in 'Irák. In spite of the efforts of the Meccans, the Syrian army invested the city. Hosain b. Nomair had caused balistas to be placed on the neighbouring heights; and these, under the management of an Abyssinian soldier, hurled against the Ka'ba enormous stones and vessels full of blazing bitumen, with such effect that the temple took fire and was consumed. After a siege of two months, Ibn Zobair was beginning to despair, when he received, through an Arab of the desert, news of the death of Yazíd. The Caliph had in fact died on the 15th of Rabí' I. (11th November 683).

[1] The parasang is nearly equivalent to an English mile.

[2] Son of the famous Sa'd b. Abí Wakkás, conqueror of Persia under 'Omar, and founder of Cúfa.

[3] Shí'ites comes from *Shí'a*, a word which in Arabic signifies "sect." It is the name given to the partisans of the family of 'Alí, who acknowledge no legitimate Caliphate outside of that family. Shí'ism is the religion of Persia.

[4] See Chodzko, *Théâtre persan*, Paris, 1878.

[5] Harra is the volcanic district outside of Medina. One of the gates of the city is called the Gate of Harra.

Hosain b. Nomair immediately offered the Caliphate to Ibn Zobair, on condition that he should grant a complete amnesty to all those who had taken part in the battle of Jarra and in the siege of Mecca. 'Abdallâh had the folly to refuse, and Hosain then returned to Damascus.

Thus rid of his enemy, 'Abdallah caused the title of Prince of the True Believers (Amir al mo'minin) to be conferred on him — a title which 'Omar had already received, and which was afterwards adopted by all the Caliphs. He sent one of his brothers, 'Obaid Allah, to Medina, and chose as governor of Egypt 'Abd al Rahman b. Jahdam, who repaired to that province, and caused the authority of Ibn Zobair to be acknowledged there. At Basra and at Cufa, many of the inhabitants did not hesitate to acknowledge him, and received a Zobairite governor, while the Kharijite and the Shi'ite took up revolt — the former at Basra under the leadership of Nafi' b. Azrak, the latter at Cufa under that of Solaiman b. Sorad — and expelled the Omayyad governor, 'Obaid Allâh b. Ziyâd, who took refuge at Damascus. Mesopotamia soon followed the example of Irak. Everywhere the population seemed disposed to abandon the cause of the Omayyads. The Kharijite and Mokhtar b. Abi 'Obaid, who had supported Ibn Zobair, now deserted or betrayed him in favour of this pretender, and quitted Mecca. The son of Zobair, remaining thenceforth master of Mecca, occupied himself tranquilly in rebuilding the Ka'ba, which he restored on its ancient foundations.

3. It was in the midst of this break-up of his party that, immediately after the death of Yazid, his eldest son, Mo'awiya II., was elected Caliph at Damascus, at the age of only seventeen or twenty. He was a young man of weak character, and imbued, it is said, with Shi'ite opinions. He felt himself incapable of ruling and was contemplating abdication, when he died, after a reign of but forty days, by poison, as some say; of the plague, as others assert. The Caliphate was immediately offered to 'Othman b. Otba b. Abi Sofyan, cousin of Mo'awiya II., to Khalid, the second son of Yazid, who was only sixteen years old. 'Othman b. 'Otba, however, having made it a condition of his election that he should not be compelled to enter on any war, or to condemn any one to death, the choice fell at Damascus on Merwân b. al Hakam, a descendant of Omayya through his grandfather Abu l'As, but on condition that he should marry Marjan, the widow of Yazid, and should appoint Khalid, her son, as his successor.

4. Merwán b. al Hakam had been secretary to the Caliph 'Othmán, and governor of Medina under Mo'awiya. Yazid, on his accession to power, had dismissed him and put Walid b. 'Otba in his place, but Merwan had continued to live at Medina, and had been driven from it during the revolt of the year 63, and again in the following year, when 'Obaid Allah b. Zobair had taken possession of that city in the name of his brother. It might have been thought that Merwan would cherish a deep hatred of 'Abdallah Ibn Zobair, but he was an old man of sixty-two at the time of his election, and, dreading an unequal struggle, he was on the point of making his submission to the Meccan Caliph. The drooping courage of Merwan was revived by his son 'Abd al-Melik and by 'Obaid Allah b. Ziyâd, and he resolved to try the chances of war.

Dahhâk b. Kais, governor of Damascus, had declared himself on the side of Ibn Zobair, and had raised an army, principally from among the tribe of Kais. This tribe had taken offence because Mo'âwiya I. and Yazid had chosen their wives from the Yemenite tribe of Kalb, and, continuing to resent their conduct, now refused to acknowledge Khâlid as the heir-presumptive of Merwán. It was therefore on the Yemenites that Merwán had to depend for the suppression of Dahhak's rebellion. The latter had an army of nearly sixty thousand horsemen, while Merwan could bring together only thirteen thousand infantry. The two armies met at Marj Rahit, a few miles from Damascus, and, after a series of combats which lasted for twenty days, Merwan's troops gained a complete victory, and Dahhak was among the killed. The Syrian province hastened to acknowledge the conqueror, and Merwan was able to turn his attention to Egypt, which, as will be remembered, had submitted to the Meccan. 'Abd al 'Aziz, a son of Merwan, had already marched to Aila on the Red Sea and was preparing to enter Egypt. Merwan joined him, and the Zobairite governor of Egypt, beaten by their united forces, was obliged to seek safety in flight. Merwan made 'Abd al 'Aziz governor of the province. At the beginning of the year 65 (end of 684-685) Merwan returned in haste to Syria, for, during his absence, a brother of Ibn Zobair, named Mo'adh had invaded the province. Merwan triumphed over Mo'adh but an army of forty thousand men which he had sent to the Hijaz, and in which was Hajjaj b. Yusuf, then quite a young man but who afterwards played so important a part under 'Abd al Melik, was cut to pieces. This defeat was redeemed by a victory gained by his general, 'Obaidallah b. Ziyad and Hosain b. Nomair, at 'Ain al Ward over a small army of Shi'ites led by Solaiman b. Sorad; but while the battle was being fought in Ramadan 65 (April-May 685), Merwan died, suffocated, it is said, by his wife Marjan, because he had insulted her son Khalid and had broken his word by nominating his own son 'Abd al Melik as his successor. The accession of 'Abd al Melik was attended with no difficulty, as he was acknowledged by the whole of Syria and Egypt. The Kais naturally rallied round him because he had not a drop of Yemenite blood in his veins.

5. When 'Abd al Melik ascended the throne, there still remained much to be done before the unity of the empire could be re-established. Ibn Zobeir was still master of Arabia and of 'Irak, though in the latter province his authority was very much shaken by the permanent rebellion of the Shi'ites at Cufa and of the Kharijites at Basra. The Zobairite general Mohallab had, it is true, succeeded in forcing back the Kharijite into Sistan and Persia, but at Cufa the Shi'ite, at the instigation of Mokhtar, continued their agitation. Mokhtar, as we have seen, had withdrawn from Mecca after the retreat of the troops of Hosain b. Noman. He returned to Cufa, and there fomented serious disturbance. Many of the inhabitants of that city repented bitterly of having allowed Hosain to put to death the grandson of the Prophet to be massacred. Amid the general disorder of the Moslem empire Mokhtar hoped to make his own authority acknowledged in 'Irak and Mesopotamia. He put himself forward as the avenger of the family of 'Ali and pretended to have been commissioned by a son of 'Ali, Mohammed b. Hanafiya,[1] who was living at Medina, to give effect to his claims to the Caliphate. Many Shi'ites believed him, and, determined their chief, Solaiman b. Sorad, joined Mokhtar. On learning the intrigues the Zobairite governor threw him into prison. Soon after the defeat of Solaiman at 'Ain al Warda, at the request of Mokhtar, his brother-in-law, who was no other than 'Abdallah the son of 'Omar, the governor consented to set him at liberty on his swearing to make no further attempt against him. As Solaiman had fallen on the

[1] ... to be the son of the Hanafite woman. The mother Mohammed ... of the tribe of Hanafa ... Mokhtar, ... partisans who looked on him ... not to be Caliph. The ... received the name of Kaisanites from a freedman 'Ali, called Kaisán, who was the most ardent advocate of Mohammed's pretensions. After Mokhtar had declared in favour of Mohammed his supporters received the name of Mokhtarites.

field of battle at 'Ain al Warda all the Shi'ites now acknowledged Mokhtar as their chief. He, however, considered himself bound by his oath, remained inactive until the governor who had imposed it was replaced by 'Abdallah b. Mo'ti. The new Zobairite governor, suspecting with reason that Mokhtar was about to recommence his intrigues, thought it advisable to invite him to his presence. At the instigation of his friends Mokhtar accepted the invitation, but plotted with them to kill Mo'ti by surprise. A however self-confident, he did not venture to hold a levee each week, for the purpose of gathering troops, Mokhtar was obliged to screen all these preparations under the ceremonial customary on the occasion of the Friday prayer. Mo'ti, however, had been warned by his body-guard, Abu Shaiba Sa'd, who had only demanded the dismissal of his servants in order to ascertain the real wishes of Mohammed b. Hanafiya, cut off four of the latter's fingers on the night of the 13th to the 14th, the conspirators intended to occupy the principal gates of the city by a *coup de main*, but the governor was on his guard, and Mokhtar and his friends took the course of besieging Qasr Ibn Mokaitil and other strongholds. All the troops which 'Abdallah b. Mo'ti could muster there were successively beaten, and Mokhtar soon remained master of Qufa in triumph, compelling the Zobairite governor to flee to Basra. Once master of Qufa, Mokhtar chose a council already in existence of the chief men of the Shi'a. He sent envoys to Medina to Mohammed b. Hanafiya, to Mecca and even into Azerbaijan, with the view to induce the people to take the oath of allegiance to him. He then sent his general Yazid b. Anas and Sa'id b. Hodhaifa, against the Omayyad troops which had entered Mesopotamia after the battle of 'Ain al Warda and thus prevented the advance of the Syrian army into Iraq. Another of Mokhtar's generals, Ibrahim b. Malik al-Ashtar, defeated a Syrian force on the Syrian road near Mosul, and Obaid Allah b. Ziyad, who commanded them, fell in the battle. Ibrahim was rewarded by Mokhtar with the government of Mosul. Mokhtar himself next took the title of "Lieutenant of the Family" and inserted in the *khotba* on Friday prayers, prayers on behalf of Mohammed b. Hanafiya, who had given consent to declaring him Caliph. After this, seated on his throne, surrounded by his adherents, he caused all those who had taken part in the murder of Hosain, the grandson of the Prophet, viz. 'Omar b. Sa'd and Shimr, to be brought out and put to death.

While these events were occurring, the Caliph at Damascus 'Abd al-Malik, sent an army of observation to the frontiers of Mesopotamia. Mokhtar, having been informed of this, despatched a force of cavalry and men from Qufa, under the command of a certain Sharahil. His real object was to concentrate forces near Medina, with a view to attacking Ibn Zobair. But the latter penetrated his design, and two thousand Meccan men-at-arms were sent by his order to meet Sharahil, who was defeated.

In the same year (A.H. 66 = Mohammed b. Hanafiya had come to Mecca to perform the ceremonies of the pilgrimage.

[1] Mahdi, in the well-known, and by none more than by the Shi'ites to their member of the family of 'Ali who, according to their belief, is one day to regain possession of the whole world and set up the reign of righteousness in it. In Mokhtar's time, Mohammed b. Hanafiya was looked upon as the Mahdi.

Ibn Zobair took advantage of this to seize his person, and confined him in a small house adjoining the well of Zamzam within the precincts of the Ka'ba. Mohammed succeeded in conveying intelligence of his detention to Mokhtar; and he, delighted to find his friend implored by the very man whose followers he called himself, swore to effect his release. He despatched a thousand chosen horsemen, who managed to conceal their march so well, that they were under the walls of Mecca before the son of Zobair had been able to make the slightest preparations for defence. They made their way into the Holy City; but, being unwilling to draw the sword within that sacred ground, they armed themselves with clubs, broke in the door of the house in which Mohammed b. Hanafiya was imprisoned, released him, and escorted him out of the city. A son of Mohammed, called 'Ali, who had also been thrown into prison, likewise succeeded in escaping, and rejoined his father at Qaraqisa, near Mecca.

In the following year, Ibn Zobair, who was determined to get rid, at all costs, of so dangerous an adversary as Mokhtar, ordered his brother Mosfab to effect a junction with Mohallab, the governor of the Kharijites, and to march against Qufa. Mosfab and Mohallab invested the city, and Mokhtar's chances of resistance against them, were few. Taken prisoner, and beheaded 'Irak thus, for the second time, fell under the rule of Ibn Zobair. Ibrahim b. Malik, who held Mosul in the name of Mokhtar, submitted to the conqueror, on condition of retaining his government. But Mosfab deprived him of his office and put Mohallab in his place. He himself was appointed governor of 'Irak by his brother, and having installed himself at Basra, placed Qufa under the orders of his lieutenant Harith. The year after, the Kharijites of Sejestan raised a fresh insurrection, and invaded 'Irak. Mohallab had to be recalled from Mosul and during his absence it was Ibrahim b. Malik whom Mosfab chose to supply his place. The period of the pilgrimage caused a momentary truce to all these struggles, and in that year was seen the curious spectacle of four different standards planted near Mecca, belonging respectively to four parties chief, each of whom was a pretender to the empire: the standard of 'Abdallah b. Zobair, Caliph of Mecca; that of the Caliph of Damascus, 'Abd al-Malik; that of the son of 'Ali, Mohammed b. Hanafiya; and that of the Kharijites, who were at that time under the command of Najda b. 'Amir. Such, however, was the respect inspired by the holy places, that no disorder resulted from the presence of so many inveterate rivals.

The Omayyad Caliph, whose troops had been beaten at Mecca, and who had been hitherto content to watch the frontier of Arabia, was again prevented from carrying on his military operations more actively by the breaking out of trouble in Syria. At the beginning of A.H. 69 (A.D. 688-689), 'Abd al-Malik having left Damascus at the head of a numerous army, with the purpose of marching against 'Irak, the Omayyad 'Amr b. Sa'id, whom he had appointed governor of Damascus, took advantage of his absence to lay claim to the supreme power and to have himself proclaimed Caliph by his partisans. 'Abd al-Malik was obliged to retrace his steps, and to lay siege to his own capital. The garrison of Damascus took fright, and deserted their posts, so that 'Amr b. Sa'id, abandoned by his followers, was compelled to surrender at discretion. 'Abd al-Malik at first meant to spare him, but he afterwards changed his mind, and struck off his head with his own hand. Scarcely had he suppressed this revolt when the Emperor of Constantinople, Justinian II., in violation of the thirty years' truce formerly concluded between Mo'awiya I. and Constantine IV., sent a Greek army to invade Syria. 'Abd al-Malik was obliged to buy peace

or the time, for he required all his forces to dispute the mpire with the son of Zobair. He consented, it asserted, to pay the Greek- an indemnity of one thousand ieces of gold weekly. He then gave his attention to the newal of the projected expedition against 'Irak. Mo'ab he Zobairite had rendered himself odious to the inhabitants of Basra and Cufa by his exactions, and a party favourable to 'Abd al Melik was already formed in those ities. The Omayyad Caliph marched forth at the head f an army composed of Syrians and Egyptians, and ncamped three parasangs from the plain of Dur al 'Athalik, not far from the site of Baghdad where Mo'ab ad established his army. Before joining battle 'Abd al Melik had written secretly to all the chiefs of Mo'ab's my, making them the most seductive promises if they would agree to desert the cause of Mo'ab. This proved rowned with success; and on the eve of the battle which ook place on the 13th Jomadi II. A.H. 71 (13th ember 690), several of the principal officers of amp of 'Abd al Melik with their troops passed over to attacked his enemy the next day. In the course of the ound himself deserted by his troops and by the chiefs of o survive his defeat, he entered Basra by night and victory opened the gates of that city to 'Abd al Melik had received him with acclamations. His sons at Cufa, and their partisans in the province, sent to as brother Bishr, while Khalid b. 'Abdallah, governor of Basra, he returned in triumph to Syria. Soon after, the Omayyad arms became victorious over those of the Kharijites in Fars (Persia), the Caliph's brother Mohammed so much against these sectaries with the support of Mohallab, who was their terror, and of the succession Rey. Khalid succeeded completely in the same province and drove the Kharijites out of Khorasan and Kirman. On his side, the Omayyad Caliph put down revolt in Khorasan, a province which still remained faithful to the Zobairite cause. Its governor was treacherously assassinated by his lieutenant Rafi', who proved, on the ories of this service, the governor here of the province.

Only Arabia now remained to the Zobairites. In person 'Abd al Melik made preparations to depose him at last. Accordingly he raised an army, but when his generals found that another siege of Mecca was in contemplation, not one of them was willing to accept the command. At obscure officer, Hajjáj b. Yusuf, boldly offered to lead the expedition. 'Abd al Melik had little confidence in him, and therefore at first placed only two or three thousand horsemen under his command. Hajjáj at once passed into the Hijaz without resistance, and pitched his camp at Taif, not far from Mecca. Ibn Zobair tried to dislodge him, but in the frequent encounters between his troops and those of Hajjáj, the latter always had the advantage. 'Abd al Melik then decided on sending him a reinforcement of five thousand men, on receiving which Hajjáj moved to Mecca. The blockade lasted several months, during which the city was a prey to all the horrors of siege and famine. Hajjáj had set up ballistas on the neighbouring heights and poured a hail of stones on the city and the Ka'ba. Famine at length triumphed over the last adherents of the son of Zobair. Ten thousand fighting men, and several of the sons of the pretender, left the city and surrendered. Mecca being thus left without defenders, Hajjáj took possession of it and invested the Ka'ba. Then the son of Zobair, seeing that ruin was inevitable, went to his mother Asmá, who had reached the age of a hundred and asked her counsel. She answered that he must die sword in hand; and when, in embracing him for the last time, she felt the cuirass which he wore, she exclaimed that such a precaution was unworthy of a man resolved to perish. 'Abdallah took off his cuirass, and taking refuge in the Ka'ba, passed the night there in prayer. At daybreak, the 14th of Jomadi I. in the year 73 (1st October 692), the Omayyad troops made their way into the mosque. 'Abdallah attacked them furiously, notwithstanding his advanced age, but at last fell overwhelmed by numbers. His head was cut off, carried to Hajjáj, and sent by the victorious general to Damascus.[1]

With Ibn Zobair perished the influence which the companions of Mohammed had hitherto exercised in Medina and Mecca, though they continued to be the [illegible], had no longer that political importance which had marked their position in the early days of Islam. Temporal supremacy was henceforth to be vested in the house of Omayya, which, with Damascus as its capital, was to rule the Moslem world for nearly a century.

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[1] On these events see Quatremère, *Mémoire sur la vie et le règne d'Abd el Melik fils de Zobair*. Paris, 1858.

His son and heir the Caliph Abd al Melik [illegible] by observation. At the moment [illegible] the Caliph he opened a copy of the Koran which [illegible] and [illegible] "We must now part."

overnor of Khorá. (n.)[1] whence he directed several expeditions against Transoxiana.

While Mohallab was fighting against the Khárijites in Persia, Hajjáj himself had had to struggle against rebellion. Three Kharijite chiefs, Sálih, Shabib, and Motarrif, had succeeded in creating a party in Mesopotamia and 'Irák. [illegible] had even [illegible] its audacity so far as to march upon Cufa, and for a moment had occupied that city. Hajjáj overcame the rebels, and through his vigilance, Katari b. al Fujá'a, another Kharijite chief, after having penetrated as far as Tabaristán, on the Caspian Sea, was taken and killed by two Omayyad generals.

When to give the government of Khorásán to Mohallab, Hajjáj had committed that of Sijistán to 'Obaid Alláh b. Abi Bakra. At the beginning of A.H. 79 'Obaid Alláh's troops were beaten by the Prince of Kabul. Hajjáj thought advisable to remove 'Obaid Alláh and to replace him by the captain of his guards, Abd al Rahmán b. al Ash'ath. The was a bad choice, for Ibn al Ash'ath had often given proofs of an insubordinate temper, and Hajjáj soon had occasion to repent of it. In fact, soon after his arrival at Sijistán, he [illegible] but even [illegible] its audacity so far as to march upon Cufa, and for a moment had occupied that city. Hajjáj overcame the rebels, and through his vigilance, Katari b. al Fujá'a, another Kharijite chief, after having penetrated as far as Tabaristán, on the Caspian Sea, was taken and killed by two Omayyad generals.

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[1] In A.H. 78, 'Abd al Malik had taken measures to render independent on the governor of Irák [illegible] Hajjáj and the right of directly nominating the governors of those provinces.

[2] The Prince of Kabul is called both Rutbil by some historians, and Zunbil by others. See Weil, *Geschichte der Chalifen*, i. 419; Tabari, transl. by Zotenberg, iv. 127 *seq.* Mirkhond, transl. by Rehatsek and de Meynard, index, s. v. Rotbil. According to Abulfeda's *Geography*, p. 343, Ibn al Ash'ath was killed in the province of Arrokhaj (Arachosia), and his head was sent to Damascus and Egypt.

this long struggle that, in the year 83, Hajjáj laid the foundations of the city of Wásit (the Intermediate); so called because it is situated midway between Cufa and Basra. Some time after the suppression of this revolt, in the year 84, Hajjáj deprived Yazíd b. Mohallab of the government of Khorásán, accusing him of partiality towards the rebels, and appointed in his stead first his brother Mofaddal b. Mohallab, and nine months after Kotaiba b. Moslim, who was destined at a later period to extend the sway of the Moslems in the East as far as China.

While these events were taking place, 'Abd al Malik was engaged in the West in a struggle against the Greeks. We have seen that in the year 69 the Caliph, compelled at the then war to direct all his efforts towards 'Irák and Arabia, had concluded a disgraceful peace with Justinian II. It was not till A.H. 73 (A.D. 692-693) that he resumed hostilities in Armenia, Asia Minor, and Africa. The operations in Asia Minor and in Armenia were entrusted to Mohammed b. Merwán, brother of the Caliph, and to 'Othmán b. Walíd. They beat the Greeks at first, but, in consequence of subsequent reverses, the Moslems were compelled to accept peace, which was broken shortly by the Greeks about the year 75 or 76, the Caliph in one of his letters to Justinian II. having used expressions which displeased the Christian monarch. In retaliation, Justinian threatened to have legends offensive to Islám struck on his coins. Up to that time, the Moslems had used pieces of their own, and principally used Byzantine and Persian money, thus menacing 'Abd al Malik to institute a purely Arabic coinage. He was a Jew of Tamia, named Sonain, who commenced in this direction. Justinian II. refused to receive these coins in payment of the tribute, and declared the treaty at an end. The renewed Moslems fought valiantly, and succeeded in extending their frontiers to Mar'ash, on the side of Asia Minor, and to Amid, on the side of Armenia. From this time forth the Moslems made yearly expeditions against the Greeks, but they were only razzias, from which the Greeks often avenged themselves by incursions into the territory of Islám.

In Africa we have seen that 'Okba b. Náfi' had been slain by the Berbers, who had taken Kairawán. In the year 73 Abd al Malik sent Hassán b. No'mán into Africa, at the head of a numerous army. He retook Kairawán, swept the coast as far as Carthage, expelling the Greek garrisons from all the fortified places, and then, turning his arms against the Berbers, beat them completely that they submitted for a long time to the tribute and the conscription. But when Hassán left Africa, the Greeks, under the successor of Justinian, retook the coast line. Hassán prepared to return to Africa, but previously demanded from the governor of Egypt, 'Abd al 'Azíz, the recall of a freedman, whom he had appointed governor of a part of the province of Africa. 'Abd al 'Azíz refused, and Hassán went to Damascus to complain to the Caliph. Soon after his arrival at the capital he died, and the governor of Egypt placed Músá b. Nosair at the head of the expedition. This general reconquered the seaboard as far as Carthage, and drove the Greeks permanently from it. The daring Músá continued his triumphant march, and took possession of the whole of the coast to Tlemcen. One of his lieutenants, in the year 82, carried a reconnaissance by sea as far as Sicily. The Moslem fleet having been destroyed by a storm, Músá equipped another, and entrusted its command to his brother 'Abdalláh, who returned to Sicily and effected

razzia there. Merwán, the father of 'Abd al Melik, had designated as successor to the latter his other son, 'Abd al 'Azíz, governor of Egypt. 'Abd al-'Aziz having died in the year 84, 'Abd al-Melik chose as heirs of the empire, first his son Walíd, and after him his second son Solaiman.[1] He himself survived 'Abd al 'Azíz only two years, and died 14th Shawwál 86 (8th October 705), at the age of about sixty. His reign was one of the most important in the annals of Islam, but also one of the most glorious. 'Abd al Melik not only brought triumph to the cause of the Omayyads, but extended and strengthened the Moslem power externally. Amid so many grave anxieties, he yet found time for his pleasures. He was passionately fond of poetry, and his court was crowded with poets, whom he loaded with favours, even if they were Christians, like Akhtal. In his reign flourished also the two celebrated rivals of Akhtal, Jarir and Farazdak.[2]

6. Immediately on his accession Walíd continued Hajjáj in the government of 'Irák, and appointed as governor of Medina his cousin 'Omar b. 'Abd al 'Azíz, who was received there with joy, his piety and gentle character being well known. Under his government important works were undertaken at Medina and Mecca by order of Walíd, who, having no rivals to struggle against, was able to give his attention to pacific occupation. The mosque of Medina was enlarged, wells were found, the streets widened, and hospitals established. At Mecca many improvements were introduced. The reputation of 'Omar attracted to the two Holy Cities a great number of the inhabitants of 'Irák, who were groaning under the iron hand of Hajjáj. The latter, who was not a man to let his prey escape from his grasp, was so much out with Walíd that he obtained the dismissal of 'Omar b. 'Abd al 'Aziz in the year 93, and the appointment of 'Othmán b. Hayyán at Medina, and of Khálid b. 'Abdallah at Mecca. These two prefects compelled the refugees at Mecca and Medina to return to Irák, where many of them were cruelly treated and even put to death by Hajjáj. It was probably his cruelty which drove so many men of 'Irák to enlist in the armies of the East and the South; and this may in some degree account for the unheard-of successes of Kotaiba b. Moslim in Transoxiana, and of Mohammed b. Kásim in India. They may also be explained by the ambition of Hajjáj, who, it is said, cherished the project of creating a vast empire for himself to the east and south of the Moslem realm, and had secretly promised the government of China to the first of his generals who should reach that country. Be this as it may, in the course of a very few years Kotaiba conquered the whole of Bokhara, Khárizm, and Transoxiana or Má wara annahr, as far as the frontier of China. Meanwhile Mohammed b. Kásim invaded Mokrán, Sind, and Multan, carried off an immense booty, and reduced the women and children to slavery. In Armenia and Asia Minor, Maslama, brother of the Caliph Walíd, and his lieutenants, also obtained numerous successes against the Greeks. In Armenia, Maslama even advanced as far as the Caucasus.

The most important achievement, however, of Walíd's reign was the conquest of Spain. The narrative of this conquest belongs specially to the history of Spain, and we shall therefore only touch briefly on it here. We have seen that, even in the Caliphate of 'Abd al Melik, Músá b. Nosair had penetrated as far as Tlemcen in Africa. Under Walíd, Músá, who had been appointed governor of Africa, entered Morocco, occupied Fez and Tangier, and then returned to Kairawán, having made his lieutenant governor of Tangier and of all the West of Africa. town of Ceuta still held out under its governor who held it in the name of Witiza, King of Spain, having been dethroned by Roderic, Julian thought might find the Arabs useful allies in the struggle he proposed to carry on against the usurper, and to negotiations with Tarik. The latter, foreseeing possibility of conquering for the advantage of the country which had been represented to him as a repeated instructions from Musa, who referred the to the Caliph. Walíd gave Mú *carte blanche*, and inclined to make alliance with Julian. He first, sent four ships, with five hundred men under the of Tarif, to reconnoitre the country. This expedition Tarik, now of men, operation to his kindness, passed into Spain himself head of twelve thousand men, in the year 92 (A.D. and landed at the port which the race received the Jabal Tárik, or "Mountain of Tarik," a name which afterwards corrupted by the Westerns into Gibraltar. the news of this invasion, Roderic led a numerous against the Arabs, but was completely routed near and perished in the conflict. Mú jealous success of his lieutenant, hastened to Spain with thousand men, and his first step on arriving was Tarik order to suspend his march. But Tarik, observing, divided his little army into three columns obtained possession successively of Ecija, Malaga, Cordova, and Toledo. Músá, hopeful of arresting victorious march of Tarik, determined to play the a conqueror himself, and took Seville, Carmona, Mérida. On rejoining Tarik at Toledo the first took was to throw him into prison. The Caliph ever, gave orders that he should be set at liberty restored to his command. The two conquerors shared the country between them, and, in less three years, all was subdued, to the very the Pyrenees. Meanwhile Walíd, fearing to declare his independence, recalled him to Damascus, observed after appointing his son 'Abd al 'Aziz Spain, and arriving Seville at his return. Mú Spain in the month of Safar, viz. 95 (October 713), in company with Tarik, bringing immense Damascus, and leading in his train a great number prisoners. His journey from Ceuta to Damascus one long triumph. He reached Egypt in the Rabí I. in the following year (November 714), and marched towards Damascus, where not arrive till two months and a half later, at the moment when Walíd had just breathed his last, brother Solaiman had been saluted as Caliph. renowned Hajjáj had preceded his sovereign, expired five days before the end of Ramadan, Músá did not receive the rewards due to his distinguished services. Accused of peculation by the new Caliph was beaten with rods, and condemned to a fine of pieces of gold, and all his goods were confiscated. Solaiman did not stop here, he caused 'Abd al 'Aziz to Músá, to be put to death in Spain, and cut off his cruelty extended so far as to show his severed head to Músá, him whether he recognised it. He replied that it had often a hundred thousand times appeared to him in ordered his death. Músá died soon after. After there is no further mention of him after the beginning the reign of Solaimán, and we must therefore suppose that he retired into private life.

[1] 'Abd al-Melik had several other sons, two of whom, Yazíd and Hishám, also reigned.

[2] See Caussin de Perceval, *Journal asiatique*, 2e série, vols. xiii. and xiv.

[3] According to Eastern chronicles, Julian's hatred of Roderic from the latter's having dishonoured his daughter.

Sulaimán had nearly missed the throne. Walíd, in
very year of his death, wished to have his son 'Abd
iz b. Walíd chosen as his successor, and had offered
many great sums of money to induce him to surrender
his right to the Caliphate; but Sulaimán obstinately
refused to do so. Walíd went still further, and sent
to the governors of all the provinces, calling on
them to cause the people take the oath of allegiance to
his son. None except Hajjáj and Kuteiba b. Moslim
ever dared to act at once upon the order of succession
signed by 'Abd al Melik, and Sulaimán succeeded
without difficulty at the death of his brother. We can
conceive the hatred felt by Sulaimán for Hajjáj
for all that belonged to him, but once Hajjáj
death, but he soon began
on his family, and chose to melt all that he had
First of all, Mohammed b. Kásim the conqueror
Sind, who was cousin to Hajjáj, was dismissed from
post and outlawed. Hajjáj had deprived Yazíd b.
Muhallab of the government of Khorásán. Sulaimán
vited on him that of 'Irák. Kuteiba b. Moslim, on
the accession of Sulaimán, knew that he was
safe certain, and therefore anticipated the Caliph by
revolt. But Sulaimán ordered Kuteiba's troops to
desert by authorising them to return to their homes, and
when the illustrious general sought to carry his army with
him a conspiracy was formed against him which ended in
murder. Yazíd b. Muhallab, who preferred Khorásán
which obtained permission to exchange. Immediately
after his return to Khorásán he set on foot a scheme of new
conquests against Jurjan and Tabaristán. But the
resistance of Khorásán, which he experienced oppressively,
and complaints against him to the Caliph, accusing him
of numerous extortions in order to obtain such a sum of
money as would enable him to rebel against his sovereign
on that day Sulaimán determined to get rid of Yazíd
However, he was then dreaming of the conquest of
Constantinople, he thought it prudent to dissemble his
dissatisfaction for some time.

The Byzantine empire was disturbed by internal
strife during the years A.D. 715-717. Sulaimán
resolved to take advantage of the circumstance to aid himself
in favor of the hereditary enemy of Islám and prepared a
formidable expedition. A fleet of eighteen hundred
sails, equipped at Alexandria, sailed to the coast of
Asia Minor, took on board the Moslem army, commanded
by Maslama, and transported it to Europe. The army
encamped under the walls of Constantinople, 15th August
A.D. seven months after Leo III. the Isaurian, had ascended
the throne. Once more the Greek fire prevailed against
the Moslem. Their fleet was destroyed by this terrible
engine of war; the army could obtain no fresh supply of
provisions, and suffered all the horrors of famine. Meanwhile
the Caliph, who desired to be present in person at the
taking of Constantinople, had set out to join the
army. He fell ill at Dábik, not far from Aleppo, and died
there on the 25th of September in the same year, after
having nominated as his own successor his cousin, 'Omar
b. 'Abd al 'Azíz, and as successor to the latter, Yazíd b.
Abd al Melik, his own brother. In vain did the new
Caliph despatch from Egypt a fleet of four hundred ships
with army and provisions to the army before Constantinople;
this fleet also was destroyed by the Greeks, and
the Moslem army was decimated by famine, and soon by
the plague as well. A hundred thousand men perished
miserably under the walls of Constantinople, and Maslama
brought back to Asia Minor a mere handful of soldiers,
that with great difficulty.

'Omar b. 'Abd al 'Azíz, incensed at this disaster,
and his revenge on the Christians of his own states by
excluding them from all public employments, in spite of
the great services they rendered there, and by loading
them with imposts to such an extent that one public
functionary wrote thus to the Caliph: "If things continue
to go on in Egypt as at present, all the Christians will
become Moslems to escape taxation, and the State will
lose its revenue." To this the pious 'Omar replied: "I
should look on the conversion of all the Christians as a
great piece of good fortune, for God sent his prophet to
act the part of an apostle, and not of a tax gatherer." By
his rebuke of intolerance, by the simplicity of his life, and
by his zeal in observing the precepts of his religion and
enforcing their observance, 'Omar has acquired in Moslem
history the reputation of a saint. But the sanctity of a
prince is not the greatness of a State, and
reign of 'Omar as we shall see, was injurious rather than
advantageous to Islám. He alienated the provincial
governors by his severity, and the family of 'Abbás took
advantage of the general discontent to stir up the people
secretly, and thus to prepare the way for the fall of the
dynasty.

It will be remembered that Sulaimán died before carrying
out his purpose of deposing Yazíd b. Muhallab, the
governor of Khorásán. 'Omar II. took it on himself to
fulfil the design. He summoned Yazíd to his presence,
and on his arrival at Damascus, threw him into prison,
and demanded the restitution of the money which he
believed him to have misappropriated. As Yazíd alleged
that he had rendered account of it, the Caliph banished
him to Dahlak, a small island in the Red Sea, but soon
brought him back, and placed him in close confinement.
It was not till A.H. 101, when 'Omar II. was dying, that
Yazíd succeeded in escaping and took refuge in 'Irák.
Mokhallad, the son of Yazíd, whom his father, on quitting
Khorásán, had left there as his lieutenant, was also
summoned to Damascus, and the Caliph at first appointed
Jarrah b. 'Abdallah governor of that province, but soon
after on receiving complaints against him, replaced him
by 'Abd al Rahman al Koshairi, whom he desired to use
every effort for the conversion of the unbelievers, rather
than to think of extending the Moslem power by force
of arms. With so pacific a disposition, it is easy to
understand that the Caliph did not signalize his reign by
conquest; except a revolt of the Kharijites in 'Irák,
which was suppressed by Maslama, his caliphate was not
disturbed by any warlike event. Its most noticeable
occurrence, as we have said above, was the commencement
of the 'Abbásid movement.

The 'Abbásid family derived its name from 'Abbás, who
was Mohammed's uncle on the father's side, and who
during the Prophet's life, had enjoyed universal consideration
among the Moslems. It was he who, at the death of
the Prophet had the charge of washing the corpse. The
first Caliph Abúbekr, 'Omar, 'Othmán, and 'Alí, showed
the utmost deference to 'Abbás; and his eldest son
'Abdallah had been united in the closest friendship with
Hasan, the unfortunate son of 'Alí. After the assassination
of 'Alí, and the slaughter of Hosain, 'Abdalláh had
retired to Mecca, and there brought up his numerous
family in hatred of the Omayyads. It was from his
youngest son 'Alí, born A.H. 40, that the 'Abbásid dynasty
proper. Under the Caliph 'Abd al Melik, this 'Alí was
living at Damascus, but, on his marrying Lubbába, the
divorced wife of 'Abd al Melik, the Caliph conceived a
great aversion for 'Alí. Walíd, the son and successor of
'Abd al Melik, inherited his father's prejudices, subjected
'Alí to every kind of insult, and drove him from his court.
Walíd's successor, Sulaimán, gave him leave to return to
Damascus, but 'Alí, instead of availing himself of this
permission, preferred to retire to Homaima, a town situ

ated in the south of Syria, on the confines of Arabia. It was in this retirement that his son Mohammed conceived the design of supplanting the Omayyad dynasty. We have said that the first 'Abbasids were closely united with the family of 'Ali. Mohammed b. 'Ali, the 'Abbasid, saw clearly that it was only among the followers of 'Ali that he was likely to be able to form a party. To attain the object, he formed the plan of making it believed that a descendant of the Prophet's son-in-law had transmitted to him his rights to the Caliphate. It will be remembered that Mohammed b. Hanafiya had come forward as a pretender to the throne at the troublous period when Ibn Zobair and 'Abd al Melik were disputing the Caliphate. According to the story of the 'Abbasids, Abu Hashim 'Abdallah, the son of Ibn Hanafiya, had gone to Homaima to the house of Mohammed b. 'Ali and had made over by deathbed a legal transfer of his rights to Mohammed by appointing him his heir. Whatever may be the truth respecting this transfer, Mohammed the 'Abbasid proabroad the report of it, and chose especially for the propagation the provinces in which the family of 'Ali had the greatest number of adherents, 'Irak and Khorasan. Emissaries sent by him into these two provinces, the caliphate of 'Omar II., began to stir up the people in secret against the reigning house. 'Omar was probably acquainted with these intrigues, but he had not time to repress them, for he died on the 20th or 25th of Rajab A.H. 101 (5th or 10th February 720), after a reign of about two years and a half.

Yazid II. 9. Yazid, the son of 'Abd al Melik, ascended the throne without resistance. His first care was to pursue Yazid b. Mohallab, who had escaped from his prison and taken refuge in 'Irak. Besides reasons of state, Yazid II had personal reasons for ill will to Yazid b. Mohallab. One of the wives of the new Caliph, the one who gave birth to that son of Yazid II who afterwards reigned under the name of Walid II., was niece to the celebrated Hajjáj, who, as it will be remembered, had hated and persecuted Yazid b. Mohallab. Aware of the alliance of the new Caliph with the family of Hajjáj, the son of Mohallab had made every effort to co-operate in his overthrow. He was informed of the illness of 'Omar II., for he well knew that Yazid II. would spare neither him nor his family. In fact, the Caliph sent express orders to the prefect of 'Irak to arrest all the brothers and other members of the family of Mohallab who were to be found at Basra, and this order was immediately carried out. But Yazid b. Mohallab had many partisans in 'Irak. He collected a small army, and fought with such valour that in a short time he succeeded in making himself master of Basra, where he had himself proclaimed Caliph. The public treasury fell into his hands, and he employed it in paying his troops and in raising fresh ones, whom he sent on expeditions into Khúzistán or Ahwáz, Farsistan, Mokran, and Sind. As this revolt threatened to spread far and wide, Yazid II was obliged to have recourse for its suppression to the celebrated Maslama. Early in A.H. 102, this illustrious general took the field, and completely defeated Ibn Mohallab near Basra. Yazid fell in the battle, and his brothers fled beyond the Indus, but were pursued and slain by the lieutenants of Maslama.

This revolt suppressed, Yazid II. was able to give his thoughts to the extension of the empire, an object which had been so much neglected by his predecessor. Several expeditions were directed against Farghana in Trans-oxiana, against the Khazars in Armenia, and against the Greeks in Asia Minor, but without any very decided results. In Africa, serious troubles had been caused by the appointment as governor of a certain Yazid b. Abi Moslim, who had been secretary to Hajjáj, and who followed the example of his master's implacable harshness. The Berbers rose in insurrection, slaughtered the unfortunate governor, and chose in his place Mohammed b. Aus. The Caliph at first ratified the choice but soon after dismissed Mohammed from his post and replaced him by Bishr Safwan, who sent out an expedition against Sicily.

In Europe, the Arabs obtained at this time some decided successes. Under the orders of Samah, their governor in Spain, they crossed the Pyrenees, and took possession of Narbonne; but, having been beaten at Toulouse, they had to retrace their steps. It was the celebrated Abderrahman Abd al Rahman al Ghafeki who effected their retreat.

Yazid II died three years later of a dangerous illness contracted, it was said, by excessive indulgence in the use of wine. On his death-bed he designated as his successor his son Walid. Hisham ascended the throne without opposition.

Hisham was a prudent prince and an enemy of luxury, as is testified by the reformation of 'Omar II. To this severity may in part be attributed the disturbances which broke out in the provinces during his reign. The governors were accustomed to respect loyalty to the Caliph only when the latter did not refrain from the most rigorous exercise of authority on account. Hisham was by nature very avaricious, a fault highly calculated to make him odious to those about him. Lastly, he favoured the Yemenites, and thus alienated from him the powerful party of the Kaisites. All these circumstances combined to favour the Abbasid agents in their propaganda in 'Irak and Khorasan, and succeeded beyond their hopes. The Kaisite tribes, offended at seeing the Caliph bestow the best posts on Yemenites, were ready to espouse with enthusiasm the cause of any one whose aim was the overthrow of the Omayyads. Rebellion had been smouldering in the province for thirteen years, and broke out at last at Cufa and in the whole of 'Irak, under chiefs called Mochtar and Kahtaba, and when these insurgents had been crushed, others sprung up in their place, Abu al Walhoz, Al Ashath, and Al Sakhtayani. The prefect of 'Irak, Khalid b. 'Abdallah, was accused of favouring the revolt, was degraded, and replaced by Yusuf b. 'Omar, who threw him into prison, where he remained for eighteen months. This measure increased the discontent of the people of 'Irak, and a member of the family of 'Ali, Zaid b. 'Ali, collected round him a small body of partisans, and had himself proclaimed Caliph, A.H. [illegible] (A.D. 739-740). Unfortunately for Zaid, he had to do with the same Cufans whose fickleness had already been fatal to his family. At the moment of danger he was deserted by his troops, fought an unequal conflict, and fell dead at the feet of Hisham's horse.

In Khorasan also there were very serious disturbances. In the year 106 (A.D. 724-725), there had already been a revolt at Balkh excited by the emissaries of the 'Abbasids. The following years brought with them fresh troubles which led to the dismissal of the governor of Khorasan, Asad, the brother of Khalid b. 'Abdallah, who had been prefect of 'Irak. Under the successors of Asad, who were successively Nasr b. 'Abdallah, Joneid, 'Abd al-Rahman, and 'Asim b. 'Abdallah, seditions broke out in Transoxiana, which were repressed with great difficulty, and it was not until the year 120 that, by the appointment of the brave and prudent Nasr b. Sayyar as governor of Khorasan, peace was for a time restored to that region. The 'Abbasid emissaries, nevertheless, secretly continued their propaganda.

In India, several provinces which had been convert

The 'Abbásid Caliph Ma'mún certainly did not believe in it, for he thought it his duty to restore the Caliphate to the family of 'Ali, by appointing as his successor 'Alí Ridá, a descendant of the Caliph 'Ali.

to Islam under the Caliphate of 'Omar II. declared themselves independent and this led to the founding of several strong cities for the purpose of controlling those provinces. It was thus that the cities of Mahdíza and Mansúra had their origin.

In the north and north-west of the empire there were no internal disorders, but the Moslems had much to do to maintain themselves there against the Alans, the Turkomans, and the Khazars. The illustrious Maslama lost his life in battle, and Merwán b. Mohammed, afterwards Caliph, took his place as prefect of Armenia and Azerbaijan. He succeeded in imposing peace on the petty princes of the Eastern Caucasus, and in consolidating the Arab power in that quarter. The war against the Byzantines lasted during the whole of Hishám's reign. In Asia Minor, the Moslems reoccupied Cæsarea, and laid siege to Sicca. Arab writers even declare that Constantine, afterwards Emperor of Constantinople, was made prisoner in the year 111 (A.D. 729/730), but the Byzantine authorities make no mention of this fact. On the other hand, they notice an important defeat of the Moslem arms in A.D. 739. This defeat, which is acknowledged by the Arab writers, cost the life of their general, 'Abdallah surnamed al Battál "the hero" whose prowess still lives in the memory of the people of Asia Minor.

In Africa, several successive prefects were fully occupied to repress the constant insurrections of the Berbers. In Spain, the attention of the Moslems was principally turned to avenging their defeat beyond the Pyrenees. As early as the second year of the reign of Hishám, Anbasa, governor of Spain, crossed the Pyrenees and pushed on military operations vigorously. Carcassonne and Nismes were taken. The death of 'Anbasa, in A.H. 107 (A.D. 725/726), put a stop to hostilities, but they recommenced still more vigorously six years later. 'Abd al-Rahman (Abderame) the same who, under Yazíd II., had led back to Spain the remnants of the Moslem army, crossed the mountains anew, and penetrated into Gascony by the passage of Roncevaux. The Moslems beat the Duke Eudes, gained possession of Bordeaux, and overran the whole of Southern Gaul as far as the Loire. But in A.H. 114 (A.D. 732) Charles Martel, whose aid the Duke of Aquitaine had implored, succeeded in intercepting 'Abd al-Rahman at [illegible], near Poitiers, but the Moslems were obliged to effect a hasty retreat, and to return to Spain. Two years later the new governor of Spain, 'Okba b. al Hajjáj, re-entered Gaul, and pushed forward expeditions as far as Burgundy and Dauphiné. Charles Martel, with the help of the Lombards, again drove back the Arabs as far as Narbonne. Thenceforth the continual revolts of the Berbers in Africa on the one hand, and on the other the internal troubles which disturbed Spain and which led at a later period to its independence, offered insurmountable obstacles to the ambition of the Moslems and prevented them resuming the offensive.

Such was the state of the empire when Hishám died on the 6th of Rabí' II. A.H. 125 (6th Feb. A.D. 743), after a reign of twenty years. He had not been a great man either in energy and ability. Yet under his reign the Moslem power declined rather than advanced, and signs of the decay of the Omayyad dynasty began to show themselves. The history of his four successors, Walíd II., Yazíd III., Ibráhím, and Merwán II., is but the history of the fall of the Omayyads.

11. Walíd II., the son of Yazíd II., ascended the throne without opposition at the death of Hishám; but he soon made himself so much hated and despised by his debaucheries and his irreligion that even the sons of Hishám and of Walíd I. plotted with the enemies of the Omayyads. Yazíd, one of the sons of Walíd I., went so far as to take openly the title of Caliph, and to march against Damascus which Walíd II. had quitted for fear of a pestilence which was then raging there. This step was fatal to the Caliph. The inhabitants of Damascus opened their gates to Yazíd who took possession of the arsenals, and used the arms they contained to equip new troops. Walíd II., on his side, collected his adherents and marched against his rival. The two armies met at a place called Bakhrá, on the confines of Syria and Arabia. Yazíd had no difficulty in overcoming his opponent, who was abandoned by his own soldiers. Walíd II. died fighting, having reigned little more than a year, and his head was taken to Damascus and carried about the city at the end of a spear. (Jomád II., A.H. 126, March-April 744.)

12. The death of Walíd II., far from appeasing the troubles of the State, put its unity in greater jeopardy than ever. The distant provinces escaped from the power of the new Caliph. In Africa, 'Abd al Rahmán b. Habíb declared himself independent. In Spain, every emir aspired to free himself from a suzerainty which appeared to him only nominal. In Khorasan the 'Abbásid emissaries were more and more busy, acting in the name of Ibráhím b. Mohammed, who had become the head of the family by the death of his father, Mohammed b. 'Alí. Even in Syria Yazíd III. saw his authority disputed. Himself belonging to the sect of Mo'tazilites, who rejected the doctrine of predestination—a sect to which we shall have occasion to return in treating of the religious history of Islam—he aroused all the orthodox against him. Besides this many of the Syrians, from a sudden change of feeling, now decreed to avenge the death of Walíd II. The inhabitants of Emesa revolted, and marched against Damascus. They were beaten at a place called Thanfya al Okab, or The Eagle's Pass, twelve miles from the capital. Palestine rose in its turn, and chose as its Caliph another Yazíd, cousin of the reigning prince. This revolt also was suppressed. But a greater danger menaced Yazíd III. The Omayyad Merwán b. Mohammed, who was, as we have said, governor of Armenia and of Azerbaijan, also prepared to dispute the supreme power with the Caliph of Damascus, and invaded Mesopotamia. Yazíd III., in his alarm, offered him the government of this last province as the price of peace. Merwán accepted these conditions, but he would probably not have left his rival long at rest, had not the latter died after a reign of only six months.

13. Yazíd III. left his brother Ibráhím as his successor. At the news of Yazíd's death, Merwán collected a powerful army and entered Syria. Having beaten Ibráhím's generals one after the other and taken Emesa, he advanced rapidly towards Damascus. Solaimán b. Hishám tried to oppose his march, but he was defeated at 'Ain al-Jar between Baalbec and Damascus, and the Caliph Ibráhím took flight, while Solaimán, the son of Hishám, laid hands on the public treasure, and then fled in turn. Merwán entered Damascus, and caused himself to be proclaimed Caliph. The reign of Ibráhím had lasted only two months. Ibrahim himself soon acknowledged the new Caliph, and submitted to his authority.

14. Merwan II. was a man of energy, and might have preserved the strength of his dynasty, if the ferment in the east of the empire had been less strong. Unfortunately for him, the 'Abbásid movement had never ceased to gain ground in Khorásán, and the chief adherent of the family of 'Abbas, Abú Moslim, was in no degree inferior to the Caliph in energy and ability. This Abú Moslim, whose origin is obscure and disputed, had been distinguished by the 'Abbásid Mohammed b. 'Alí, the same who alleged that he had been appointed heir to the claims of the family of 'Alí to the supreme power. If we may believe the legend

Mohammed had even foretold that the accession of his family would take place *in the year of the ass*,[1] through the efforts of Abú Moslim, and that one of his three sons would ascend the thro These three sons were: Ibrá him, 'Abdalláh, called Abú 'l-'Abbás, and 'Abdalláh, called Abú Ja'far. Whatever we may think of this prediction, it is certain that under Merwán II. Abú Moslim was the principal emissary of the 'Abbásid Ibráhím, and had been able to form a vast conspiracy in Khorasan, which broke out in A.H. 128, at the very moment when it had been discovered by Nasr b. Sayyár, the Omayyad governor of the province. Even before this, Merwán II. had had to suppress disorders which had broken out in Syria, Palestine, and 'Iráḳ; and the Caliph could now rely so little on Syria that he had thought it necessary to quit Damascus, and to fix his abode at Harrán, in Mesopotamia. On learning the revolt of Abú Moslim, Merwán II. wrote to Nasr b. Sayyár, directing him to act with vigour against the fomenters of sedition. It was easier to give such an order than to execute it, for Abu Moslim was at the head of a numerous army, absolutely devoted to the 'Abbásids. Merwán II. thought it necessary at the same time to secure the person of the 'Abbásid pretender Ibrahim, who was still living at Homaima. Ibrahim was therefore arrested, conveyed to Harran, and thrown into prison. He found means, however, of communicating with his lieutenant Abu Moslim, and the latter, who had received the most extensive powers from his chief, marched direct upon Merv, the capital of Khorásan, and drove out the governor Nasr. At the news of [illegible] Caliph, no longer able to restrain his anger, had his captive Ibrahim put to death; an execution which, at a later period, brought upon the Omayyads the most terrible reprisals. The brother of Ibráhím, Abú 'l-'Abbás, surnamed Saffáh, "The Sanguinary," on account of his cruelties by Ibráhím's death became chief of the 'Abbásids, immediately quitted Homaima with all the members of his family, and took refuge in Khorasan that his presence there might sanction and encourage the insurrection. Abú Moslim, now master of Khorasán by the capture of Merv, had meanwhile sent an army against 'Iráḳ, under the orders of Kahtaba b. Shabib, who had beaten the Omayyad army, commanded by Yazíd b. Hobaira, governor of that province. In A.H. 132 Abú 'l-'Abbás arrived at Merv. After remaining there some time, waiting for a favourable moment, he decided on openly assuming the title of Caliph. He installed himself in the governor's palace, and thence went in state to the mosque, where he mounted the pulpit, and officiated in the capacity of successor of the Prophet. All those present took the oath of allegiance to him, and Abú 'l-'Abbás returned to the palace, over which the black flag was flying, black being the distinctive colour of the 'Abbásids.[2] But he did not remain long at Merv. Committing the government of that city to his uncle Dáwúd, he went to review his army, and divided it into several corps, which he directed against different points. After this he went to Chaldæa, and there established himself in a spot not far from Cufa, to which he gave the name of Hashimiya, or the city of Hashim, the ancestor of his own family and of that of the Prophet. Another of his uncles, 'Abdallah b. 'Ali, whom he had sent on an expedition against the city of Shahrozur, took possession of that place, and leaving Abu 'Aun 'Abd al Melik b. Yazíd there as governor, rejoined his nephew and sovereign at Hashimiya. Meanwhile the Omayyad Caliph had marched against Shahrozur. Abu 'Aun went out to meet him, and was joined by a strong reinforcement of cavalry under 'Abdallah b. 'Ali. The 'Abbásids only numbered forty five thousand soldiers, but these were experienced and resolute warriors. The Omayyad army, though much more numerous, was ill commanded and devoid of spirit. A battle ensued, and fortune favoured the rebels. In vain did Merwan show himself everywhere, his soldiers gave way and repassed the Zab in disorder, hurrying away in their flight the unfortunate Merwán. (Jomadi II. 132, A.H. 25th January 750.) This victory cost the Omayyads their empire. Merwan attempted at first to take refuge at Mosul; but the inhabitants of that city having declared for the enemy, the prince went to his capital Harrán, whence he was driven by the army of 'Abdallah b. 'Ali. Merv successively to Emesa to Damascus, to Palestine, and finally to Egypt. He was pursued without intermission by Sálih, brother of 'Abdallah b. 'Ali, who at last came up with him at Búsir on the frontiers of the Delta. Merwán took refuge in a Coptic church; but the 'Abbásids pursued him into the building, and slew him at the foot of the altar. His head was cut off and sent to Cufa, where the new Caliph then

Thus perished in the East the dynasty of the house of Omayya, which, having been founded by usurpation, had only maintained itself by shedding torrents of blood, and was destined to perish in blood. We now enter upon the history of the new dynasty, whose origin we have described, and under which the power and glory of Islam reached their highest point.

Here we give the

GENEALOGICAL TABLE OF THE OMAYYADS.

Omayya.

Abú 'l-'As.

Hakam.

4. MERWÁN I.

Mohammed.

14. MERWÁN II.

5. 'ABD AL MELIK. 'Abd al-'A[illegible]

[illegible] OMAR I.

Harb.

Abú Sofyán

1. MOʿÁWIYA I.

2. YAZÍD I.

3. MOʿÁWIYA II.

6. WALÍD I. 7. SOLAIMÁN 9. YAZÍD II. 10. HESHÍM.

11. WALÍD II.

12. YAZÍD III. 13. IBRÁHÍM.

[1] To understand this allusion we must know that Merwan II. had received the nickname of *Himár*, "the ass," on account of his temperance and the strength of his constitution.

[2] Historians are divided as to the date at which black became the Abbásid colour. According to some, the first 'Abbásids wore a robe of black silk as early as at the battle called that of the Camel. According to others, it was only after the murder of Ibrahim by Merwan that the Abbásids adopted black as a sign of mourning. See Quatremère, *Mémoires historiques sur la dynastie des Khalifes Abbassides*. Paris, 1837.

Sect. II.—The 'Abbásids.

1. From the death of Merwán may be reckoned the real accession of the 'Abbasid dynasty to the Caliphate, which thus returned to the hands of the grand nephews of the Prophet. Abu 'l-'Abbás, whose proper name was Abdallah, and who afterwards received the surname of Saffah, was, as has been said above, a man of energetic will, who hesitated at nothing to ensure the triumph of his dynasty. When he caused himself to be proclaimed Caliph at Cufa, one of his partisans, Abú Salama, who had still then believed that Abú 'l-'Abbas was working to restore the posterity of 'Ali to the throne, and not to gain possession of the empire for himself, hesitated to take the oath of obedience to the new Caliph. Abu 'l-'Abbas immediately resolved on his destruction, but fearing that Abu Salama might have a secret understanding with the governor of Khorasan, he began by sending his own brother Abú Ja'far into that province to sound Abu Moslim. The latter loudly disclaimed any alliance with Abu Salama, and, that no suspicion might rest upon him, he sent a confidential agent to Cufa, and had Abú Salama assassinated. Still further to prove his zeal for the house of 'Abbas, Abu Moslim also got rid of Solaiman b. Kathir, another 'Abbasid emissary, whom he suspected of partiality towards the family of 'Ali. On his side, Abu 'l-'Abbas caused 'Abdallah b. Mo'awiya, an adherent of 'Ali's family, to be treacherously slain, though he had distinguished himself in the war against Merwan. As for the Omayyads, they were systematically followed up and put to death. The new Caliph desired to exterminate that family, not only for the sake of revenge, but also that he might deprive the Syrians of any pretext for fresh insurrections. In fact, hardly had Abu 'l-'Abbas been proclaimed Caliph at Cufa, when the Omayyad governor of Kinnesrin, Abú 'l-Ward b. Kauthar, notwithstanding that he had taken the oath to the new sovereign, gave the signal for revolt in the name of the Omayyads. Abu 'l-'Abbas immediately ordered his uncle 'Abdallah b. 'Ali, who had been made governor of Palestine, to act with the utmost rigour against all members of the Omayyad family on whom he could lay his hands. That he might let none of them escape, 'Abdallah pretended to grant an amnesty to all Omayyads who should come in and acknowledge the new Caliph, and even promised them the restitution of all their property. Ninety members of that unfortunate family allowed themselves to be entrapped by these specious promises, and 'Abdallah, on pretence of sealing the reconciliation of the two parties, invited them to a banquet. But when they were all collected, a body of executioners rushed into the hall, and slew the Omayyad with blows from whips and rods. A grandson of Hishám 'Abd al-Rahman b. Mo'awiya, who had taken refuge in Africa, alone escaped this massacre. It was he who, at a later date, founded in Spain the Omayyad dynasty of Cordova. The cruelty of the 'Abbasids excited a feeling of horror in the whole of Syria, and the revolt soon became general. Abú 'l-Ward b. Kauthar found himself at the head of forty thousand men, and pitched his camp at Marj al-Akhram, a plain near Kinnesrin. The revolt spread even to Mesopotamia and 'Irak. One of Merwan's former generals, Ishák b. Moslim, laid siege to Harrán, while Yazid b. Hobaira, formerly governor of 'Irák, raised an insurrection at Wásit. In Khorásán also, as many as thirty thousand malcontents took up arms against Abú Moslim. Notwithstanding this formidable display of force, the 'Abbasids remained conquerors. In Syria, 'Abdallah b. 'Ali beat Abú 'l-Ward at Marj al-Akhram. Abú Ja'far, brother of the Caliph, compelled Ishák b. Moslim and Yazid b. Hobaira in succession to submit. Lastly, Abú Moslim quieted the rising in Khorasán. Mosul also attempted an insurrection, but Yahyá, a brother of the Caliph, quenched the revolt in streams of blood. All the provinces being thus reduced to peace, the new Caliph distributed them among the principal members of his family and his best generals. To his brother Abú Ja'far he gave a part of Mesopotamia, Azerbaijan, and Armenia; to his uncle 'Abdallah b. 'Ali Syria; to his uncle Dawúd, Arabia, Hijáz, Yamán and Yemen, to his cousin 'Isá b. Músá, the province of Cufa. Abú Moslim continued in possession of the government of Khorasan, Transoxiana, and a part of Fársistán. Egypt was entrusted to Abú 'Aun. Another uncle of the Caliph, Solaiman b. 'Ali, received the government of Basra, with Bahrain and 'Oman. Lastly, the province of Mosul was taken from the cruel Yahya, and granted to one of the uncles of Abú 'l-'Abbás, Ismá'íl b. 'Ali, who received besides the government of Ahwáz. In Sind, the Omayyad governor had succeeded in maintaining himself, but was defeated by an army sent against him under Musa b. Ka'b, and the black standard of the 'Abbásids was raised over the city of Mansúra. If we omit Africa and Spain in describing this division of the provinces of the empire, it is because the 'Abbásids never gained a real footing in Spain, while Africa remained in only nominal subjection to the new dynasty.

Abu 'l-'Abbas, after having definitively established his power, left the town of Hashimiya and fixed his residence at Anbar, where he died on the 13th of Dhú 'l-Hijja, A.H. 136 (9th June 754).

2. Abu 'l-'Abbas had designated as his successors, first Abu Ja'far, and after him his cousin 'Isá b. Músá. At the moment of the death of Abú 'l-'Abbás, Abú Ja'far, who then assumed the title of Al-Mansúr, "the Victorious," was not in 'Irak. He had undertaken the leadership of the pilgrims who had started on the journey to Mecca, and among whom figured the celebrated Abu Moslim. 'Abdallah b. 'Ali, uncle of Abú 'l-'Abbás, dissatisfied at having been excluded from the succession, took advantage of this absence to revolt. Having raised an army and proclaimed himself Caliph, he marched against Harran and laid siege to it. On receiving the news, Abú Ja'far hastened to return to Anbár in company with Abu Moslim, whom he placed at the head of his troops, and sent against the rebel. At the approach of Abú Moslim, 'Abdalláh, who had among his troops a body of seventeen thousand men of Khorásán, feared that they might declare for Abú Moslim, had them all slaughtered, as the historians assert, by his Syrians, and then hastened to meet his enemy. The two armies met at Nisibis, and, after a number of skirmishes, a decisive engagement took place on the 7th of Jomádí II., A.H. 137 (28th November 754). 'Abdalláh was defeated and compelled to submit to Al Mansúr, who spared his life. The new and brilliant service thus rendered by Abú Moslim to his sovereign ought to have placed him even higher in the favour of Mansúr than he already stood. On the contrary, it was the cause of his ruin. The Caliph wished to commit the task of maintaining order in Syria to Abú Moslim, but the latter refused to give up his government of Khorásan, where he enjoyed an extraordinary reputation and possessed numerous adherents, and, instead of obeying the order of the Caliph, directed his march towards the East. Thenceforth Mansúr looked on him only as a dangerous rebel, and sought for means of getting rid of him. On pretence of conferring with him on business of state, he induced him to come to Madáin (the ancient Ctesiphon), caused him to be put to death by his guards, and ordered his body to be thrown into the Tigris. Thus miserably perished the real founder of the 'Abbási

ynasty, after having accomplished his work, which, as
e historians assert, cost the lives of more than 600,000
en. Notwithstanding the defeat of 'Abdallah b. 'Alí
d the murder of Abú Moslim, the spirit of rebellion was
t yet broken. Risings took place in Mesopotamia and
a still greater extent in Khorásán; and the Caliph's
oops were repeatedly beaten by the rebels; but order
as at last re established by Mansúr's generals, by Khazim
Khozaima in Mesopotamia, and by Mohammed b. al
sh'ath in Khorásán.

About the same time Africa and Spain escaped from
e dominion of the Eastern Caliphate, the former for a
eason, the latter permanently. The cause of the revolt
f Africa was as follows: As soon as Mansúr ascended the
rone, he wrote to 'Abd al-Rahman, announcing the
eath of Abú 'l 'Abbás, and requiring him to take the
th of allegiance. 'Abd al-Rahmán sent in his adhesion
the new Caliph, and added a few p[illegible]ts of litt
he Caliph was so much dissatisfied that he replied by a
reatening letter which excited the anger of 'Abd al
ahmán. He called the people together at the hour of
rayer, mounted the pulpit, publicly cursed Mansúr, and
en declared his deposition from the Caliphate. He next
used a circular letter to be written, commanding all
Maghrebins to refuse obedience to the Caliph; and this
tter was circulated and read from the pulpit throughout
e whole extent of the Maghrib (the West). A brother of
bd al-Rahmán, Ilyas, saw in this revolt an opportunity of
taining the government of Africa for himself. Seconded
y many of the inhabitants of Kairawan, who had
emained faithful to the cause of the 'Abbásids, he attacked
is brother, slew him, and proclaimed himself governor in
is stead. This revolution in favour of the 'Abbásids was,
owever, of no long duration. Habíb, the eldest son of
bd al Rahmán, had fled on the night of his father's
urder, and Ilyás caused him to be pursued, with the
bject of transporting him to Andalusia. Habíb was
aptured, but the vessel which was to convey him to Spain
aving been detained in port by stress of weather, the
artisans of independence took arms, rescued Habíb, and
repared to resist Ilyás, who was marching against them
t the head of an army. Under these circumstances a
ortunate idea occurred to Habíb. He challenged his
ncle Ilyás to single combat. Ilyás hesitated, but his
wn soldiers compelled him to accept the challenge. He
easured arms with Habíb, and was laid prostrate by
im with a thrust of his lance. The party of independ
nce thus triumphed, and several years elapsed before the
Abbásid general, Al-Aghlab, was able to enter Kairawan,
nd regain possession of Africa in the name of the Eastern
Caliph. From this time forward, it must be added, Africa
nly nominally belonged to the 'Abbásids; for, under the
Caliphate of Hárún al-Rashíd, Ibrahim, the son of Al
Aghlab, who was invested with the government of Africa,
ounded in that province a distinct dynasty, that of the
Aghlabites.

Coincidently with the revolt in Africa, the independent
Caliphate of the Western Omayyads was founded in Spain.
The long dissensions which had preceded the fall of that
ynasty in the East, had already prepared the way for the
ndependence of a province so distant from the centre
f the empire. Every petty [illegible] there tried to seize
overeign power for himself, and the people groaned under
he consequent anarchy. Weary of these commotions, the
Arabs of Spain at last came to an understanding among
hemselves for the election of a Caliph, and their choice fell
pon the last survivor of the Omayyads, 'Abd al-Rahman
. Mo'áwiya, grandson of the Caliph Hishám. This
rince was wandering in the deserts of Africa, pursued
y his implacable enemies, but everywhere protected and
concealed by the desert tribes, who pitied his misfortunes
and respected his illustrious origin. A deputation from
Andalusia sought him out in Africa, and offered him the
Caliphate of Spain, which he accepted with joy. On 25th
September, A.D. 755, 'Abd al Rahmán landed in the Iberian
Peninsula, where he was universally welcomed, and
speedily founded at Cordova the Western Omayyad Caliph
ate, with which this history has no further concern.

While Mansúr was thus losing Africa and Spain, he was
trying to take from the Greeks the city of Malatiya,
which, from the importance of its situation, was looked
on as the key of Asia Minor. In A.H. 139-140 (A.D. 756-
757), a Moslem army of 70,000 men invested the place,
and, after a vigorous siege, Malatiya was taken by
assault. After this success the Moslems marched through
Cilicia, entered Pamphylia, and cut to pieces a Greek
army on the banks of the Melas. The Greeks asked and
obtained a seven years' truce, which Mansúr was the more
disposed to grant because new and very serious troubles
had been stirred up in his empire by certain sectaries
of Khorásán, called Rawándís. These Rawándís, like
other Persian sectaries, admitted a number of
doctrines completely foreign to Islam, such as the trans-
migration of souls and the incarnation of the Deity as a
man. They believed for instance, as historians assert
it, that divine honours ought to be paid to the Caliph
Mansúr. They had their name from Rawand, a city
near Isfahán, where the sect originated. A great number
of these sectaries had repaired to Hashimiya, the residence
of the Caliph, and there persisted in marching in pro-
cession round his palace, as if it had been the Ka'ba.
Mansúr, refusing to receive this impious homage, caused
the principal chiefs of the sect to be seized and thrown
into prison. The Rawándís immediately [illegible] in revolt,
broke open the prison doors, rescued their chiefs, and
pushed their audacity so far as to besiege the Caliph
in his own palace. Very fortunately for Mansúr, the
populace declared against the Rawándís and massacred
them; but from that time forward he took a dislike to
the city of Hashimiya, and resolved to choose another
residence. He had at first thought of fixing his place of
abode at Cufa; but he remembered the fickle character of
the inhabitants, and decided on founding an entirely new
city on the banks of the Tigris. His choice fell upon
a spot near the ancient Ctesiphon, the capital of the
Sassanids, called Baghdad. There he himself laid the
first stone of the city which was to be the centre of the
civilised world as long as the Caliphate lasted. A revolt,
however, of some importance soon called Mansúr's atten-
tion from the building of Baghdad. The descendants of
'Alí, who had had reason to [illegible] that the 'Abbásids
were labouring for their advancement, were now cruelly un-
deceived. In A.H. 145 (A.D. 762-763), Mohammed Mahdí,
great grandson of Hasan, and surnamed Al Nafs al Zakiya
("the pure soul"), collected a large number of adherents
at Medina, and had himself proclaimed Caliph. The
governor of Cufa, 'Isa b. Músá, received orders to march
against him, and entered Arabia. The partisans of 'Alí
were defeated, and Mohammed Mahdí fell in battle. But
meanwhile his brother Ibrahim had gone to Basra, and
had there succeeded in exciting a revolt, in presence of
which the 'Abbásid governor had been obliged to capitu-
late. The adherents of 'Alí, emboldened by this success,
spread themselves over 'Iraq, and obtained possession of
several places, among which was the city of Wasit.
Ibrahim was already advancing towards Cufa, at the
head of a strong army, when 'Isa b. Músá, who had been
hastily recalled from Arabia, threw himself in his way.
A terrible conflict took place. At last Ibrahim fell,
pierced by an arrow, and, in spite of the desperate effort

x followers, his body remained in the hands of the
y. The partisans of 'Alí then dispersed, and never
ventured to have recourse to arms.

e Caliph was highly delighted when he heard of the
ive victory gained by 'Isá, but, far from rewarding
ilant conduct, he tried to compel him to renounce his
of succession to the Caliphate, with the view of
itut ng as heir pre umptive his own son Mohammed.
t first energetically refused to abandon his rights;
Ja'far did not hesitate at a shameless deception, and
ced false witnesses, who swore that 'Isa had waived
im in favour of Mohammed b. Mansúr. However
ingly, 'Isá was obliged to yield his priority to
mmed, but it was understood that, in case of the
of the latter, the succession should return to 'Isa
of the false witnesses was, it is asserted, Khálid b.
ak, the head of that celebrated Persian family the
endes, which played so important a part in the reign
arún al Rashíd. To this Khálid, Mansúr had
sted the elevated post of minister of finance.

A.H. 158 (A.D. 774-775), Mansúr, feeling the decline
powers, resolved to undertake for the last time the
nage to Mecca. At the last station on the route he
fell from his horse, and died at the gate of the Holy
He was nearly seventy years of age, and had
d for twenty two years. He was buried at Mecca.

Mohammed b. Mansúr was at Baghdád when he
ed the news of his father's death, and hastened to
himself proclaimed Caliph. He then took the title
ahdí ("the well directed"). To make his accession
me to his subjects, he began by granting an amnesty
reat number of persons who had incurred the anger
ansúr, and had been thrown into prison. Among
was a certain Dáwúd b. Ya'kúb, whom Mahdí after
made his prime minister. But, on the other hand,
did not choose to confirm in their posts the pro
l governors in whom his father had placed confidence;
pplied their places by creatures of his own. These
es displeased the people of Khorásán, who revolted
the leadership of a certain Yúnus b. Ibrahím, sur
l Al Barm. Mahdí sent against him his general
b. Mazyad, who, after a desperate struggle, defeated
, took him prisoner, and brought him in triumph to
dád, where he was put to the torture and executed.
had been scarcely a year on the throne, when he
ed to accomplish the pilgrimage to Mecca, and at the
time to visit the tomb of his father. Leaving his
son Músa as governor of Baghdád, he set off,
panied by his second son Hárún and a numerous
The chroniclers relate that the Caliph had ordered
t number of camels to be laden with snow, and that
ached Mecca without having exhausted this store.
diately on his arrival in the Holy City, he applied
lf, at the request of the inhabitants, to the renewal
veils which covered the exterior walls of the Ka'ba.
very long time these veils had been placed one over
er, no care having been taken to remove the old
ing when a new one was put on; so that the accumu-
weight caused uneasiness respecting the stability of
alls. Mahdí caused the temple to be entirely stripped,
covered the walls again with a single veil of great
ss. On this occasion he distributed considerable
sses among the Meccans. From Mecca, Mahdí went
edina, where he caused the mosque to be enlarged.
ng his stay in that city he formed himself a guard
nour, composed of two hundred descendants of the
s,[1] to whom he assigned lands in 'Iráḳ to be held in
fief. Struck by the difficulties of every kind which
to be encountered by poor pilgrims who desired to
to Mecca from Baghdád and its neighbourhood, he re
to come to their help. His first care was to have the
from Baghdád to Mecca laid out, and its divisions m
by milestones. He next ordered the construction at
stage of a kind of inn, where the poorer travellers
find shelter and food. He also saw to having new
dug and cisterns built along the whole route.

Whilst he was devoting himself to these pious la
he was menaced by a dangerous revolt in Khorásán
leader was a sectary called Hakim, surnamed Al-Mok
or the Veiled One, because he never appeared in
without having his face covered with a mask.
Mokanna' hoped to gather a great number of adh
around him, and to govern the province as absolut
Abu Moslim had formerly done. His religious tea
consisted in the assertion that God had several
become incarnate among men, and that his last in
tion was Mokanna' himself. Many Persians were se
by his words, and still more by the hope of plun
the property of the Moslems, which Mokanna' pro
to give up to them. The governor of Khorásan
several other generals who marched against these se
were defeated; but at last the Caliph charged a
captain, Sa'íd al Hara-shí, with the direction of oper
and Sa'íd, having compelled the impostor to throw
self into the city of Kash, soon reduced him to a
between surrender and death. Mokanna' preferre
latter alternative, and took poison.

These disturbances did not suffice to turn M
thoughts from the hereditary enemy of the Cali
Every summer he sent expeditions into Asia
against the Greeks, but these were not successfu
the Caliph decided on leading his army in person. I
levied in Khorásan a large number of those mounta
who had always distinguished themselves by their v
he assembled his army in the plains of Baradán, c
banks of the Tigris, and commenced his march A.H
taking with him his second son Hárún, and leavi
eldest son Músa as governor of Baghdád. The latt
also designated as his successor in the Caliphate,
Músá having definitively renounced the throne.
traversed Mesopotamia and Syria, entered Cilicia
established himself on the banks of the Jaihán (Pyra
Thence he despatched an expeditionary force, at the
of which his son Hárún was nominally placed. In r
that prince being too young to direct military opera
the chief command was exercised by his tuto
Barmecide Yahya b. Khálid. Hárún took the fort
Samalu after a siege of thirty-eight days. In conse
of this feat of arms, Mahdí made Hárún gover
Azerbaijan and Armenia. Two years later war
out afresh between the Moslems and the Greeks.
IV., Emperor of Constantinople, had recently died, l
the crown to Constantine Porphyrogenitus. This
was then only ten years old, and would have been
able of governing. His mother Irene took the rege
herself. By her orders an army of 90,000 men,
the command of Michael Lachanodracon, entered
Minor. The Moslems, on their side, invaded
under the orders of 'Abd al-Kabír, but were defeat
the Greeks. Mahdí then recalled his son Hárún
enjoined on him to avenge the failure of the a
Islam. Hárún assembled an army of nearly 1
men, and conceived the project of carrying the war
very gates of Constantinople. The patrician N
who sought to oppose his march, was defeated by H
general, Yazíd b. Mazyad, and forced to take ref
Nicomedia. Hárún marched through Asia Mino

[1] The first citizens of Medina who embraced Islam were called Ansár; see, p. 554.

pitched his camp on the shores of the Bosphorus. Irene took alarm, sued for peace, and obtained it, but on humiliating conditions. This brilliant success increased Mahdí's affection for Hárún to such an extent that he resolved, a few years later, to declare him his successor instead of Músá. It was necessary first to obtain from Músá a renunciation of his rights; and for this purpose his father recalled him from Jorján, where he was then engaged on an expedition against the rebels of Tabaristan. Músá, who had had information of his father's intentions, refused to obey this order. Mahdí determined to a in person against his rebellious son (A.H. 169), and set out, accompanied by Hárún. But, after his arrival at Másabadhán, a place in Persian 'Iráḳ or Jabal, the Caliph died suddenly, at the age of only forty three. There are two versions of the cause of his death, some attributing it to an accident met with in hunting, others believe him to have been poisoned. If this was really the case, although we have no proofs against Músa, we may reasonably suspect him of having been privy to the sudden death of his father.

4. Mahdí having died before he could carry out his plan for assuring the throne to Hárún, the succession naturally fell to Músá, and he was proclaimed Caliph at Baghdad in the year of his father's death. He took the title of Hádí (He who directs). Hárún made no opposition to the accession of his brother, and the army which had accompanied Mahdí returned peacefully from Jabal to Baghdad.

The accession of a new Caliph doubtless appeared to the partisans of the house of 'Alí a favourable opportunity for a rising. Hosain b. 'Alí, a descendant of that Hasan who had formerly renounced his pretensions to the Caliphate through fear of Mo'áwiya I., raised an insurrection at Medina with the support of numerous adherents, and had himself proclaimed Caliph. But having unfortunately conceived the idea of going on pilgrimage to Mecca, he was attacked at Fakh by a party of 'Abbásids, and perished in the combat. His cousin Idrís b. 'Abdallah succeeded in escaping and fled to Egypt, whence he passed into Morocco; and there, at a later period, his son founded the Idrísite dynasty.

Hádí, as may be supposed, had never been able to forget that he had narrowly escaped being supplanted by his brother. He formed a plan for excluding Hárún from the Caliphate, and transmitting the succession to his own son Ja'far. He neglected no possible means of attaining this object, and obtained the assent of his ministers, and of the principal chiefs of his army, who took the oath of allegiance to Ja'far. Only Yahyá b. Khálid the Barmecide, Hárún's former tutor, absolutely refused to betray the interests of his pupil. In a discussion which took place between him and the Caliph on this subject, Yahya showed such firmness and boldness that Hádí resolved on his death, and Harthama b. A'yan, one of the bravest generals of the empire, had already received the order to go and take his head, when the Caliph died suddenly. One of those terrible domestic dramas had been acted of which so many were afterwards seen in the palace of the Caliphs. The mother of Hádí and Hárún was Khaizorán, a haughty and intriguing woman, whose aim it was to get the direction of affairs into her own hands, leaving Hádí only the shadow of power. Her influence over all matters of government was so well understood that her door was beset all day by a crowd of petitioners, who neglected the Caliph and preferred to address their requests to her. Hadí soon became indignant at the subordinate part which his mother wished him to play, and after a dispute on the matter, he attempted to poison her. Khaizorán, hoping to find a more submissive instrument of her will in her second son, and wishing to protect herself against fresh attempts at murder, caused Hádí to be taken unawares and smothered with cushions by two young slaves whom she had presented to him. (Rabí' I., A.H. 170, Sept. A.D. 786.)

5. We have now reached the most celebrated name among the Arabian Caliphs, celebrated not only in the East, but in the West as well, where the stories of the Thousand and One Nights have made us familiar with that world which the narrators have been pleased to represent to us in such brilliant colours.

On the unexpected death of Hádí, the generals and ministers who had declared against Hárún, perceiving that popular favour did not incline to the son of the late Caliph, hastened to rally round the son of Khaizorán and Hárún, surnamed Al Rashíd (The Upright), ascended the throne without opposition. His first act was to choose as prime minister his former tutor, the faithful Yahyá the Khálid, and to confide important posts to the two sons of Yahya, Fadl and Ja'far, the former of whom was also his own foster brother. The Barmecide family were endued in the highest degree with those qualities of generosity and liberality which the Arabs prized so highly. The chroniclers are never wearied in their praises of the Barmecides. Loaded with all the burdens of government Yahyá brought the most distinguished abilities to the exercise of his office. He put the frontiers in a state of defence, and supplied all that was wanting for the security. He filled the public treasury, and carried the splendour of the throne to the highest point. The following anecdote will show what an amount of confidence and affection the Barmecide family succeeded in winning.—

After Hárún, as we shall relate further on, had ruined the Barmecides, of whose influence he was jealous, he forbade the people to impose elegies on the disgrace of the family and commanded that all who disobeyed this order should be punished. One day [illegible] of the Caliph's guard was passing near a ruined building, he perceived a mare bearing a paper in his hand and reciting aloud, and with many tears, a lament over the ruin of the palace of the Barmecides. The soldier arrested the man and led him to the palace of the Caliph, who ordered the culprit to be brought before him and asked him why he had infringed his orders. "Prince," replied the man, "let me recount to you my history, when thou hast heard it do with me as thou wilt. I was an inferior clerk, under Yahya b. Khálid. He said to me one day, 'Thou must invite me to [illegible].' 'My lord,' I replied, 'I am quite unworthy of such [illegible], and my house is not fit to receive thee.' 'No,' said Yahya, 'thou must absolutely do what I require of thee.' 'In that case,' answered I, 'grant me one hour's delay that I may make [illegible] arrangements.' Yahya started for some months. A[illegible] as I informed him that I was ready, he returned to my abode accompanied by his two sons, Fadl and Ja'far, and by some of his men. Scarcely had he dismounted from his horse when I [illegible] seemed to give him something to eat. I offered him some [illegible] chicken. When he had eaten his fill he went over the whole of my [illegible] and having seen it all, he asked me to show him the [illegible]. I replied to it, 'My lord,' said I, 'thou hast seen everything. No,' said he, 'I must have another house.' I then assured him that I had but one, but he persisted [illegible] and sending for a waggon, ordered him to make an opening in the wall. 'My lord,' said I, 'must I venture thus to make my way into my neighbour's house?' 'It matters not,' replied he. Where a doorway had been opened we passed through it, followed by his two sons, and I went after them. We entered a delightful garden, well planted and watered by fountains. In this garden stood a beautiful house with pavilions adorned with [illegible] carpets, and filled with [illegible], all of perfect beauty. 'All this is thine,' said Yahya to me. I kissed his hand and poured out my thanks to him; and then I learned that on the very day when he had spoken to me of my wish he had bought the land adjoining to my house, and had caused it to be laid out for me without my even suspecting it. I had certainly noticed that building was going on, but I was far from imagining that all this was intended for me. Yahya next addressed himself to Ja'far and said: 'Here are certainly a house and grounds, but who will provide for their support?' 'I,' replied Ja'far, 'will give him a farm and its dependences, and will send him the deeds of gift.' 'Very well,' continued Yahya; 'but how is he to live until he shall receive the revenue of his property?' 'I will give him a thousand pieces of gold,' said Fadl, 'and I will send them to

Thanks to these magnificent gifts, I afterwards gained
alth,- wealth which I still enjoy. Since that day, I have
t any opportunity of singing the praises of that noble
And now, Prince, slay me if thou wilt; I am ready to
arun, effected by this tale, let the man depart, and in
rbade so man to weep for the tragical end of the sons of
(*Il Fachri*, ed. Ahlwardt, p. 237.)

nich the administration of Hárun's state was com-
to kehrul hands, yet the first years of his long
e not free from trouble. Towards the year 176
793), a member of the house of 'Ali, named
Abdallah, who had taken refuge at Dailam on
the Caspian Se in forming a
l party, and publicly announced his pretensions
Caliphate. Harun immediately sent an army
00 men against the rebel, under the command of
Reluctant, however, to fight against a descendant
Prophet, Fadl first attempted to induce him to sub
promising him safety for his life and a brilliant
at the court of Bachdad. Yahya accepted these
ns, but he required that the Caliph should send
ers of pardon countersigned by the highest legal
ies and the principal personages of the
consented to do so, and Yahya, furnished with the
safe conduct, repaired to Bachdad, where he met
splendid reception. At the end of some months,
, he was calumniously accused of piracy, and
ph, seizing this opportunity of ridding himself of
who might prove dangerous, threw him into prison,
e was soon after put to death. Dreading fresh
tion, Harun thought it well to secure the person
her descendant of 'Ali, Musa b. Jafar, who was
at Medina, where he enjoyed the highest consider
The unfortunate man was sent to Bachdad, and
ed by person
while Harun did not forget the hereditary enemy
whom he had already fought. Under his reign
strong place Syria was formed into a special
e, which received the name of 'Awasim. The
of fortifying the city of Tarsus was committed to
he chief of the Turkish soldiers, whom the Caliphs
gramme to employ, and who were at a later period
ome their masters. The ancient Anazarbus was
and garrisoned with a military colony from
an. Thanks to these measures, the Moslem armies
le to advance boldly into Asia Minor. Ithak-
n entered Phrygia and defeated the Greek gover
that province. A Moslem fleet destroyed that of
ks in the Gulf of Satalia. Harun in person
Asia Minor in the year 181 (A.D. 797-798), and
the following years his general gained continual
s over the Byzantines, so that Irene was compelled
ter peace. An attack by the Khazars called the
attention from his successes in Asia Minor. That
had made an irruption into Armenia, and then
had been so sudden that the Moslems were unable
nd themselves, and a hundred thousand of them
ere reduced to captivity. Two valiant generals,
ma b. Khazim and Yazid b. Mazyad, marched
the Khazars and drove them out of Armenia.
he mid st of the cares of war, Harun did not forget
igious duties, and few years passed without h
the pilgrimage. In one of these pilgrimages, A.D. 802, he was accompanied by his two eldest
Mohammed and 'Abdallah, and having determined
he order of succession in so formal a manner as to
ay all pretext for future contentions, he executed
by which he appointed Mohammed his immediate
fter him 'Abdallah, and after 'Abdallah a third of
s, named Kásim. Mohammed received the surname
min (The Sure), 'Abdallah that of Al Ma'mún (He
in whom men trust), and Kásim that of Mo'tamin billá
(He who trusts in God). Hárún further stipulated that
Ma'mún should have as his share, during the lifetime of
his brother, the government of the eastern part of the
empire. Each of the parties concerned swore to observe
faithfully every part of this deed, which the Caliph caused
to be hung up in the Ka'ba, imagining that it would be
thus guaranteed against all violation on the part of men.
These precautions were to be rendered vain by the perfidy
of Amin. We shall see hereafter how he kept his oath
and how he expiated his treachery by death.

It was in the following year, at the very moment when
the Barmecides thought their position most secure, that
Hárún brought sudden ruin upon them. The causes of
this disgrace have been differently stated by the annalists.
Some relate that the Caliph, preferring to all other society
that of his sister 'Abbasa and of Ja'far b. Yahyá, resolved
to unite them in marriage, in order to be able to bring
them together in his presence without a breach of etiquette.
He meant, however, that Ja'far should continue to be
only the nominal husband of his sister. Ja'far accepted
this condition, but it was not long before he forgot it,
and the Caliph learned that his sister had given birth to a
son. This, it is said, was the cause of Ja'far's disgrace,
which involved his father and his brother. This story
may be true; but the principal cause of the fall of the
Barmecides appears to have consisted in the abuses of
power of which they had been guilty, and in the sovereign
influence which they exercised on those around them.
The Barmecides lived in a magnificent palace opposite to
that of the Caliph. Seeing one day an extraordinary crowd
around the dwelling of his first minister, Hárun was moved
to say: "Verily Yahyá has taken all business into his
own hands, he it is who really exercises supreme power;
as to me, I am Caliph only in name." This secret dis-
satisfaction was increased by a new act of disobedience
on the part of Ja'far. Hárún had ordered him to put to
death secretly a member of the house of 'Alí, whose
intrigues he dreaded. Ja'far allowed the victim to escape,
and afterwards swore to the Caliph that his orders had
been executed. Soon after, however, information against
him was given to Hárún, who, after compelling Ja'far to
acknowledge the truth, had his head struck off and brought
to him by Masrúr, the chief of his eunuchs. On the very
next day Yahya, his son Fadl, and all the other Barmecides, were arrested and imprisoned; all their property
was confiscated; and Hárún chose as his prime minister
Fadl b. Rabí', who had been his chamberlain.

In the same year, a revolution broke out at Constantinople, which overthrew the Empress Irene, and raised
Nicephorus to power. The new emperor had scarcely
ascended the throne, when he thought himself strong
enough to refuse the payment of tribute, and wrote a
insulting letter to Harun, who contented himself with
replying: "Thou shalt not hear, but see, my answer."
He then assembled an army, entered Asia Minor, and
took Heraclea, plundering and burning along his whole
line of march, till Nicephorus, in his alarm, sued for
peace. Scarcely had the Caliph returned into winter
quarters, when Nicephorus broke the treaty. Notwithstanding the rigour of the season, Hárún retraced his
steps, and this time Nicephorus was compelled to observe
his engagements. The year after, A.H. 189 (A.D. 805), disturbances arose in Khorasán. They were caused
by the malversations of the governor of that province,
Ali b. 'Isa, and the Caliph went in person to Merv to
judge of the reality of the complaints which had reached
him. 'Ali b. 'Isá hastened to meet the Caliph on his
arrival at Ray. He brought with him a great quantity
of presents, which he distributed with such profusion

among the courtiers that every one found a thousand reasons for excusing his conduct. Hárún confirmed him in his post and returned to Baghdád, through which, however, he only passed, and went on to Rakka on the Euphrates, a city which became his habitual residence. He did not long enjoy the repose which he went there to seek, for Nicephorus again broke the treaty of peace, and the Caliph was obliged to take the field anew. Once more Nicephorus was beaten, and so completely that he was obliged to submit to the very harsh conditions which the victor imposed on him.

Two years later, new disturbances broke out in Khorasán, where a certain Ráfi' b. Laith had revolted. Hárún set out again for that province, accompanied by his son Ma'mún. It was to be his last journey. He was attacked by a tumour in the abdomen, and struggled in vain against this malady, which carried him off a year after his departure, A.H. 193 (A.D. 808-809), just on his arrival at the city of Tús, the birthplace of the great epic poet of Persia, Firdausí. Hárún was only forty-seven years of age.

6. On the death of Hárún, his minister Fadl b. Rabí' hastened to call together all the troops of the late Caliph, and to lead them back to Baghdad, in order to place them in the hands of the new sovereign, Amín. He even led back the corps which was intended to occupy Khorasan, and which ought to have fallen to the share of Ma'mún, according to the testament of Hárún. Fadl b. Rabí' thus committed a serious violation of the rights of Ma'mún, but he cared little for this, being chiefly desirous of winning the confidence of the new Caliph. He was quite aware, however, that in thus acting he was making Ma'mún his irreconcilable enemy; and he therefore purposed to use every endeavour to arouse against him the enmity of his brother Amín. He advised him to exclude Ma'mún from the succession, and the Caliph was weak enough to listen to him. Receiving the order to resign his government of Khorasán and to repair to Baghdad, Ma'mún was greatly perplexed; but his tutor and vizier, Fadl b. Sahl, reanimated his courage, and pointed out to him that, if he obeyed the orders of the Caliph, certain death awaited him at Baghdád. Ma'mún resolved to hold out against Amín, and found pretexts for eluding the orders of his brother and remaining in Khorásán. Amín, in his anger, caused the testament of his father, which, as we have seen, was reserved in the Ka'ba, to be destroyed, declared, on his own authority, the rights of Ma'mún to the Caliphate to be forfeited, and caused the army to swear allegiance to his own son Músá, a child five years of age, on whom he bestowed the title of Náṭiḳ bil Ḥaḳḳ, "He who speaks according to truth" (A.H. 194, A.D. 809-810). On hearing the news, Ma'mún, strong in the rightfulness of his claim, retaliated by suppressing the Caliph's name in all public acts. Amín immediately despatched to Khorasan an army of fifty thousand men, under the command of 'Alí b. 'Isá. Ma'mún, on his side, raised troops among his faithful people of Khorásán, and entrusted their command to Táhir b. Hosain, who displayed remarkable abilities in the war that ensued. In the following year, the two armies met under the walls of Ray, and victory declared for Táhir. Ma'mún now no longer hesitated to take the title of Caliph. The year after, Amín placed in the field two new armies, commanded respectively by Ahmed b. Mazyad and 'Abd Alláh b. Homaid b. Kahtaba. The skilful Táhir b. Hosain succeeded in creating divisions among the troops of his adversaries, and obtained possession, without striking a blow, of the city of Holwán, an advantage which placed him at the very gates of Baghdád. Ma'mún immediately sent Táhir reinforcements under the orders of Harthama b. A'yan, which enabled him to maintain a firm hold on all the conquered territory, and to continue his victorious march to the capital. Reverses naturally lead to fresh reverses. One after the other the provinces fell away from Amín, and he soon found himself in possession of Baghdád alone, which was speedily invested by the troops of Táhir and Harthama. That unfortunate capital, though blockaded on every side, made a desperate defence for two years. Ultimately the eastern part of the city fell into the hands of Táhir, and Amín, deserted by his followers, was compelled to surrender. He resolved to treat with Harthama, as he hated Táhir, but this step caused his ruin. Táhir learned by his spies that Harthama was to receive the Caliph in person, and gave orders to a body of horsemen to arrest Amín as he issued from Baghdad under cover of the night. On the bank of the Tigris, Harthama awaited Amín with a boat, but scarcely had the Caliph set foot in it, when the agents of Táhir poured on it a storm of arrows and stones. The boat sank, and the Caliph had to make his escape by swimming. But he was closely followed up, and had scarcely left the river when he fell into the hands of his enemies, who shut him up in a hut and went to inform Táhir of the capture. The victorious general immediately ordered him to be put to death, and the order was carried out. The head of the unfortunate Amín was cut off and sent to Ma'mún, A.H. 198. It was presented to him by his vizier, Fadl b. Sahl, surnamed Dhú 'l-Riyásatain, or "the man with two governments," because his master had committed to him both the ministry of war and the general administration. Ma'mún, on seeing the head, hid his joy beneath a feigned display of sorrow.

7. On the day following that on which Amín had perished so miserably, Táhir caused Ma'mún to be proclaimed at Baghdad. The accession of this prince appeared likely to put an end to the evils of civil war, and to restore to the empire the order necessary for its prosperity. It was not so, however. The reign of Ma'mún that reign on which art, science, and letters, under the patronage of the Caliph, threw so brilliant a lustre, had a very stormy beginning. Ma'mún was in no haste to remove to Baghdad, but continued to make Merv his temporary residence. In his gratitude to the two men to whom he owed his throne, he conferred on Táhir the government of Mesopotamia and Syria, and chose as prime minister of the empire Fadl b. Sahl, who had been already his vizier in the government of Khorasan. The adherents of 'Alí seized on the elevation of Ma'mún to power as a pretext for fresh revolts at Mecca, at Medina, and in 'Irák. At Cufa a certain Ibn Tabátaba also broke out into open rebellion, and placed an army in the field under one of his partisans, Abú 'l-Saráya. Hasan b. Sahl, brother of Ma'mún's prime minister, who had been made governor of all the provinces conquered by Táhir, immediately sent troops against Cufa. They were defeated, and Abú 'l-Saráya, encouraged by this first success, and no longer finding a secondary part sufficient for his ambition, poisoned his chief Ibn Tabátaba, and put in his place another of the family of 'Alí, Mohammed b. Mohammed, whom, on account of his extreme youth, he hoped to govern at his will. Fresh troops sent against Abú 'l-Saráya fared no better than the first, and several cities of 'Irák, as Basra, Wasit, and Medain, fell into the hands of the rebels. Abú 'l-Saráya was already marching against Baghdad, when Hasan b. Sahl, in great alarm, had recalled Harthama b. A'yan, one of the heroes of the civil war, who was already on his way back to Merv. As soon as this general had returned from Khorasan, the face of affairs changed. The adherents of 'Alí were everywhere driven back, and the whole of 'Irák fell again into the hands of the 'Abbásids. Cufa was taken by assault, and both Abú 'l-Saráyá and Mohammed b. Mohammed were

made prisoners. The former had his head struck off; the latter was sent to Khorásán. The revolt in Arabia was also quickly stifled, and it might have been supposed that peace was about to be re-established. This, however, was by no means the case. The civil war had caused a swarm of vagabonds to spring, as it were, from underground at Baghdád. They proceeded to treat the capital as a conquered city, and such was their audacity that they plundered houses and carried off women and children at mid-day. It became necessary for all good citizens to organize themselves into a regular militia, in order to master these ruffians. Meanwhile, at Merv, Ma'mún was adopting a decision which fell like a thunderbolt on the ʿAbbásids. In A.H. 201 (A.D. 816-817), under pretence of putting an end to the continual revolts of the partisans of ʿAlí, and acting on the advice of his prime minister, Fadl, he publicly designated as his successor in the Caliphate ʿAlí b. Músá, a direct descendant of Hosain the son of ʿAlí, and proscribed black, the colour of the ʿAbbásids, in favour of that of the house of ʿAlí, green. This step was well calculated to delight the followers of ʿAlí, but it naturally could not fail to exasperate the ʿAbbásids and their partisans. The people of Baghdád refused to take the oath to ʿAlí b. Músá, and, becoming presumptive, declared Ma'mún deposed, and elected his uncle Ibrahim, son of Mahdí, to the Caliphate.[1] The news reached the Caliph only indirectly, for his minister Fadl, desiring to leave Ma'mún only the shadow of power, kept all important events carefully from his knowledge. The eyes of the Caliph were opened, and he now perceived that Fadl had been treating him as a puppet. His anger knew no bounds. Fadl was one day found murdered, and ʿAlí b. Músá died suddenly. The historians bring no open accusation against Ma'mún of having been the two personages; but it seems clear that it was not chance that did him such a seasonable service. Ma'mún of course affected the profoundest grief, and, in order to disarm suspicion, appointed as his prime minister the brother of Fadl, Hasan b. Sahl, whose daughter Burán he also afterwards married. But on the other hand, in order to quiet the people of Baghdád, he wrote to them: "The cause of your dissatisfaction in the heinous ʿAlí b. Músá no longer exists; since he who was the object of your resentment has just died." From that moment the pseudo-Caliph Ibrahim found himself deserted, and was obliged to seek safety in concealment. His precarious reign had, however, lasted nearly two years. Ma'mún now decided on making a public entry into Baghdád, but to show that he came as a master, he still displayed for several days the green flag of the house of ʿAlí, though at last, at the entreaty of his courtiers, he consented to resume the black. From this time the real reign of Ma'mún began, freed as he now was from the guardianship of Fadl. His general Tahir alone continued to excite his suspicions. Under the pretence that he could no longer endure the sight of the murderer of his brother, he removed Tahir to a distance by appointing him governor of Khorásán. Like most of the great Muslim generals, Tahir, it is said, conceived the project of creating an independent kingdom for himself. His death, A.H. 207, prevented its realization; but as his descendants succeeded him one after the other in the post of governor, he may be said to have really founded a dynasty in Khorásán. When, two years later, the impostor Bábak set up a communistic sect in Armenia and Azerbaijan, it was a son of Tahir, ʿAbdallah, who was commissioned by Ma'mún to put him down. Notwithstanding his ability, ʿAbdallah could not accomplish the task, and it was only under Ma'mún's successor that Bábak was taken and put to death.

Ever since Ma'mún's entry into Baghdád, the pseudo-caliph Ibráhím had led a wandering life. He was arrested one night in Baghdád, under the disguise of a woman, and brought before Ma'mún. The latter generously pardoned him, and also granted an amnesty to the former minister of Amín, Fadl b. Rabí', although he had been the chief promoter of the terrible civil war which had so lately shaken the empire. After that time, Ibráhím the son of Mahdí lived peacefully at the court, cultivating the arts of singing and music, in which he excelled.

Tranquillity being now everywhere re-established, Ma'mún gave himself up, without hindrance, to his scientific and literary tastes. He caused works on mathematics, astronomy, medicine, and philosophy, to be translated from the Greek. It was also by his orders that two learned mathematicians undertook a measurement of a degree of the earth's circumference. Ma'mún interested himself, too, in questions of religious dogma. Shocked at the opinion which had spread among the Moslem doctors, that the Koran was the uncreated word of God, he published an edict commanding them to renounce this error. Several distinguished doctors, and, among others, the celebrated Ibn Hanbal, founder of one of the four orthodox Moslem sects, were obliged to appear before an inquisitorial tribunal; and as they persisted in their belief respecting the Koran, they were thrown into prison. Meanwhile, war having broken out between the Greeks and the Moslems, Ma'mún set out for Asia Minor, to put himself at the head of his army. On his arrival at Tarsus he received from the governor of Baghdád the report of the tribunal of inquisition, and ordered that the culprits should be sent off to him. Happily for these unfortunate doctors, they had scarcely started on the road to the frontiers, when news of the Caliph's death reached Baghdád. Ma'mún having bathed in the Podendon, a burning fever was the result, which brought him to the grave in A.H. 218 (A.D. 833). Before his death, he designated as his successor his brother Mo'tasim billáh (whose surname is Defence in God), whom he had for a long time preferred to Mo'tamin.

8. The accession of the new Caliph Mo'tasim met at first with active opposition in the army, where a powerful party had been formed in favour of ʿAbbás, the son of Ma'mún. Thanks, however, to the disinterested conduct of that prince, civil war was averted. ʿAbbás publicly renounced all pretension to the Caliphate, and took the oath of allegiance to his uncle. Mo'tamin, the son of Harún, imitated the conduct of ʿAbbás, and the whole army accepted Mo'tasim, who made his public entry into Baghdád in the month of Ramadan 218.

The new Caliph, far from putting a stop to the persecution which had been directed against the orthodox doctors, took up and carried out the views of Ma'mún. The doctor Ibn Hanbal was beaten with rods and thrown into prison, together with several of his companions, and was not restored to liberty till the Caliphate of Motawakkil. This persecution had already prejudiced the people against Mo'tasim, and their discontent became more marked when the Caliph created a new body of troops, specially intended to watch over his person. This new guard was composed of Turks, an unbridled and undisciplined body of soldiery who, moreover, held in open contempt the religious precepts of Islam. Tired of the excesses of every kind committed by the Turks, the people of Baghdád rose in insurrection, and Mo'tasim, not daring to act with severity either against his guard or the citizens, took the course of quitting the city. Leaving the government of the capital in the hands of his son Wáthik billáh (He who trusts in

[1] On this event, see a remarkable essay by Barbier de Meynard, in the *Journal asiatique* for March-April, 1869.

od), he established himself with his guard at Sámarra, a mall place situated a few leagues above Baghdád, and hanged its name to Sorra-man-ra'a (He rejoices who es it). This resolution of Mo'tasim was destined to cove fatal to his dynasty; for it placed the Caliphs at the ercy of their Prætorians. In fact, from the time of Io'tasim, the Caliphate became the plaything of the urkish guard, and its decline was continuous. Some orious feats of arms, however, were still performed nder Mo'tasim. The sectary Bábak was at last taken by fshín, a Turkish general of the Caliph, in the year 223 .D. 837-838). Babak was carried to Baghdad, led hrough the city on the back of an elephant, and then elivered to the executioners, who cut off his arms and is legs. Afshín, however, was very ill rewarded for his ervices, for shortly afterwards the Caliph had him put to eath on a charge of heresy.

The death of Ma'mún had for the moment suspended ostilities with Constantinople, under Mo'tasim the war as rekindled. A valiant Greek general, Manuel, who ad incurred the displeasure of the Emperor Theophilus, ook refuge with the Caliph, who eagerly welcomed him nd gave him a command. Manuel began by reducing horásán, which had risen in revolt, and Mo'tasim was so ell satisfied with him that he thought of employing him gainst his own countrymen. This was precisely what heophilus dreaded, and he took measures accordingly to ring back the banished general to his side. He sent an mbassador to Mo'tasim, under pretence of ransoming me Greek prisoners; but the real object of his mission, hich he contrived to communicate to Manuel, was the ecall of that general. Manuel, forgiving great animosity gainst his country, himself asked to be allowed to lead a Moslem army into Cappadocia. The Caliph granted his equest, and sent with him his own son Wathik billah ut, as soon as they reached the frontiers of Cappadocia, lanuel confessed to the young prince that his intention as to return to Constantinople, and quitted the army. heophilus, taking advantage of the confusion into which he departure of Manuel had thrown the Moslems, made n incursion into Syria, laid waste that province as far as abatra, and returned loaded with booty. At the news of is disaster, Mo'tasim assembled a formidable army, stimated at more than two hundred thousand men, enetrated into Asia Minor, beat the Greeks, and took he city of Amorium, which he ordered to be razed to the round. A revolt which broke out at Baghdad in favour f his nephew 'Abbás, the son of Ma'mun, compelled the Caliph to turn back. Mo'tasim had the unfortunate Abbás arrested, and he was soon after found dead in his rison. Mo'tasim survived him only four years. He died t Sorra-man-ra'a, in A.H. 227 (A.D. 841-842).

9. His son Wáthik, who succeeded him, showed himself o less intolerant on the doctrinal question of the uncreated Koran. He carried his zeal to such a point that, n the occasion of an exchange of Greek against Moslem risoners, in the year 231 (A.D. 845-846), he ordered that ll the Moslem captives who would not declare their elief that the Koran was a human work, should be left n the hands of the enemy. The reign of Wáthik billah was not otherwise marked by any very striking events. He died in 232 (A.D. 846-847), after a reign of five years, as he had appointed no successor before his death, the principal personages of the state at first cast their eyes on is son Mohammed; but they had scarcely saluted him with the title of Caliph, when they changed their purpose, nd offered the supreme power to Motawakkil 'ala 'llah He who trusts to God), brother of Wáthik. This prince was therefore elected in the same year in which Wáthik ied.

10. The first act of Motawakkil was an atrocious cruelty. He seized Mohammed b. 'Abd al Melik, his brother's vizier, who had always been his enemy, and ordered him to be placed in a furnace bristling within with iron points, which was then raised to a red heat. The Caliph looked on at the agonies of his victim incessantly repeating: "Pity is a weakness." This had been the favourite maxim of the unfortunate vizier. An impostor named Mohammed b. Faraj had set himself up as a prophet, giving out that he was Moses risen from the dead. By means of this pious fabrication, he had contrived to attract twenty-seven followers. The Caliph had him seized, and condemned him to perpetual imprisonment, but first he compelled each of the followers of Mohammed to give the pretended prophet ten blows on the head with his fist; and the poor wretch expired under the hands of his own disciples (A.H. 235, A.D. 849-850).

In the year of his elevation to the Caliphate, Motawakkil had regulated the succession to the empire in his own family, by designating as future Caliphs his three sons, Montasir billah (He who seeks help in God), Mo'tazz billah (Strong through God), and Mowayyad billah (Assisted by God). In acting thus, his object was to protest against the tendency of his predecessors to favour the house of 'Alí, and to guard against the attainment of the Caliphate by any member of that house. Motawakkil displayed the most extreme hatred for the descendants of the Prophet. He even went so far as to destroy the chapel erected over the tomb of Hosain at Kerbela, and to forbade the Shí'ites to visit the spot. Not content with attacking the liberty and the property of the descendants of 'Alí, he insulted their belief, by taking buffoons into his pay, whose business it was to turn the person of 'Alí into mockery. He also persecuted the Christians and the Jews; excluding them from all public employments, and obliging them to send their children to Moslem schools. In the year 237, a revolt broke out in Armenia. The Caliph sent the Turk Bugha against the rebels, but they met him with a vigorous resistance, and it was four years before peace was restored to the province. During that time the Greeks effected a descent on Egypt, and Damietta was taken and burned. Motawakkil caused Damietta to be fortified, and transferred his own residence to Damascus, doubtless that he might be able to keep a closer watch on the proceedings of the Byzantines. He soon thought himself strong enough to take the offensive, and poured his Turkish soldiery into Asia Minor, where they encountered the same Manuel who had been formerly received at the court of Mo'tasim. After an alternation of successes and reverses, both Moslems and Greeks retired from the conflict. Motawakkil then returned to his residence at Sorra-man-ra'a, and there caused a magnificent quarter to be built, which he called Ja'fariyya[1]. There he gave himself up to debaucheries, till at last, during one of his orgies, he was murdered by a Turkish soldier named Wasif, who had been bribed to the deed by his own son Montasir billah (A.H. 247, A.D. 861-862).

11. On the very night of his father's assassination Montasir had himself proclaimed Caliph. The conspirators among the Turkish soldiery compelled him to deprive his two brothers, Mo'tazz and Mowayyad, who were not agreeable to them, of their rights of succession. Montasir did not long enjoy the fruits of his crime. He died five months after, by poison, it is said.

12. The Turkish soldiery, which now arrogated to itself the mastery over the Caliphate, chose in succession to Montasir his cousin Ahmed, who took the title of Mosta'

[1] That is, "City of Ja'far." Ja'far was Motawakkil's own proper name.

billáh (He who looks for help to God). Under the reign of this feeble prince, the Greeks inflicted serious losses on the Moslems in Asia Minor. The Turkish soldiery, instead of attempting to repair these losses, revolted against the Caliph whom they had themselves chosen, and plundered the city of Sorra man ra'a. Taking advantage of these disorders, a descendant of 'Alí, named Hasan, gained possession of Tabaristán and Jorján, and permanently deprived the Eastern Caliphate of those provinces. At the same time, insurrections sprang up in every part of the empire. Next, the chiefs of the Turkish soldiery, in their mutual jealousies, began to tear each other to pieces. The infatuated Caliph fled from Sorra man ra'a, and took refuge at Baghdád. The Turks now resolved on his destruction, and forgetting that they themselves had deprived Mo'tazz billáh, brother of Montasir, of his legitimate rights, chose him as their Caliph. They next placed at their head a brother of Mo'tazz, named Mowaffak billah, and besieged Mosta'in at Baghdád. At the end of one month (A.H. 252, A.D. 866), Mosta'in surrendered, and was put to death.

13. Mo'tazz billáh, thus called to the throne by the very men who had previously sought to exclude him from it, resolved to free himself from the yoke of the formidable Turkish soldiery which thus made and unmade Caliphs. But to maintain a struggle against such terrible adversaries, the new sovereign would have needed an ability and energy which he did not possess. He made, indeed, a very impolitic beginning in getting rid of his brothers Mowayyad and Mowaffak, of whom he put the former to death, and drove the latter into exile. Some time after, it is true, he had the satisfaction of seeing Wasif, one of the chief of the Turkish soldiery, lose his life in a mutiny of his own troops, and that of defeating in person another chief, Bugha, whom he afterward caused to be beheaded. But in the following year (A.H. 254), the Turks chose as their leaders the sons of Wasif and Bugha, Sálih and Mohammed, who avenged their fathers by plundering the palace of the prime minister and besieging that of the Caliph, whom they seized and threw into close confinement, where he died of hunger and thirst, A.H. 255.

14. Immediately after the fall of Mo'tazz, the Turks brought from Baghdad one of the sons of Wathik billah, and proclaimed him Caliph, with the title of Mohtadi billah (Guided by God). Mohtadi, a man of noble and generous spirit, exerted himself, but in vain, to release his predecessor from prison. Having failed in this, he kept the vexatious measure of power which his masters left him, and applied it to the regeneration of Moslem society, the decay of which appeared to him imminent. He forbade wine and games of chance; he devoted much of his time to the administration of justice; he examined in person every sentence passed by the judges, and gave public audience to the people twice a week for the redress of their grievances. The farmers of the revenue were subjected to strict control, and the taxes were considerably lightened. It seemed as if these reforms were likely to re-establish order and prosperity in the empire. But Mohtadi came too late, and the Turks did not leave him time to finish his work. Sálih, one of the chiefs of the Turkish soldiery having been assassinated by a rival, Mohtadí punished the guilty person with rigour. The Turks, in their rage, besieged the palace and slaughtered the unfortunate Caliph (A.H. 256, A.D. 870).

15. Whether from weariness, or from repentance, the Turkish soldiery discontinued for a time their hateful excesses. A son of Motawakkil was brought out of prison to succeed his cousin, and reigned for twenty-two years under the name of Mo'tamid 'ala 'llah (He whose support is God). During his reign two great events took place, tokens and precursors of the dissolution of the Caliphat Eastern Persia and Egypt separated themselves by for from the empire, and two new dynasties establish themselves in these countries, those respectively of t Saffárids and the Túlúnids. The founder of the form Ya'kúb b. Laith, was the son of a coppersmith (Saffá At the head of a band of resolute men, he invaded succes ively Khorásan, Kirmán, and Sijistán, and at last the Cali Mo'tamid, powerless to arrest his progress, was obliged give an official recognition to accomplished facts. B Ya'kub was not satisfied with this; he soon possess himself of Tabaristán, Fársistán, and Ahwáz, and then marched against Baghdád. Fortune, however, desert him, he was beaten in the neighbourhood of Wásit (A. 262), and compelled to return to Persia in order to levy new army there. In 265 he resumed his march again Baghdád, but was obliged by sickness to halt at Jond ábúr, where he died: not, however, till he had obtain from the Caliph a formal investiture of all the provinc he had conquered. He was succeeded by his broth 'Amr. On the other side, a certain Ahmed b. Túlún, t son of a freedman, who had obtained from the Caliph t post of governor of Egypt, planned the creation for himse of an independent kingdom. Under Mo'tamid he ev invaded Syria, and perhaps would have pushed his co quests still farther, had not death overtaken him in A. 270 (A.D. 883-884). His son Khomarúya succeeded hi in Egypt, and though, at a later period, he submitted pay tribute to Mo'tadid, nevertheless a dynasty had be founded in that country which lasted for twenty one yea longer. Mo'tamid died eight years after Ahmed b. Túlú

16. The reign of Mo'tadid billáh (He who seeks l support in God), who succeeded his uncle Mo'tamid, principally remarkable for the rise of the celebrated se of the Carmathians (Karámita), who for two centuries la waste the Moslem empire, and for the extinction of t Saffarid dynasty in Persia, where it was replaced by th of the Samanids. Some details respecting the origin a the creed of the Carmathians will be found in the thi section of this article. We shall content ourselves here wi stating the fact that these sectaries, who were numero in 'Irak, Syria, and Eastern Arabia, kept in check all t armies which were sent against them. Under the reign Mo'tadid they invaded Mecca and committed great ravag there. In A.H. 281, Mo'tadid repaired the disasters whi they had caused there, and raised important works abo the Kába. Mo'tadid died in 289 (A.D. 902), leavi the throne to his son Moktafí billáh.

17. Moktafí billáh (He who sufficeth himself in Go reigned for six years, during which he had constantly struggle against the Carmathians. One of his genera indeed, gained a signal victory over these sectaries; but, avenge their defeat, they lay in wait for a caravan whi was on its return from Mecca, and massacred twen thousand pilgrims. This horrible crime raised the wh of Arabia against them. The Carmathians were beat again, and Dhikruya one of their ablest generals, w taken and put to death. The sectaries remained quiet f some time, and the Caliph took advantage of this respi to take Egypt from the house of Túlún, and to confer i government on the Ikhshídites. Moktafí died A.H. 2 (A.D. 907-908). His activity and energy revived for moment the prestige of the Caliphate; but this fleeti renewal of its greatness was soon to disappear, and dec resumed its course.

18. The new Caliph, Moktadir billáh (Powerful throu God), was only thirteen years of age when he ascend the throne. His extreme youth prejudiced the people Baghdád against him; they rebelled, and swore allegian to 'Abdalláh, son of the former Caliph Mo'tazz; but t

arty of Moḳtadir prevailed, and his rival was put to eath. Moḳtadir, however, was too young to exercise ny real power; he was governed by his eunuchs. He was, esides, a man of feeble character, and looked on helpssly at the death-struggle of the empire, upon which alamities of every kind now poured in. The Greeks nvaded Mesopotamia. A truce was concluded with them, ut the Carmathians then recommenced their disorders in yria. The indolence of the Caliph, and his inaction in he face of this danger, alienated all hearts from him, and he eunuch Múnis, the principal chief of his party, took he lead in deposing him and proclaiming in his stead his rother Ḳáhir billáh (Victorious through God), in the ear 317 (A.D. 929-930). Kahir, however, having refused o distribute a donative to the army on the occasion of his ccession, a counter revolution took place, and Moktadir, who had been imprisoned, was taken from his dungeon nd replaced on the throne, only three days after his deosition. Favoured by these disturbances, the governor of Iosul, Násir al-Daula, declared himself independent, and ounded definitively the dynasty of the Hamdanits; thus ausing an additional dismemberment of the empire. The armathians in their turn, under the guidance of a new chief, Abu Táhir, obtained possession of Mecca, and carried off he celebrated black stone of the Ka'ba, which they did not estore till very long afterwards. Meanwhile the eunuch Múnis had been disgraced. He withdrew at first to Mosul, o the court of Násir al-Daula; but it was to raise an rmy and march upon Baghdad, where the Caliph had gain fixed his abode. The object of Munis was not to ttack the Caliph, but only to take vengeance on his ersonal enemies. Moḳtadir was induced by evil counellors to make a sally against Munis. His troops were ut to the rout, and he himself fell on the field of battle, n the year 320 (A.D. 932).

With the reign of Moḳtadir is connected one of the reatest events in the history of the Caliphate, the foundaion of the Fátimite dynasty, which reigned, first in the Maghrib and then in Egypt, for nearly three centuries. The first of this family who put forward any pretensions o the Caliphate was 'Obaid Allah, surnamed the Mahdi, or Messiah of the followers of 'Alí, who gave himself out as direct descendant of 'Alí, through his wife Fatima, the aughter of Mohammed, whence the name of Fatimite. It eems to be proved that 'Obaid Allah was really descended rom a certain 'Abdalláh b. Maimun el Kaddáh, the ounder of the Ismailian sect, of which the Carmathians were only a branch. This 'Obaid Allah had himself become pontiff of the Ismailians. As early as the Caliphate of Moktafí, one of 'Obaid Alláh's missionaries, named Abú 'Abdalláh, had succeeded in gaining numerous partisans in the province of Africa, then subject to the Aghlabites, and the victories of this missionary had wrested Eastern Africa from the family of Aghlab when Moḳtadir ascended the throne. 'Obaid Allah then repaired to his new realm (A.H. 303), and founded the city of Mahdíya, which he made his capital. He tried also, but without success, to seize Egypt, the conquest of that country was reserved for one of his successors, Mo'izz li-dín-illáh. 'Obaid Alláh died two years after Moktadir, leaving to his son Ḳáim an empire already sufficiently powerful to cause uneasiness to the 'Abbásids, to the Omayyads of Spain, and to all the Christian princes whose states bordered on the Mediterranean.

19. **Ḳáhir billáh**, on being raised anew to the throne after the death of his brother Moḳtadir, still bore ill will to his patrons, and tried to free himself from their guardianship. The emirs of his court dethroned him a second time and put out his eyes. One of his nephews was then proclaimed Caliph under the name of Rádí billáh (Content through God). This prince, who was entirely governed by those about his person, created in favour of a certain Abúbekr Mohammed b. Raïḳ, the office of Amír al Omará, or Emir of the Emirs, which nearly corresponds to that of Mayor of the Palace among the Franks.[1] The Amir al Omará was charged with the administration of civil and military affairs. He also acted as the Caliph's deputy in sacerdotal functions, and was named next after him in the public prayers. Thenceforth the Caliphate was no longer anything but an empty shadow. During the reigns of Kahir and Radi, the Carmathians became more audacious than ever. The Amir al Omará was obliged to purchase from them the freedom of pilgrimage to Mecca at the price of a disgraceful treaty. Thus the Caliphate found itself almost reduced to the province of Baghdad. Khorasan, Trans-oxiana, Kirman, and Persia were in the hands of independent sovereigns, the Samanids, the Buyids, and a prince named Wa-himgir. The Hamdanites possessed Mesopotamia, the Seljukites, Armenia. Egypt was under the rule of the Ikh-hidites, Arabia was held by the Carmathians; Africa, as we have seen, had become the prey of the Fatimites. The single transient success obtained by Radi was the capture of Mosul in A.H. 328 (A.D. 939-40), and even this success he owed to the Turk Bejkem, who had succeeded Mohammed b. Raïḳ as Amir al Omara.

Radi died in the following year, and was succeeded by Mottaḳi billáh (He who fears God). From his very accession, this prince saw himself exposed to the attacks of a certain Al-Baridí, who had carved out for himself a principality in Chaldea, and who now laid siege to Baghdad. Nasir al Daula, prince of Mosul, who had been reinstated in his government, offered an asylum to Mottaki, put his troops at his disposal, and succeeded in repelling Al-Baridí. In return he obtained the office of Amir al-Omará. But there were other competitors for that post. Turun, a former lieutenant of Bejkem, protested sword in hand against the choice of the Caliph, and threatened Baghdad. Ikh-hid, sovereign of Egypt, offered Mottaki a retreat in his state, but Turun, fearing to see the Caliph obtain such powerful support, found means to entice him to his tent, and had his eyes put out, A.H. 330 (A.D. 941-942).

As successor to Mottaki, Turun chose Mostakfi billah (He who places his whole trust in God). This prince, like his predecessors, was a mere puppet in the hands of his ministers. A new Amir al Omara, Zirak b. Shirzad, made himself so hateful to the people of Baghdad by his deeds of violence and rapacity that they besought the help of the Buyid Ahmed, the third prince of that dynasty, entered Baghdad, overthrew Zirak, and took his place under the title of Mo'izz al Daula. Mostakfi soon had enough of this new master, and ventured to conspire against him. The plot was discovered, and Mo'izz al-Daula had the eyes of the Caliph put out. There were now at Baghdad three Caliphs who had been dethroned and blinded, Kahir, Mottaki, and Mostakfi. Mo'izz al Daula thought for a moment of restoring the illusory title of Caliph to the descendant of 'Ali. He feared, however, lest this should lead to the recovery by the Caliphs of their former supremacy, and his choice fell on a son of Moktadir under the name of Moti' billah (He who obeys God). Reserving to himself all the power and revenues of the Caliph, he allowed Moti' merely a secretary and a moderate pension. The prince of Mosul, who began to think his possessions threatened by the neighbourhood of Mo'izz, entered on a struggle with him and tried to wrest Baghdad from him; but he failed, and was obliged to

[1] See Defremery, *Mémoire sur les Emirs al Omara*. Paris, 1848.

subnit to the payment of tribute. We have said above that Mo'izz al Dawla professed a great veneration for the house of 'Alí. His preference showed itself in public acts. He caused the most terrible imprecations against the Omayyads to be posted up at the doors of the mosques. This tep nitated men's minds; and a general insurrection was imminent at Baghdad, when Mo'izz died (A.H. 356), leaving his power to his son 'Izz al Dawla.

While the 'Abbasid family was thus dying out in shame and degradation, the Fatimites, in the person of Mo'izz li-dín-illáh, were reaching the highest degree of power and lustre (see DEAZY, vol. vii. p. 750 *sqq.*). Jauhar, a general of Mo'izz li-dín-illáh, conquered Egypt for his master, and Arabia acknowledged the sovereignty of the Fatimite. The Carmathians, who had so long contended against the 'Abbasids, now came to better terms with Moti', and their general made the Caliph the offer of driving back the Fatimites, on condition of his grandson in the government of Egypt. Moti' preferred to stand neutral in the struggle; and the Carmathian general, who with the support of Moti' might perhaps have triumphed over Mo'izz, was beaten by his powerful rival. Moti', having been struck by paralysis, was obliged to abdicate in the year 363 (A.D. 973-974), and left the empty title of Caliph to his son Tá' li-amr-illáh (Obedient to the command of God). The new Caliph lived at first in peace, for it was now the office of Amír al Omará which provoked ill will. Under the reign of Tá' the Buyid princes contended furiously with one another for the office of Emir, and one of them, 'Adod al Dawla, having conquered 'Izz al Dawla, took the title, never before employed, of Shahin-shah, or king of kings. On his death he transmitted his office to his three sons, who held it successively, under the name of Sham al Dawla, Sharaf al Dawla, and Baha al Dawla. The last, who was as avaricious as he was ambitious, took offence at the Caliph Tá' for having disposed of certain sums of money, of which he wished to reserve the management to himself, compelled him to abdicate in A.H. 381, and replaced him by a grandson of Moktadir, who took the name of Kadir billah (Powerful through God), and reigned forty one years under the tutelage of the Búyids. Meanwhile events were preparing the fall of the Buyids. In Persia, Mahmud of Ghazni was founding the powerful empire of the Ghaznevids, which extended to the Indus, and the Seljuk Turks were already invading Khorasan. It was under the successor of Kadir billah that that sanguinary revolution took place, which was to give over the government of Baghdad to the Seljúks.

Kadir billah died in A.H. 422 (A.D. 1030-31), and was succeeded by Kaim bi-amr-illah (He who is charged with the business of God). The new Caliph, groaning under the iron hand of his Amír al Omará, called to his aid the Seljuk Toghrul Beg, who entered Baghdad in the month of Ramadan in the year 447 (A.D. 1055-1056), overthrew the Buyids, and took their place. Some years later, Toghrul married the daughter of the Caliph. At his death Toghril left to his nephew Alp Arslan the title of sultan, a flourishing empire, and unconfirmed power. Under Kaim, he enjoyed the Caliphate in peace under the tutelage of Alp Arslan and of his successor Malik Shah, till his death in A.H. 467. His grandson, Moktadi bi-amr-illah (He who obeys the orders of God), who succeeded him, owed to the power of Malik Shah the honour of recovering his supremacy in Arabia. At Medina and Mecca his name was substituted in the public prayers for those of the Fátimite Caliphs. This was, after all, a mere gratification to his vanity, for Malik Shah was the real sovereign, and the Caliph thought himself highly honoured in marrying the daughter of his powerful patron. This union, however, far from drawing closer the bonds of friendship between Malik Shah and Moktadí, became on the contrary a cause of strife. The Caliph having put away his wife, who had wearied him by her peevish humours, was compelled by Malik Shah to appoint the child whom he had had by her as his successor to the prejudice of his eldest son. Malik Shah also exiled his son in law to Basra. Just, however, as this order was about to be carried out, Malik Shah died. Moktadi survived him only a few months. It was during the reign of his successor Mostazhir billáh (A.H. 487-512) that the first crusade took place. We need not here enter into the details of those wars. It is sufficient to say that from the date of the first crusade Baghdád ceases, so to speak, to have any special history. The successors of Mostazhir billah (He who seeks to triumph through God) were Mostarshid billah (He who asks guidance from God) (A.H. 512-529); Rashid billáh (Just through God), A.H. 529-530, Moktafi l-amr illáh (He who follows the orders of God), A.H. 530-555; Mostanjid billah (He who invokes help from God), A.H. 555-566; and Mostadí' bi-amr-illáh (He who seeks enlightenment in the orders of God), A.H. 566-575. Under the last, the Fátimite dynasty was at length destroyed, and Egypt fell again under the spiritual authority of the Caliphs of Baghdád. It was one of the generals of the Emir Núr al dín, the celebrated Saláh al-dín (Saladin), who made this important conquest in A.H. 567 (A.D. 1171-1172). He maintained himself in Egypt as Sultan, founded a new dynasty, that of the Ayyúbites, and in some sort compelled Násir li-dín-illáh (He who helps the religion of God), the successor of Mostadí' (A.H. 575-622), to acknowledge his title and to ratify his usurpation.

A still more formidable danger was now threatening Baghdad. The terrible Jinghíz Khán was issuing from the depths of Asia at the head of his Mongols, and was beginning to invade Transoxiana. Under Násir li-dín-illáh's successors, Zahir billah (Victorious through God) (A.H. 622-623), and Mostansir billáh (He who asks help from God), A.H. 623-640, the Mongol invasion advanced with immense strides; and when, after them, Mosta'sim billáh (He who seeks his defence in God) was named Caliph in the year 640 (A.D. 1242-1243), the last days of the Caliphate had arrived. Hulágu, who was then sovereign of the Mongols, determined to make himself master of the whole of Western Asia. He placed himself at the head of his immense hordes, swept everything before him on his march, and arrived under the walls of Baghdád. In vain did Mo'tasim sue for peace. The siege was actively pursued, and on the 29th of Moharram 656 (5th February 1258), the Mongols forced their way into Baghdad and planted the standard of Hulágu on the highest of its towers. The city was given up to fire and slaughter; Mo'tasim was thrown into prison, and died there a few days after; and with him expired the Eastern Caliphate, which had lasted 626 years, from the death of Mohammed.

In vain, three years later, did a scion of the race of the 'Abbasids, who had taken refuge in Egypt, make an effort to restore a dynasty which was now for ever extinct. At the head of a few followers, he marched against Baghdád but was repulsed by the governor of that city, and died fighting. At a later period, another descendant of the 'Abbasids also sought an asylum in Egypt. The Sultan Baibars, after a judicial investigation of his origin, proclaimed him Caliph under the name of Hákim bi-amr-illáh. His sons inherited this empty title, but, like their father, remained in Egypt, without power or influence. The shadow of sovereignty continued to exist till the conquest of Egypt by the Turks.

LOGICAL TABLE OF THE 'ABBÁSID CALIPHS DOWN TO THE FALL OF BAGHDÁD.

'Abbás.
'Abdalláh.
'Alí.
Mohammed.

Ibráhím. 1. Abú 'l-'Abbás. 2. Mansúr.
3. Mahdí
4. Hádí. 5. Hárún al-Rashíd
6. Amín. 7. Ma'mún. 8. Mo'tasim
Mohammed. 9. Wáthik. 10. Mot
12. Mosta'ín. 14. Mohtadí
affák. 11. Montasir. 15. Mo'tamid. 13. Motadid
o'tadid.
áhir. 18. Moktadir. 17. Moktafí
22. Mo'takfí
Ishák. 23. Motí'. 21. Mottakí. 20. Radí
24. Tá'i'.
25. Kádir.
26. Káim.
hammed Dhakhírat al-Dín.
27. Moktadí.
28. Mostazhir.
Moktafí. 29. Mostarshid.
Mostanjid. 30. Ráshid.
Mostadí'.
Násir.
Záhir.
Mostansir.
Mosta'sim.

III.—SKETCH OF THE INSTITUTIONS AND CIVILIZATION OF THE EASTERN CALIPHATE.

hammed had begun to bestow political unity on Arabia, e had done still more: he had given her the Koran, starting-point and base of the future civilization of . It was for the preservation and the better understanding of the sacred text that the first believers were create grammar and lexicography, and to make collh of the poems of their own and former times, those esses of the meaning of words," as the Arabs call To elucidate questions of dogma they created gy. Jurisprudence, in like manner, issued from the n, and the historical sciences at first gathered around As early as the first century of the Flight, schools founded in 'Iráḳ, at Baṣra and at Cufa, in which all uestions to which the study of the Koran gave rise stated, and answered in different ways. Natural e and mathematics were less directly concerned with acred book, and were consequently neglected during whole period of the Omayyad dynasty. They only to be cultivated when, under the 'Abbásids, the study of philosophy led to the use of translations from the Greek. The institutions of Islam were developed, no doubt, as new wants made themselves felt, in proportion to the extension of the empire, but they were nevertheless founded on the first arrangements made by the Prophet and handed down by him in the Koran.

Under the first four Caliphs these institutions continued in a rudimentary state. The Caliph (*Khalífa*, substitute or successor) was elected by the Moslem community and, after receiving from all its members the oath of fidelity (*Bai'a*) which they were bound to take, united the temporal and spiritual powers in his own hand. He was at the same time high priest, ruler and judge. He was compelled, however, by the very extent of the empire to delegate his powers to these agents (*Amil*, plural *'Ommal*) whom he commissioned to represent him in the provinces. The State revenues, which entered the public treasury (*Bait al mál*), were composed (1) of the tithe, or tax for the poor (*Zakát*), which every Moslem was bound to pay; (2) of the fifth, raised on all booty taken in war, the rest being divided among the warriors; (3) of the poll tax (*Jizya*) and the land tax (*Kharáj*), which only affected non-Moslem subjects. The Caliph administered the revenues of the State at his own pleasure, applying them to the necessities of war, to public works, to the payment of officials, to the support of the poor, and to the distribution of the annual pensions, in which every Moslem had originally a right to share. The State could possess landed property. Under 'Omar I. we find that the pasture land belonging to the State supported not less than forty thousand camels and horses. To 'Omar I. was due the regulation of the poll tax by a fixed scale. The rich, whether Christians or Jews, paid four dinars (about thirty two shillings) yearly; people of the middle class, two dinars; the poor, one dinar. Besides the payment in money, the subject races had to make contributions in kind, intended for the support of the troops. The land tax consisted of a general rent in proportion to the extent, character, and fertility of the lands possessed by the conquered.

As the sums produced by these different imposts were often very considerable, it became necessary, as early as the Caliphate of 'Omar I., to create a special office charged with the account of their expenditure. This organization was borrowed by Omar from the Persians, and it retained its Persian name of Diwan, a term afterwards applied to all government offices. The Arabs, at that time being too illiterate for such employment, the task of keeping the registers of the Diwan was entrusted to Greeks, Copts, and Persians. 'Omar also gave his attention to the apportionment of the individual pensions of the Faithful. Every one received a larger or smaller sum according to the greater or less nearness of his connexion with the family, or the tribe, of the Prophet. Thus 'Aïsha, who had been the favourite wife of Mohammed, received every year a pension of twelve thousand dirhems,[1] the other widows of the Prophet only received ten thousand. The Hashimites and Mottalibites, that is members of the Prophet's family, also received ten thousand dirhems. The Emigrants and the Defenders, those citizens of Mecca and Medina who had been the first to embrace Islám, had five thousand dirhems, and that was the sum which 'Omar I. allotted to himself. For every other Moslem of full age, the pension varied from 1000 to 300 dirhems. We can easily understand what an influence the hope of this pension must have exerted on the conquered races, and how much it must

[1] The dirhem was equivalent to one franc.

[2] His moderation was not imitated by his successor, 'Othman, who made it his principal object to enrich all the members of his own family at the expense of the rest of the Moslems.

have contributed to their conversion. On accepting Islam they acquired a right to the pension, besides ceasing to pay the land tax and the poll tax.

Even in the earliest days of Islam the Arabs were not entirely devoid of military skill. Many of their tribes had been brought into relations with the Greeks and Persians, and had acquired from them some ideas of the art of war. Thus, in the time of Mohammed, the division of an army into a centre, right and left wings, vanguard and rear-guard, was understood, and the art of defending a camp or a city by entrenchments was also known. The Arabs fought on foot, on horseback, and mounted on camels. The arms of the infantry consisted of a spear, a sword, and a shield, and sometimes also of bow and arrow. The horsemen fought chiefly with the lance. For defensive arms, besides the shield, the Arab were acquainted with the helmet, the coat of mail, and the cuirass of leather covered with plates of iron. It was not till the period of the Omayyads that they began to employ military engines, such as the balista. The army was divided by tribes; and each tribe had its flag which consisted of a piece of cloth fastened to a lance. As regards the recruiting of their armies, every man able to carry arms was originally bound to render military service. 'Omar I., to whom Islam owes so many of its institutions, was the first to divide his armies into distinct corps, and to assign to each corps a fixed station. These stations were the province of Cufa, that of Basra, and afterwards the provinces of Emesa, of the Jordan, and of Palestine. These provinces afterwards became military colonies, all the inhabitants of which were bound to render military service, as distinguished from the other provinces, where service was optional, or at all events regulated by the necessities of the moment.

With the accession of Mo'awiya I. to the supreme power, the mechanism of the State was modified and became more complicated. Mo'awiya endeavoured to copy the ceremonial of foreign courts. He built himself a palace at Damascus, and set up a throne in the audience-chamber, the door of which was kept by a chamberlain (*Hajib*). When he attended the service at the mosque he occupied a choice pew with a gratuity in front (*Maksura*). When he left his palace, he was surrounded by a bodyguard (*Shorta*), commanded by a provost (*Sahib al Shorta*). Lastly, in the course of his own lifetime, he caused his son Yazid to be acknowledged as his heir-presumptive, and thus established the principle of hereditary succession, which was opposed to the spirit of Islam, and was the source of every kind of calamity. As regards the administration of the State, Mo'awiya acted at his own will and pleasure. Thus, in order to secure the service of 'Amr b. al 'As, the conqueror of Egypt, he gave up to him the revenues of that province, a part of which ought to have gone to the State. He also took an important step with regard to the annual pensions of the Beit-al-Mal, which he reduced by about two and a half per cent. The administration of the public funds in the different provinces was left to their Prefects, who were expected to pay into the public treasury only the surplus of their respective revenues. The empire had been at first divided into ten provinces: 1. Syria (subdivided into four *Jund*, or military districts); 2. Cufa, with Arabian 'Irák and Persian 'Irák; 3. Basra with Persia, Sijistán, Khorasan, Bahrain, and 'Omán; 4. Armenia; 5. Mecca; 6. Medina; 7. The Indian Marches; 8. Africa; 9. Egypt; 10. Yemen. Mo'awiya, however, subsequently thought proper to make Khorasán a separate province. Under his successors, and according to the necessities of the moment, it was sometimes reunited to the government of 'Irák. In 'Irák itself, Mo'awiya joined Basra and its dependencies to Cufa.

Under Mo'awiya the Prefects had the most extensive civil and military powers. They had even the right of the direct appointment of their Sub-Prefects. Mo'awiya, notwithstanding, thought it advisable to disconnect from their powers the offices of Judge (*Kádí*) and of Religious Official (*Imám*), which were entrusted to special functionaries named directly by the Caliph. The Caliph was, however, always at liberty to modify these arrangements at his own pleasure. Under the successors of Mo'awiya, we find certain Prefects invested at the same time with the dignities of Cadi and Imám.

It was also to Mo'awiya that the State owed the creation of a Chancery (Diwán al akhtám, or Seals-office), in which all decrees proceeding from the Caliph were registered; so that, when once issued, these decrees could not be falsified. Mo'awiya also exerted himself to ensure rapidity of communication throughout the empire, by instituting the courier post (*Barid*), in imitation of the post of the Persians and Byzantines.

After Mo'awiya we must come down to the time of 'Abd al Melik to meet with any important innovations in Moslem institutions. Before the reign of that Caliph the books of the public offices were kept by Christians and Persians, and drawn up in Greek and Persian. 'Abd al Melik ordered the exclusive employment of the Arabic language, and substituted Moslems for all the Christian and Persian clerks in the government offices. It was this same Caliph who founded the monetary system of Islam, and who was the first to strike dinárs (pieces of gold worth about ten francs), and dirhems (pieces of silver worth about a franc), with legends in Arabic. The postal system was also very much improved and developed under this prince. 'Abd al Melik was powerfully seconded by the famous Hajjáj, who was able to re-establish in 'Irák the disputed principle of obligatory military service, and who also succeeded, by skilful management, in raising the condition of agriculture in that province. Walíd, the successor of 'Abd al Melik, especially distinguished himself by the foundation of religious institutions. In his reign the mosque of Damascus, half of which had hitherto remained in the hands of the Christians, was appropriated exclusively to the Moslems, and considerably embellished. Hospitals were also established for lepers, the poor, the blind, and the sick. The pious 'Omar II. devoted all his efforts to the embellishment of the mosque of Damascus. An edict of 'Omar I. had forbidden Moslems to acquire landed property, agriculture being considered an occupation unworthy of a free man. This law had fallen into disuse; but 'Omar II. put it in force again, and declared null and void every purchase of land made by a Moslem subsequently to A.H. 100. The effects of this law might have been fatal to the empire; but it again became obsolete under the Caliphate of Hishám.

At the accession of the 'Abbásids the centre of the empire was displaced. Damascus fell from the rank of its capital to that of a provincial town; while Baghdád, a small and unknown village, became the mistress of the world. Under the first 'Abbásid the empire—not including the province of Baghdád—was divided as follows:—1. The province of Cufa. 2. The province of Basra, with the district of the Tigris, Bahrain and 'Omán; 3. Hijáz and Yaffamet. 4. Yemen. 5. Ahwáz; 6. Fársistán; 7. Khorásán. 8. The province of Mosul; 9. Mesopotamia, with Armenia and Azerbaijan; 10. Syria; 11. Egypt and the province of Africa (Spain being a dependency of Africa); 12. Sind. Al-Saffah afterwards made Palestine a distinct province, and separated Armenia and Azerbaijan from Mesopotamia. Still later, Hárún al Rashíd created a new province to the north of Syria, which received the name of 'Awásim. Each newly-conquered province was always united to that one of the older provinces to which it was nearest.

Simultaneously with the accession of the 'Abbásids, Persian influence began to preponderate. The Persian, Khálid b. Barmak, was entrusted with the administration f the finances (*Díwán al-Kharáj*) by As-Saffáh, who was lso the first Caliph who transferred the burden of public ffairs from himself to a Prime Minister (*Wazir*, whence, n European languages, the term *Vizier*). The title of Vazír was unknown to the Omayyads. The office of Prime Minister was of Persian origin. It existed till the ime of the Caliph Rádí, when that of Amír al Omará vas substituted for it. When the Caliphs had fallen nder the tutelage of the Búyids, it was the latter who hose Viziers, leaving to the Caliphs only Secretaries *Rayis al Rawasí*). Under the Seljuk Sultans the Caliphs vere again permitted to choose their own Viziers.

The institution of the office of Vizier was not the least mong the causes of the decadence of the Eastern Caliphate The 'Abbásids gradually became unaccustomed to the xercise of power and the management of affairs, and thus ost all direct influence over their subjects. Besides the Minister of Finance and the Vizier, the 'Abbásid created nother important office, that of Postmaster General (*Sahib l-Baríd*), whose duty it was to collect at a central office ll the information which arrived from the provinces and o transmit it to the Prime Minister. Thus the administrative services were greatly extended under the 'Abbásid They were subdivided as follows: 1. *Diwan al Kharaj*, or Ministry of Finance; 2. *Diwán al-Diyá'*, or Bureau of State property; 3. *Diwan al-Zimám*, Registry Office or Exchequer Office; 4. *Diwan al Jund*, or Ministry of War; 5. *Nazar al-Mazálim*, or Court of Appeal; 6. *Diwan al Mawáli wal-Ghilmán*, or Bureau of the freedmen and slaves of the Caliphs; 7. *Diwan Zimam al Nafakat*, or Office of Expenditure; 8. *Diwan al Barid*, or Office of the Posts; 9. *Diwán al-Rasáil*, or Office of Correspondence; 10. *Diwán al Tauki'*, or Office of the Imperial Seal, and of the registration of official documents. There were also offices for the despatch and reception of official documents, and for the inspection of weights and measures.

We cannot better conclude this brief summary of the institutions of the Caliphate than by giving a sketch of the organization of the State, according to the Moslem authors themselves.

The supreme chief received the title of Caliph, or of Commander of the Faithful (Amír al Mo'minín). He united in his own person all the powers of the State; his Ministers and all public functionaries acted only by virtue of a commission from him. They, like all other Moslems, were at the mercy of the Caliph, who had power of life and death over them. As spiritual chief, the Caliph was also the supreme judge in question of dogma. In theory he held his powers by the free choice of the majority of Moslems; but, when he had once received their oath of allegiance, he became their absolute master. The condition of eligibility to the Caliphate was to belong to the tribe of Koraish. In Moslem belief, the subjects of the Caliph owed him obedience and aid so long as he should fulfil his duties with exactness. These consisted in maintaining the principles of religion, in administering justice scrupulously, in defending the territory and assuring its safety, in carrying on war for the subjugation of the infidels, and in spending the public revenue in conformity to the law. If the Caliph failed in the performance of his duty, rebellion against him became lawful.

The Ministers might be absolute or dependent. If dependent, they simply executed the orders of their sovereign. If absolute, they took his place, and exercised all the powers of a Caliph except that they could not, at least in theory, designate any successor to the reigning Caliph. It was only to the Caliph himself that they were responsible for their actions.

The Prefects, when once appointed, whether by the Caliph or the Vizier, became so many petty sovereigns and, legally, owed an account of their actions only to the Caliph, or to his Prime Minister, when the latter was absolute.

The Generals were appointed either by the Caliph or by the Vizier, or lastly by the Prefect, when only a local war was in question. They were sometimes invested with very extensive powers, such as those of concluding treaties of peace, of administering justice, and of dividing the booty. The General, in his turn, appointed the officers (*Wukalá*) and under officers (*Uzzás*). It was a general order that infidels, before hostilities against them were opened, should be summoned to embrace the faith, or to submit by capitulation. The conversion of infidels was valid, even when effected sword in hand on the field of battle, and the new convert became inviolable in person and property. On the other hand, every infidel taken prisoner was sold as a slave, with his wife and children. He might even be put to death. Apostates were never to be spared, they were put to death, and their property confiscated.

Justice was administered by Cadis, appointed either by the Caliph, by the Vizier, or by the Prefect. To be eligible as a Cadi (*Kadi*), it was requisite that a man should be 1. A male and of respectable age; 2. In full possession of his mental and physical faculties; 3. A freeman; 4. A Moslem; 5. Of good moral character; 6. Acquainted with the principles of the law and their application. The duties of the Cadi were to examine into the disputes and law suits brought before him, to enforce the execution of his judgments, to name judicial commissioners to the administration of the goods of minors, madmen, etc., to administer the mortmain property of mosques and schools, (*wakf*, plural *awkaf*), to watch over the execution of wills, to inflict due legal penalties on those guilty of crimes or misdemeanours,[1] and to inspect the highways and public building. When any locality possessed no Imam, or public officiator at the mosque, it was the Cadi who performed this duty. The assistants of the Cadi were Notaries (*Shohud*), Secretaries (*Ouaama*), and Deputies (*Naiyibun*). If the Cadi died, his subordinates lost their offices *ipso facto*. On the other hand, the death of the Caliph did not nullify the powers of the Cadi, but it was necessary that he should be confirmed by the new sovereign.

The Court of Appeal (*Nazar al Mazalim*) was instituted to take cognizance of those cases in which the parties concerned appealed from the judgment of the Cadi. The sittings of this court were presided over by the Caliph in person. It was established by the Omayyad 'Abd al Melik. The last Caliph who sat in public to examine appeal cases was Mohtadi. After him a special judge was appointed to the function of president of the Court of Appeal.

Besides the Judges there were Inspectors (*Mohtasib*) charged with the police of the markets and the care of morals. The Mohtasib's duty was to take care that weights and measures were not falsified, and that buyers were not deceived as to the quality of the goods sold. He had the power of inflicting summary punishment on delinquents, but only in the case of flagrant offences. If the person charged denied the facts, he was to be brought before the Cadi. As regards morals, the Mohtasib took care that widows and divorced women should not remarry before the expiration of the legal period prescribed by the

[1] The principal offences were apostasy, neglect of religious duties, refusal to pay taxes, theft, adultery, outrages, and murder. The penalties were imprisonment, fines, corporal punishment, and death

oran. Slaves and beasts of burden were placed under is guardianship, and he protected them from ill-treatment n the part of their masters. The Mohtasib was also ommissioned to prevent public scandals, such as the sale f wine; to forbid Christians and Jews from building onses higher than those of the Faithful; and to enforce heir wearing on their dress a distinctive mark (*Ghiyár*).

Besides the offices already described, there existed three ther which require mention those of the Marshals of he Nobility (*Vikalat al Ashráf*), of the Imams, and of the mir of the Pilgrimage.

The Marshals of the Nobility were appointed in the ifferent provinces either by the Caliph, by his representative, or by the Grand Marshal. Their functions were o superintend the descendants of the family of the rophet, who formed the nobility of Islam, and to keep a egister of all the births and deaths which occurred in the amilies of the members of this nobility. In every province there were two Marshals, one for the family of 'Alí, he other for the 'Abbasides.

The duty of the Imam was to recite the public prayers n the mosque. He was appointed by the Caliph or his epresentatives, and chose in his turn his *Moeddhdhins*, who called the faithful to prayer from the tops of the minarets. In the Friday prayers it was the duty of the mam to invoke publicly the blessings of Heaven on the eigning Caliph.

The leadership of the yearly pilgrimage to the temple of Mecca was considered a great honour. It was almost always the Caliph himself or one of his near relatives who assumed the function of Amír al-Hajj. The duties of this leader of the pilgrimage were: 1. To escort the pilgrims in safety on their journeys to Mecca and back; 2. To direct the religious ceremonies during the sojourn of the pilgrims at the Holy City.

Such, briefly stated, was the organization of the Moslem State. Let us now say a few words on its religion.

We need not now recur to the object of the doctrines of Mohammed, which are treated of in their own place; but it is important to show what they became after the time of the Prophet, and what movements they aroused in Islam. The diversity of the conquered races was of itself sufficient to introduce, in the course of ages, serious modifications of the earlier religion.

But, from the very first, the Koran contained within itself the germs of discord. As long as men were content to adopt its teachings without discussion, orthodoxy might boast of maintaining itself unbroken. But as soon as they ought to examine deeply into its meaning, difficulties arose, which necessarily led the strongest minds into doubt and uncertainty. In particular, the conception of God, predestination, and free will, as presented by the

nearly as the first century of the Flight a theological school was founded at Basra, the most renowned master of which, Hasan al Basri, introduced the critical study of dogmas. His disciples, who were for the most part Persians, could not fail soon to discover that the Koran often contradicted itself, and especially that it left many dogmatic difficulties unresolved. One of the disciples of Hasan, Wasil b. 'Ata, set forth his scruples publicly, departing on three points from the orthodox doctrine. The Koran affirms the attributes of God, Wasil b. 'Ata denied them; because, he says, if the attributes of God are eternal, they constitute in some sort so many deities. We ought not therefore to affirm the existence of an attribute, that of justice, for example, but simply to affirm that God is essentially just. The Koran admits the doctrine of predestination; Wásil rejected it, as incompatible with the theory of rewards and punishments in another life, which presumes absolute free-will in man. The Koran speaks only of paradise and hell; Wásil admitted a purgatory. The sect founded by Wásil received the name of Mo'tazilite (dissident), or Kadarite, that is to say, which recognizes in man a power (*Kadar*) over his own actions. Another sect, that of the Jabarites (Partisans of *constraint*) agreed with the Mo'tazilites on the question of the attributes, but were diametrically opposed to them on that of free will. The Jabarites denied to man the slightest share in his own actions, and believed the very smallest actions of men to be the effect of predestination. The Koran, not concerning itself with the contradiction involved, admits at the same time the responsibility of man and the absolute predestination of his actions. The Jabarites rejected all responsibility, and believed that man is predestined from all eternity to paradise or to hell, for no other reason than that God has so willed it. A third sect, that of the Sifatites (Partisans of the *Attributes*), contended energetically against the two former. Keeping to the text of the sacred book, they alleged, for example, that when it is said in the Koran that God is *seated* on his throne, the expression must be taken literally. They thus fell into the grossest anthropomorphism, a doctrine which was very far from the ideas of Mohammed. In the face of these heterodox sects, the orthodox made but a poor figure. Rejecting, in the commentaries on the Koran, the explanations alike of the Mo'tazilites, of the Jabarites, and of the Sifatites, but acknowledging their inability to refute them systematically, they merely opposed to them a declaration that the Koran was neither to be explained allegorically nor always taken literally; and they concluded that, where two contradictory expressions could not be reconciled, a mystery must be admitted to exist, which it would be vain to attempt to fathom. But they did not always keep within the limits of discussion. Under the reign of 'Abd al Melik they succeeded in bringing about a persecution of the sectaries.

The Mo'tazilites, the Jabarites, and the Sifatites were dangerous only to the Church. Other sects arose, which put the State itself in peril. It will be remembered that at the time of the dispute between 'Alí and Mo'áwiya twelve thousand of the partisans of the former deserted him. These revolters, or Khárijites, originated one of the most formidable sects which ever existed in Islam. The Khárijites rejected in principle the Caliphate and the Imámate. At all events, they did not acknowledge the exclusive right of the Koraish to the Caliphate, but declared that, if it was absolutely necessary to elect a Caliph, his origin was of little consequence, provided he fulfilled his duties conscientiously and exactly. We have seen for what a length of time they kept the Omayyades in check. When they had been put down in Asia, they passed into Africa, and there made numerous proselytes among the Berbers, disposed as these were, by their independent character, to adopt with enthusiasm the principle of anarchy. The most terrible, however, of the militant sects which were formed in the bosom of Islam was that of the Shí'ites. Originally the Shí'ites were simply the partisans of 'Alí and of his descendants. In the course of time, when the whole of Persia had adopted the cause of the family of 'Alí, Shí'ism became the receptacle of all the religious ideas of the Persians, and Dualism, Gnosticism, and Manicheism, were to be seen reflected in it. Even in the lifetime of 'Alí, a converted Jew, named 'Abdallah b. Saba, had striven to introduce foreign elements into Islam. Thus, he alleged that 'Alí was to be adored as an incarnation of the Deity. These ideas, though rejected with horror by 'Alí himself, and by the greater part of the first Shí'ites, gradually made way; and all the direct descendants of 'Alí became veritable deities

the eyes of their respective partisans. A further distinction between the Shí'ites and other sects is, that they introduced the practice of giving the Koran an allegorical interpretation. This system permitted them to see in the sacred book whatever meaning they chose, and was carried out at a later date, as we shall see, by the founder of the Ismailian sect.

Under the 'Abbásids it seemed for a moment that the Shí'ite doctrines were about to triumph. We know, in fact, that the founder of that dynasty gave himself out as the heir of the house of 'Alí. But reasons of State prevailed, and the 'Abbásids, false to their first professions, on the whole supported orthodoxy. Under them reign were established the four orthodox sects Malikite, Hanafite, Shá fi'ite, and Hanbalite, which even at this day divide between them the whole Moslem world. They are named after their founders Malik, Abu Hanifa, Shafi'i, and Ibn Hanbal. These sects only differ from each other on a few points of civil and religious jurisprudence. They agree on questions of dogma. It was not, however, without difficulty that orthodoxy succeeded in obtaining the victory. Under Ma'mún and other Caliphs several doctors, as we have seen, were persecuted for believing that the Koran was the uncreated word of God. From the time of Motawakkil, however, orthodoxy remained the upper hand. Still, this reaction would not have lasted long, in face of the advance in science which marked the accession of Ma'mún to power, if the orthodox had had no other defensive weapons than material force and the assent of the majority. As philosophy made its way in Islam, thanks to the translations from Greek authors, which were made principally during the Caliphate of Ma'mun, it called forth in men's minds a movement of scientific curiosity which might have been fatal to orthodoxy. In the tenth century of our era a society of encyclopedists was formed at Basra, who, under the name of Ikhwan al Safa, or Brothers of Purity, put forth a number of very curious treatises, in which all sorts of physical and metaphysical questions were discussed and resolved in a scientific manner.[1] There is no doubt that these lucid and attractive writings would have led to a great religious revolution, if the orthodox had not understood the danger of their position, and applied themselves also to the study of philosophy, for the purpose of employing it in the service of the faith. It was thus that, towards the middle of the tenth century, a certain Abú 'l-Hasan al-Ash'arí, a descendant of that Abu Músá al-Ash'arí who had formerly acted the part of arbitrator in the dispute between Mo'áwiya and 'Alí, struck out a system in which religion appeared to be reconciled with philosophy; a system which was naturally sure to attract all commonplace minds—that is to say, the greater number. Ash'arism, or philosophic theology (Kalám), was adopted with enthusiasm by the triumphant orthodox doctors, and thenceforth pure philosophy and the heterodox sects ceased to extend their influence."[2]

The creation, however, of this philosophical theology had not done away with all dangers for orthodoxy. We have seen above that the Shí'a were divided into several sects, each holding for one of the direct descendants of 'Alí, and paying him the reverence due to a deity. One of these sects, called the Ismailian, because it acknowledged Ismá'íl, the seventh Imám or Pontiff of the posterity of 'Alí, as its chief, was the source of the greatest disorders in the Moslem empire, and was not far from being triumphant in Asia, as it was for a long time in Egypt. The Ismailians, like all the other Shí'ites, believed in the coming of a Messiah, whom they called the Mahdí, who, according to them, was one day to appear on earth in order to establish the reign of justice and equality, and to take vengeance on the oppressors of the family of 'Alí. They also believed in a God of far more elevated character than the God of the Koran, one who was unapproachable by human reason, and who had created the universe not directly, but by the intermediate action of a subordinate being, the Universal Reason, produced by an act of the divine will. The Universal Reason, in its turn, had produced the Universal Soul, which, on its part, had given birth to primitive Matter, to Space, and to Time. These five principles were the causes of the universe. Man, emanating from them, had a tendency to return towards his origin. The chief end of his being was to attain to perfect union with the Universal Reason.[3] But, left to himself, he would have been powerless to attain this end. The Universal Reason and the Universal Soul therefore became incarnate among men, in order to guide them and enlighten them. These incarnations were no other than the prophets in all ages, and, in the last period, the Imáms of the posterity of 'Alí. In the second half of the eighth century, a Persian, born in Su-tana and named 'Abdallah b. Maimun al Kaddah, nourished the dream of destroying Islam, and thought these doctrines, suitably modified, likely to be highly useful in carrying out his plans. He devised a system at once religious, philosophical, political, and social, in which, as he thought, all religions were to meet and mingle, but—and in this consisted the originality of his system—so graduated to suit different degrees of intelligence, that the whole world might become one vast Masonic association. The chief of the Ismailians, the Imam Ismá'íl, having died, 'Abdallah asserted that his son Mohammed b. Ismá'íl was to be hailed by him as the founder of this new religion, which was 'Abdallah's mission to announce to the world. Since the creation of the world, as 'Abdallah asserted, there had been six religious periods, each marked by an incarnation of the Universal Reason in the person of a prophet—Adam, Noah, Abraham, Moses, Jesus, and Mohammed had been the prophets of the six periods. Their mission had been to invite men to accept more and more perfect forms of religion. The seventh and last religion, and the most perfect of all, was that of Mohammed b. Ismá'íl, the Messiah. The Ismailians, as may be imagined, eagerly embraced the theories of 'Abdallah. In addressing the different sects and religions, 'Abdallah used special arguments with each. With the philosophers he dwelt on the philosophical principles of his doctrine. The conversion of Christians, Moslems, or Jews, was a more difficult task. 'Abdallah had established several degrees of initiation, and it was only by slow degrees, and with the most minute precautions, that he gained a mastery over the mind of the future proselyte. His curiosity was first aroused by allegorical interpretations of the Old Testament, the Gospels, and the Koran, and by proposing to him some problem which could not be solved by any of the existing religions. The solution of these problems was not to be given to him till he should have signed a paper and sworn never to reveal the mysteries with which he was made acquainted. If he took this pledge, he henceforward belonged, body and soul, to the sect, and lost his life if he made any attempt to withdraw himself from the authority of his chiefs.[4] The compact signed, the newly initiated disciple had to make a certain pecuniary sacrifice to swell the treasury of the sect. The secret

[1] The most important have been translated into German by Prof. Dieterici.

[2] See Houtsma, *De Strijd over het dogma in den Islám tot op al-Ash'ari*; and Snitta, *Zur Geschichte Abu 'l-Hasan al-As'ari's*.

[3] It need hardly be said that all these doctrines were derived from Gnosticism and from Neo-Platonism. See on the Ismailians Guyard, *Fragments relatifs à la doctrine des Ismaéliens*, and *Un maître des Assassins au temps de Saladin*.

ounded by 'Abdallah soon had a great number of members, and its missionaries spread themselves over the Moslem world. Towards 887 A.D. an Ismailian, Hamdán, urnamed Karmat, founded the branch sect of the Carmathians, whose exploits have been recorded above. The smailian preachers also made numerous proselytes in Africa and in Egypt; and in A.D. 909, 'Obaid Alláh, a descendant of the founder of the sect, but who passed as a member of the family of 'Ali, founded the Fatimite dynasty. Under the Fatimite Caliph Hakim, a new religion sprang out of Ismailism that of the Druses, so called from its inventor, a certain Darazi or Dorzi. This religion differs little from Ismailism, except that it introduces the dogma of the incarnation of God himself on earth, under the form of the Caliph Hakim. This heresy did not survive the reign of Hakim in Egypt. When the Fatimite Caliph Mostansir ascended the throne he re-established the Ismailian belief; and the Druses, driven from Egypt, took refuge in the Lebanon, where they still exist. As for the Egyptian Ismailians, they disappeared at the time of the conquest of that province by the pious and orthodox Ayyubite Saladin. This, however, was not a final deliverance of Islam from that formidable heresy. A hundred years before the return of Egypt to orthodoxy, a Persian named Hasan Sabbah, who had been initiated into Ismailism at Cairo, in the household of the Caliph Mostansir, had founded at Alamút, on the southern shores of the Caspian Sea, that Persian branch of the Ismailians known to all the world under the name of the Assassins, who held in check the most powerful princes of Islam, till they were destroyed by the Mongol invasion. From Persia, Hasan Sabbah succeeded in filling Syria with his Assassins, and every one knows the part they played during the Crusades. The Assassins of Syria have never entirely disappeared. Even at this day some are to be found in the Lebanon. There are also some representatives of the sect in Persia, in India, and even in Zanzibar; but since the 13th century they have become completely motionless.

To conclude this sketch of the development of religious beliefs, it remains to say a few words on one of the most remarkable manifestations of Islam its mysticism, or Sufism. In principle, mysticism is rather a mode of practising religion than a distinct religion, it depends on the character of the believer's mind, and adapts itself to all dogmas.[1] It is the especial tendency of tender and dreamy spirits. Thus among the Moslems it was a woman who is considered to have founded mysticism. This woman, named Rabi'a lived in the first century of the Hijra, and was buried at Jerusalem. Her doctrine was simply the theory of Divine love. She taught that God must be loved above all things, because he alone is worthy of love, and that everything here below must be sacrificed in the hope of one day attaining to union with God. These views were foreign to the Neo Platonic ideas respecting the union of the human intellect with the Universal Reason not to have any attraction for the Gnostics, who abounded in the Shi'ite sect. Mysticism therefore made great progress in Persia, and assumed the character of a sect towards the year 200 of the Hijra. A certain Abu Sa'id b. Abi'l Khair was the first who advised his disciples to forsake the world and enter on a monastic life, in order to devote themselves exclusively to meditation and contemplation; a practice which may very probably have been borrowed from India. The disciples of Abu Sa'id wore a garment of wool (*Suf*), whence they received the name of Súfis. Súfism spread more and more in Persia, and was enthusiastically embraced by those who wished to give themselves up undisturbed to philosophical speculation. Thus, under the colour of Súfism, opinions entirely subversive of the faith of Islam were professed. In its first form Súfism was quite compatible with Moslem dogma. It was satisfied to profess a contempt for life, and an exclusive love of God, and to extol ascetic practices, as the fittest means of procuring those states of ecstasy during which the soul was supposed to contemplate the Supreme Being face to face. But by degrees, thanks to the adepts whom it drew from the ranks of heterodoxy, Súfism departed from its original purpose, and entered on discussions respecting the Divine nature, which in some cases finally led to Pantheism. The principal argument of these Pantheistic Súfis was that God being one, the creation must make a part of his being; since otherwise it would exist externally to him and would form a principle distinct from him; which would be equivalent to looking on the universe as a deity opposed to God. In the reign of Moktadir, a Persian Súfi named Hallaj, who taught publicly that every man is God, was tortured and put to death. After this the Súfis showed more caution, and veiled their teachings under oratorical phrases. Moreover, it was not all the Súfis who pushed logical results so far as to assert that man is God. They maintained that God is all, but not that all is God. Súfis exist in Persia even in our own day.

It has been explained that, under the 'Abbásids, four orthodox sects were established, and that these sects differed among themselves principally with regard to jurisprudence. The law of Islam is one of its most original creations, and can only be compared in history with the development of Roman law. The laws laid down by Mohammed in the Koran might suffice for the Arabs as long as they were confined within the bounds of the peninsula. When their empire was extended beyond these limits, it was inevitable that this first code should become insufficient for their wants. As early as the time of the first four Caliphs it was necessary, in giving judgment on the new cases which presented themselves, to have recourse to analogy, and to draw inspiration from decisions given by Mohammed, but not recorded in the Koran. These first fountains, therefore, of law were, besides the sacred book the traditions of Mohammed, or *Hadith*, the collective body of which constitutes the *Sunna*, or custom. These traditions were for a long time preserved only in the memory of the companions of Mohammed, and of those to whom they had been orally communicated. But at the beginning of the second century of the Flight the need was felt of fixing tradition in writing; and it was at Medina that the first collection of them was made. It was due to the juri-consult Málik b. Anas. He rejected from his collection with the greatest care all traditions which appeared doubtful, and only preserved about seven hundred, which he arranged in the order of the subjects. To this collection he gave the name of *Mowatta*, or Beaten Path.[2] After him came the celebrated Bokhári, the compiler of the *Sahih*,[3] in which he brought together about seven thousand traditions, carefully chosen. The *Sahih* has continued to be the standard work on the subject of tradition.

The traditions did not always supply the means of deciding difficult causes. The first four Caliphs were often obliged to have recourse to their own judgment in the administration of justice. Their decisions (*Athár*) were also collected at Medina, and helped to swell the store of juridical matter.

[1] From *Hâshishin*, or eater of *Hashish* (hemp), that is, *Cannabis Indica*.

[2] See Guyard, "'Abd ar Razzak et son traité de la predestination et du libre arbitre," *Journ. asiat.*, Fev. Mar. 1873, Dozy, *Het Islamisme*, 2d Ed. 1880.

[3] Published at Tunis, in India, and at Cairo, A.H. 1280, with the commentary of Zarkání.

[4] Krehl's edition (Leyden) is still unfinished. An edition, fully vocalised, in 8 vols., appeared at Búlák, A.H. 1296.

In 'Iráḳ another school of law was formed, which is distinguished from that of Medina by a greater degree of independence. While the lawyers of Medina held strictly to the Koran, the traditions of the Prophet, and the Áthár, those of 'Iráḳ admitted, in addition to these, the deductive or analogical method (*Ḳiyás*), according to which it was lawful to create precedents, provided there was no departure from the spirit of the sacred book, from the traditions of the Prophet, or from the corresponding decisions of the first four Caliphs. Ibn Abi Laila, who filled the office of judge in 'Iráḳ under the caliphate of Mansur, was one of the first to apply this system. His renown, however, was eclipsed by that of his contemporary Abu Hanífa, who worked out a complete system of jurisprudence, with which his name has continued to be connected (Hanifite law). Fifty years after the death of Abú Hanífa, Sháfi'í, a pupil of Málik, appeared at Baghdád, and founded in his turn an intermediate system, in which he endeavoured to hold an equal balance between the purely traditional and the deductive method. The fourth system reputed orthodox is that of Ibn Hanbal, a pupil of Sháfi'í. Ibn Hanbal strove above all things to bring back religious observances to their primitive purity. His doctrine was a kind of puritanism. We may be supposed, each of these systems has been subsequently developed and commented on in a multitude of works, even the names of which it is impossible to enumerate. In order, however, to give some idea of what a Moslem treatise on jurisprudence is, we shall point out the principal subjects contained in it. It treats successively: 1. Of Purification (ablutions commanded by the law, purification of women, circumcision, etc.); 2. Of Prayers commanded by the law; 3. Of Funerals; 4. Of Tithe and Almsgiving; 5. Of the legal Fast; 6. Of the Pilgrimage to Mecca; 7. Of Commercial and other transactions; 8. Of Inheritance; 9. Of Marriage and Divorce; 10. Of the Faith; 11. Of Crimes and Misdemeanours; 12. Of Justice; 13. Of the Imámate or spiritual power, and of the Caliphate or temporal power. It is thus a complete code, religious, civil, penal, and governmental, that Moslem treatises on jurisprudence set before us; a code which embraces and foresees all the circumstances both of public and private life.

The development of science and literature runs parallel with the development of law. Before the time of Mohammed the Arabs had been distinguished only by a rare poetical talent. Islam was the signal for the springing up of all the sciences and of literature. While the study of the dogmas and ordinances of the Koran was producing theology and jurisprudence, the necessity of preserving the exact text of the sacred book, and of teaching the new converts the language of the Prophet, was giving birth to grammar and lexicography. The first school of grammar was established at Basra. The first attempts at grammar are generally attributed to a certain Abú 'l Aswad al-Do'alí, who was tutor to the children of Ziyád, the brother of Mo'áwiya. According, however, to some authors, the honour of having discovered the first elements of grammar ought to be attributed to a Persian, named 'Abd al Rahmán b. Hormuz. Be this as it may, a foreign influence must be recognized at the very commencement of this science. The vowel marks, for instance, were imitated from those of the Syriac. The division of the parts of speech into nouns, verbs, and particles was indirectly borrowed from Greek grammar. Yet the Moslems, once in possession of the principles of grammar, knew how to develop and apply them in an admirable manner. A perfect galaxy of grammarians arose in the track of Abú 'l Aswad; a rival school to that of Basra was established at Cufa, and grammar attained its highest degree of perfection under the first 'Abbásids; as is shown by the voluminous treatise of Sibawaihi, known under the name of *Kitáb*,[1] or the Book *par excellence*.

In lexicography, the Arabs were at first content to explain the rarer words of the Koran, of the traditions, and of the ancient poems; and to collect lists of terms applying to the same object, as the camel, the horse, the sword, etc. Thus small collections were formed, which served afterwards for the composition of dictionaries. The first dictionary properly so called, composed in Arabic, appears to have been the *Kitáb al 'Ain* of Khalil b. Ahmed al-Faráhidí, a contemporary of Harun al Rashid. After him came Jauhari, whose *Sahah* may still be consulted with profit. The celebrated Zamakhshari composed a dictionary of metaphors, under the title of *Asas al balagha*. Lastly Tha'álibí, in the 11th century of our era, drew up his *Fikh al Logha*, a work specially devoted to synonyms. The accessory branches of philology gave occasion to some important works. The ancient poems and proverbs were collected and commented on. Thus Abu Tammam formed his Anthology, called Hamása (*q. v.*), and Maidani his collection of proverbs (*Kitáb majmaʿ al amthál*). The study of poetry, with especial regard to its rhythm, led Khalil b. Ahmed, already mentioned as a grammarian and lexicographer, to the conception of prosody. He wrote the first treatise on that science, which served as a model to all subsequent writers on metres.[2] Pure literature remained confined to poetry. It was not that the Arabs were without a conception of the romance, the tale, or the novel. The adventures of Antar, the romances of Dhu 'l Himma, of Sayf al Yazan, the Thousand and one Nights, and various collections of stories and novels such as the *Fakihat al Khulafa* and the compilation of Bikri, well known by the extracts which Koreguetten has given in his Chrestomathy, all these show clearly that the Arabs were devoid of imagination, at least if, as we believe, these tales and romances were not pure and simple imitations from the Persian. It must be acknowledged, however, that these few productions do not, any more than the *Makamat* of Hamadhani and of Hariri, constitute a very important literature. The drama, the epic, the romance of character were absolutely unknown to the Arabs. Poetry, on the other hand, an endowment of the ancient Arabs, continued to live and flourish alone in the Eastern Caliphate last. We may count poets by the hundred, eminent in every department of that art: in descriptive, erotic, martial, and philosophic poetry, in ode, in satire, etc. The great collection entitled *Kitáb al Aghání*,[3] compiled by Isfahani, contains a choice of the finest poems, accompanied by very instructive notices of the poets, and of the circumstances under which they composed such and such pieces. Besides this, many Diwans, or complete editions of the works of poets, have come down to us. They bear the celebrated names of Nabigha of 'Anaza, of Tarafa, of Zohair, of 'Alkama, of Amrualkais, of Shanfara, of Labid, in the Islamic period (see Mo'allakát); of Jarír, Akhtal, Farazdak,[4] in the Omayyad period, and of Abú Nowás, Abu 'l 'Atahiya, Muslim, Motanabbi[5] (*q. v.*), and Abu 'l 'Ala[6] in the period of the 'Abbasids. And this list contains only the most illustrious names.

[1] The first part of which has just been published by H. Derenbourg, Paris, 1881.

[2] Published by Boulaq Dabdah.

[3] Translated by Freytag (Bonn, 1838-43), with the Arabic text of the proverbs.

[4] See Freytag, *Einleitung zur Lehre*.

[5] Published at Búlák, A.H. 1285, 20 vols. See also Kosegarten, *De Ibnol Amidi et Motanabbi carminum interpretibus commentatio*, Lond. et Gryph. 1838, 4to.

[6] See Caussin de Perceval in the *Journal asiatique*, 3rd ser., xiii. 441.

Ahlwardt, *Die Beruhmtheit des Dichters Nemus* (Greifswald, 1861), and, for a Cairo edition, *Z. D. M. G.*, xxi. 674.

[8] Edited by De Goeje.

[9] See Rieu, *De libri inscripti Tabakat al Schoara Habibi*, and Kremer, *Z. D. M. G.*, xxiv., xxxi., xxxi.

With the accession of the 'Abbásids to power, Moslem culture entered on a path fruitful in scientific progress. The second Caliph of that family, Mansúr, was surrounded by Syrian Christians of great learning, and equally well acquainted with the Greek, Syriac, and Arabic languages, and took advantage of their abilities to have a number of ancient books translated into Arabic. Thanks to him, the writings of Aristotle, Ptolemy, and Euclid spread a taste for science among the Moslems. The Caliph Ma'mún was one of those who most encouraged translations from the Greek. In this way the Moslems became acquainted with the most important productions of the ancient world. Plato, the works of the Alexandrian school, those of Hippocrates, Dioscorides, and Galen, were familiar to them. Through the Persians many Indian writings also became accessible to them, such as the fables of Bidpai,[1] and certain treatises on astronomy and algebra. The study of philosophy in all its branches was at one time in fashion, and, to appreciate the success with which it was cultivated in Islam, we need only recall the great names of Al Kindí, Al Farábí, Ibn Sina (Avicenna), Ibn Baja (Avempace), and Ibn Roshd (Averroes), whose teaching swayed the Middle Ages, and led to the revival of learning in the West.

In history and geography the Moslems distinguished themselves. The taste for history had been developed among them by the necessity of collecting all traditions relating to the Prophet, and by that of preserving their own genealogies. The study of geography was a result of their conquests. One of their most ancient historical productions was the biography of Mohammed, composed by Mohammed b. Ishák under the caliphate of Mansúr. Wákidí, another author of the 8th century of our era, compiled a history of the first Moslem conquests. At a later period, Baládhorí wrote on the same subject his *Kitab Futuh al Boldan*.[2] General history also became a subject of study, and, in the 9th century after Christ, Kotaiba compiled his *Kitab al Ma'arif*, a treatise on universal history. In the 10th century two great historians flourished, Tabarí and Mas'údí, by the first of whom we have a very extensive chronicle,[3] and by the second a general history, entitled *Moruj al Dhahab* (see MAS'UDI). After them came a perfect galaxy of well known historians and biographers, such as Hamza of Ispahán, Ibn al Tiktaka, Nowairi, Makrizi, Abú 'l-Fidá, Abú 'l Faraj, Al-Makín, Ibn al Athír, Soyúti, and Ibn Khalldún,[4] not to speak of many others who compiled local chronicles and histories, such as those of Mecca, Medina, Damascus, and Baghdad. As biographers, Nawawi and Ibn Khallikan[5] are celebrated. The history of physicians and philosophers, by Ibn Abi Osaibiya, deserves to be placed in the first rank, side by side with the history of religions and sects by Shahristaní.[6]

The Moslems were not less active in the study of geography. In the 9th century, Ya'kúbí wrote his *Kitab al Boldan*, or Book of Countries, in which he described the principal cities of the Moslem empire.[7] After him, Ibn Khordadbih composed his *Kitab al Masalik wal Mamálik*, or Book of Roads and Provinces, in which his principal object is to point out the different routes, and to give an account of the revenues derived from every province.[9] His contemporary Kodáma soon after published his treatise on the work of clerks, in which, after a notice of the various government offices, he gives a description of the provinces of the empire with an account of the post routes, their stages and distances, and of the revenues of each province. Ahmed b. Abi Ya'kúb al-Ya'kúbí wrote a description of Asia Minor and Ifríkiya. Several of the writings of the historian Mas'údí also afford highly valuable information on geography. To Yákút we owe a great geographical dictionary under the title of *Mo'jam al Boldan*.[10] Lastly, Istakhrí, Ibn Hankal, Mokaddasí, Berúní, Bakri, Zamakhsharí, Edrísí, and Abú 'l-Fidá have left us important treatises, narratives of travels, and geographical dictionaries.[11] Among the literature of voyages and travels we must also mention the curious *Chain of Histories* associated with the name of the merchant Soláiman and the narratives of Násiri Khosrú,[12] of Ibn Jobair,[13] and of IBN BATUTA (*q.v.*).

The sciences connected with geography, such as astronomy and cosmography, were also cultivated by the Moslems. As early as the reign of Mansúr, the Sanscrit treatise on astronomy entitled *Sidhhanta* had been translated into Arabic. Under Ma'mún, two observatories were founded, one at Baghdád, the other at Damascus, and two degrees of the terrestrial meridian were measured by order of that Caliph. Al-Kharizmí librarian to Ma'mún composed his *Kitab al Arif*, or configuration of the earth, in which the name of every place was accompanied by its latitude and longitude. Astronomical tables were drawn up by Yahya, Habash, Abú Ma'shar (Abumazar), and Al-Battání (Albategni). Treatises on astronomy were composed by Al Fargham and Al Kindí. Al Battání, of whom we have just spoken, was the author of important works on the obliquity of the ecliptic and on the precession of the equinoxes. We may mention in the last place the curious writings of Dimashki and Kazwíní on general cosmography, embracing several physical sciences.[14]

The study of mathematics was carried very far. The Moslems not only received arithmetic, geometry, trigonometry, and algebra from the Greeks and Hindus, but themselves gave a further development to those sciences. The works of Al Kháriznii served as guides to those learned men in Europe who first turned their attention to algebra in the 16th century.

The sciences of physics and chemistry, on the other hand, remained in their infancy. In physical science we can only mention a few works on Optics. As for Music, its study was limited to the practical, and though we may name the important treatise of Al Fárábí on the theory of Music, a treatise itself drawn entirely from Greek sources, we must acknowledge that Acoustics, properly so called, are not at all taken into consideration by him. Chemistry, considered as an exact science, continued unknown to the Moslems; yet they cultivated Alchemy with eagerness, in their search after the transmutation of metals, and Alchemy is the mother of Chemistry. Medicine, in the hands of the Arabs, remained such as they had borrowed it from the Greeks. As their religion forbade dissection, the Moslems were never able to rise above a rude empirism. They contented themselves with adding to the

[1] Translated from the Arabic by Knatchbull.
[2] Edited by De Goeje (Leyden, 1866).
[3] Edited by Wüstenfeld (Gottingen, 1850).
[4] In course of publication at Leyden, edited by De Goeje, with the assistance of J. Barth, Nöldeke, P. de Jong, E. Prym, H. Thorbecke, S. Fraenkel, J. Goldziher, D. H. Müller, M. Th. Houtsma, S. Guyard, and V. Rose.
[5] Most of these have been published by Gottwaldt, Ahlwardt, Reinke, Pocock, Experuin Torrens.
[6] The former has been edited by Wustenfeld (Gottingen, 1842-47), the latter translated into English by Mac Guckin de Slane (Lond. 1843-71).
[7] Published by Juretoa (Lond. 1842-46), and translated into German by Haarbrucker (Halle, 1850-51).
[8] Edited by A. W. Th. Juynboll and De Goeje (Leyden, 1860-61).
[9] Published and translated by Barbier de Meynard.
[10] Edited by Wustenfeld (Leipzig, 1866-70).
[11] Published, and some translated, by De Goeje, Sachau, Wüstenfeld, De Grave, Jaubert, Dozy, Amari and Schiaparelli, Reinaud, and De Slane. The last volume of Abú 'l-Fidá's Geography is now in the press.
[12] Published and translated by Schefer (Paris, 1881).
[13] Edited by W. Wright (Leyden, 1852).
[14] Published and translated by Mehren, Wüstenfeld, and Ethé.

own prescriptions, which they pretended to have received from the Prophet, those of the Greek physicians. The works of Avicenna prove this; and Ibn al-Baiṭár's treatise on the pharmacopœia also shows how small a part observation played in Arabian medicine.[1] Zoology, botany, and mineralogy made no greater progress; but they were at least among the subjects which attracted the attention of learned Moslems. The great treatise by Damíri, entitled *Ḥayát al-Ḥaiwán*, or *Life of Animals*, is of interest mainly from the legends it contains;[2] and the treatise on mineralogy by Taifashí interests us principally by the detail it gives on the origin of precious stones and the art of cutting them. It would be unjust to conclude this sketch without adding that the Moslems possess also a great number of technical treatises on the art of war, on military engines, and the Greek fire, on falconry and hunting, and on certain industries, such as those of glass, pottery, and metals. They have also written on magic, on the interpretation of dreams, and on sleight of hand. These works have as yet been very little investigated. We shall no doubt find in them interesting revelations on the history of the industrial arts, and on the history of superstition.

With an empire so vast as that of the Moslems, we may easily conceive how extensive their commerce and industry must have been. Commerce had at all times been held in honour by the Arabs. Long before the days of Mohammed, the Koraish annually sent caravans laden with all the products of Yemen, into Syria. Maritime commerce also was already flourishing in Chaldea in the 5th century of our era. The city of Ḥíra was frequented by ships coming from the Red Sea, from India, and even from China. Obolla was the emporium for the merchandise of India. It was principally thither that teakwood was brought, which served for the construction of ships and houses. Thus the Arabs, when they conquered Chaldea, found maritime commerce in full activity there, and took advantage of it. Under the 'Abbásids, Basra supplanted Ḥíra and Obolla, and became the principal port. The history of Sindibád (Sinbad the Sailor) shows how active foreign commerce was under the 'Abbásids, and with what courage the Arab sailors confronted danger. Moslem colonies were established all along the coasts of Persia and India, and Moslem voyagers did not fear to venture as far as the China Seas. On the West, the commercial movement was not less active. Caravans laden with the products of Spain left Tangier, traversed the whole of Northern Africa, and reached Syria, Arabia, and Mesopotamia. Others passed through Asia Minor, Armenia, Persia, Khorásán, and Turkestán, as far as the frontiers of China, while the route of others again was along the eastern coast of Africa, whence they brought back ivory and black slaves. Thus the silks of China, and the spices, camphor, steel, and precious woods of India, were poured into the empire, while the Moslems exported their glass, their dates, their cotton stuffs, their refined sugar, and their wrought tools to those countries. The manufacture of glass was an industry of old standing among them. The glass of Syria was celebrated, and we know that flint-glass and enamel were also made at Baghdad. Dates were cultivated principally in the neighbourhood of Basra, and also in Persia and Khúzistán. Refined sugar also came from the coast of Persia. As regards steel, the manufacture of armour and weapons was the specialty of the people of Iraḳ, of Bahrain, of 'Omán, and of Yemen. The Syrians had the credit of forging excellent sword-blades. In Syria too were made mirrors of polished steel. The weaving of various stuffs formed an important branch of industry. The striped stuffs of Yemen, and the tissues of Baghdád, Herát, Tawwaj, and Fasá, enjoyed a high repute. Damascus was renowned for the silk fabrics which have taken their name from that city. The silks of Yemen, of Egypt, and of Cufa, had also a high reputation. Tiráz produced gauze, and manufactured with gold. Egypt manufactured brocade, Armenia supplied satin. The carpet manufacture under the Caliphs had already reached the excellence which it has maintained to our own days. At that time the carpets most valued came from Farsistán and Tabaristán. Jewellery and trinkets found numerous outlets, as may be supposed. This traffic was principally carried on in the East by the Jews.

We know that the religion of the Prophet forbade any representation of the human figure. This prohibition does not appear to have been long observed, for we find that the walls of palaces and of the houses of the rich were covered with paintings. There was a school of painting at Basra, and Ibn Ḳotaiba gives us the names of two painters of high celebrity in that art, Ibn 'Azíz and Ḳosair.

The manufacture of paper was carried on very extensively, a fact which is easily explained when we think of the literary activity of the Moslems. The Arabs originally used parchments. For this, after the conquest of Egypt, they substituted papyrus, which was itself supplanted by paper when the Arabs had opened communications with China. Paper mills were established in several of the provinces and at Baghdad itself. Simultaneously with the appearance of this precious substance, the art of binding became one of the most flourishing industries, as did also the trades of the shoemaker, the saddler, and the dyer, etc. etc. Retail commerce, lastly, underwent the distribution of the products of agriculture and industry. In almost all the cities of the empire markets were held, where the fruiterer and grocer (*Bakkál*), the butcher (*Ḳassáb*), the armourer (*Sirádj*), the bookseller (*Warráḳ*), and the druggist and perfumer (*'Aṭṭár*), offered their wares for sale.[3] (ST. G.)

PART III. THE KORAN.

The Koran (Ḳo'rán) is the foundation of Islam. It is the sacred book of more than a hundred millions of men, some of them nations of immemorial civilization, by all whom it is regarded as the immediate word of God. And since the use of the Koran in public worship, in schools and otherwise, is much more extensive than, for example, the reading of the Bible in most Christian countries, it has been truly described as the most widely-read book in existence. This circumstance alone is sufficient to give it an urgent claim on our attention, whether it suit our taste and fall in with our religious and philosophical views or not. Besides, it is the work of Mohammed, and as such is fitted to afford a clue to the spiritual development of that most successful of all prophet- and religious personalities. It must be owned that the first perusal leaves on a European an impression of chaotic confusion, not that the book is so very extensive, for it is not quite so large as the New Testament. This impression can in some degree be modified only by the application of a critical analysis with the assistance of Arabian tradition.

To the faith of the Moslems, as has been said, the Koran is the word of God, and such also is the claim which the book itself advances. For except in sur. i. which

[1] The treatise has been translated into French by Dr. Leclerc.

[2] Printed at Búlák, A.H. 1292.

[3] For further information on Modern civilization, see Kremer's important work, *Culturgeschichte des Orients unter den Chalifen*, Vienna, 1875-77.

prayer for men and some few passages where Mohammed (vi. 104, 114; xxvii. 93; xlii. 8), or the angels (xix. 65; xxxvii. 164 *sqq.*), speak in the first person without the intervention of the usual imperative "say" (sing. or pl.), the speaker throughout is God, either in the first person singular, or more commonly the plural of majesty "we." The same mode of address is familiar to us from the prophets of the Old Testament, the human personality disappears, in the moment of inspiration, behind the God by whom it is filled. But all the greatest of the Hebrew prophets fall back speedily upon the unassuming human "I," while in the Koran the divine "I" is the stereotyped form of address. Mohammed, however, really felt himself to be the instrument of God, this consciousness was no doubt brighter at his first appearance than it afterwards became, but it never entirely forsook him. We might therefore readily pardon him for giving out, not only the results of imaginative and emotional excitement, but also many expositions or decrees which were the outcome of cool calculation, as the word of God, if he had only attained the pure moral altitude which in an Isaiah or a Jeremiah fills us with admiration after the lapse of ages.

The rationale of revelation is explained in the Koran itself as follows. In heaven is the original text ("the mother of the book," xliii. 3, "a concealed book," lvi. 77, "a well guarded tablet," lxxxv. 22). By a process of "sending down" (*tanzīl*), one piece after another was communicated to the Prophet. The mediator was an angel, who is called sometimes the "Spirit" (xxvi. 193), sometimes the "holy Spirit" (xvi. 104), and at a later time "Gabriel" (ii. 91). This angel dictates the revelation to the Prophet, who repeats it after him, and afterwards proclaims it to the world (lxxxvii. 6, etc.). It is plain that we have here a somewhat crude attempt of the Prophet to represent to himself the more or less unconscious process by which his ideas arose and gradually took shape in his mind. It is no wonder if in such control of imagery the details are not always self-consistent. When, for example, this heavenly archetype is said to be in the hand of an exalted "scribe" (lxxx. 13 *sqq.*), this seems a transition to a quite different set of ideas, namely, the books of fate, or the record of all human actions—conceptions which are actually found in the Koran. It is to be observed, at all events, that Mohammed's transcendental idea of God, as a Being exalted altogether above the world, excludes the thought of direct intercourse between the Prophet and God.

It is an explicit statement of the Koran that the sacred book was revealed ("sent down") by God, not all at once, but piecemeal and gradually (xxv. 34). This is evident from the actual composition of the book, and is confirmed by Moslem tradition. That is to say, Mohammed issued his revelations in fly leaves of greater or less extent. A single piece of this kind was called either, like the entire collection, *Koran*, *i.e.* "recitation" or "reading," or *kitāb*, "writing," or *sūra*, which is the late Hebrew *shūra*, and means literally "series." The last became, in the lifetime of Mohammed, the regular designation of the individual section as distinguished from the whole collection; and accordingly it is the name given to the separate chapters of the existing Koran. These chapters are of very unequal length. Since many of the shorter ones are undoubtedly complete in themselves, it is natural to assume that the longer, which are sometimes very comprehensive, have arisen from the amalgamation of various originally distinct revelations. This supposition is favoured by the numerous traditions which give us the circumstances under which this or that short piece, now incorporated in a larger section, was revealed; and also by the fact that the connection of thought in the present sūras often seems to be interrupted. And in reality many pieces of the long sūras have to be severed out as originally independent; even in the short ones parts are often found which cannot have been there at first. At the same time we must beware of carrying this sifting operation too far,—as Nöldeke now believes himself to have done in his earlier works, and as Sprenger also sometimes seems to do. That some sūras were of considerable length from the first is seen, for example, from xii., which contains a short introduction, then the history of Joseph, and then a few concluding observations, and is therefore perfectly homogeneous. In like manner, xx., which is mainly occupied with the history of Moses, forms a complete whole. The same is true of xviii., which at first sight seems to fall into several pieces; the history of the seven sleepers, the grotesque narrative about Moses, and that about Alexander "the Horned," are all connected together, and the same rhyme runs through the whole sūra. Even in the separate narrations we may observe how readily the Koran passes from one subject to another, how little care is taken to express all the transitions of thought, and how frequently clauses are omitted, which are almost indispensable. We are not at liberty, therefore, in every case where the connection in the Koran is obscure, to say that it is really broken, and set it down as the clumsy patchwork of a later hand. Even in the old Arabic poetry such abrupt transitions are of very frequent occurrence. It is no uncommon for the Koran, after a new subject has been entered on, to return gradually or suddenly to the former theme, a proof that there at least separation is not to be thought of. In short, however imperfectly the Koran may have been redacted, in the majority of cases the present sūras are identical with the originals.

How these revelations actually arose in Mohammed's mind is a question which it is almost as idle to discuss as it would be to analyse the workings of the mind of a poet. In his early career, sometimes perhaps in its later stages also, many revelations must have burst from him in uncontrollable excitement, so that he could not possibly regard them otherwise than as divine inspirations. We must bear in mind that he was no cold systematic thinker, but an Oriental visionary, brought up in crass superstition and without intellectual discipline; a man whose nervous temperament had been powerfully worked on by ascetic austerities, and who was all the more irritated by the opposition he encountered, because he had little of the heroic in his nature. Filled with his religious ideas and visions, he might well fancy he heard the angel bidding him recite what was said to him. There may have been many a revelation of this kind which no one ever heard but himself, as he repeated it to himself in the silence of the night (lxxiii. 1). Indeed the Koran itself admits that he forgot some revelations (lxxxvii. 7). But by far the greatest part of the book is undoubtedly the result of deliberation, touched more or less with emotion, and animated by a certain rhetorical rather than poetical glow. Many passages are based upon purely intellectual reflection. It is said that Mohammed occasionally uttered such a passage immediately after one of those epileptic fits which not only his followers, but (for a time at least) he himself also, regarded as tokens of intercourse with the higher powers. If this be the case, it is impossible to say whether the trick was in the utterance of the revelation or in the fit itself.

How the various pieces of the Koran took literary form is uncertain. Mohammed himself, so far as we can discover, never wrote down anything. The question whether he could read and write has been much debated among Moslems, unfortunately more with dogmatic arguments and spurious traditions than authentic proofs. At present one is inclined to say that he was not altogether ignorant of these arts, but that from want of practice he found

nvenient to employ some one else whenever he had anything to write. After the flight to Medina (A.D. 622) we e told that short pieces—chiefly legal decisions—were ken down immediately after they were revealed, by an lherent whom he summoned for the purpose; so that othing stood in the way of their publication. Hence it probable that in Mecca, where the art of writing was mmoner than in Medina, he had already begun to have s oracles committed to writing. That even long portions the Koran existed in written form from an early date ay be pretty safely inferred from various indications; pecially from the fact that in Mecca the Prophet had used insertions to be made, and pieces to be erased in s previous revelations. For we cannot suppose that he new the longer súras by heart so perfectly that he was ble after a time to lay his finger upon any particular assage. In some instances, indeed, he may have relied o much on his memory. For example, he seems to have ccasionally dictated the same súra to different persons in ightly different terms. In such cases, no doubt, he may ave partly intended to introduce improvements, and o ong as the difference was merely in expression, without ffecting the sense, it could occasion no perplexity to his llowers. None of them had literary pedantry enough question the consistency of the divine revelation on hat ground. In particular instances, however, the difference of reading was too important to be overlooked hus the Koran itself confesses that the unbelievers cast up as a reproach to the Prophet that God sometimes ubstituted one verse for another (xvi. 103). On one ccasion, when a dispute arose between two of his own llowers as to the true reading of a passage which both ad received from the Prophet himself, Mohammed is said have explained that the Koran was revealed in seven orms. In this apparently gemmæ dictum seven stand of ourse, as in many other cases, for an indefinite but limited umber. But one may imagine what a world of trouble has cost the Moslem theologians to explain the saying accordance with their dogmatic beliefs. A great number of explanations are current, some of which claim the uthority of the Prophet himself, as, indeed, fictitious tterances of Mohammed play throughout a conspicuous art in the exegesis of the Koran. One very favourite, ut utterly untenable interpretation is that the "seven orms" are seven different Arabic dialects.

When such discrepancies came to the cognisance of Mohammed it was doubtless his desire that only one of he conflicting texts should be considered authentic; only e never gave himself much trouble to have his wish arried into effect. Although in theory he was an upholder of verbal inspiration, he did not push the doctrine o its extreme consequences; his practical good sense did ot take these things so strictly as the theologians of ater centuries. Sometimes, however, he did suppress whole sections or verses, enjoining his followers to efface or forget them, and declaring them to be "abrogated." A very remarkable case is that of the two verses in lii., when he had recognised three heathen goddesses as exalted beings, possessing influence with God. (*Supra*, p. 549.)

So much for abrogated readings; the case is somewhat different when we come to the abrogation of laws and directions to the Moslems, which often occurs in the Koran. There is nothing in this at variance with Mohammed's idea of God. God is to him an absolute despot, who declares a thing right or wrong from no inherent necessity but by his arbitrary fiat. This God varies his commands at pleasure, prescribes one law for the Christians, another for the Jews, and a third for the Moslems; nay, he even changes his instructions to the Moslems when it pleases him. Thus, for example, the Koran contains very different directions, suited to varying circumstances, as to the treatment which idolaters are to receive at the hands of believers. But Mohammed showed no anxiety to have these superseded enactments destroyed. Believers could be in no uncertainty as to which of two contradictory passages remained in force; and they might still find edification in that which had become obsolete. That later generations might not so easily distinguish the "abrogated" from the "abrogating" did not occur to Mohammed, whose vision, naturally enough, seldom extended to the future of his religious community. Current events were invariably kept in view in the revelations. In Medina it called forth the admiration of the Faithful to observe how often God gave them the answer to a question whose settlement was urgently required at the moment. The same naïveté appears in a remark of the Caliph 'Othman about a doubtful case: "If the Apostle of God were still alive, methinks there had been a Koran passage revealed on this point." Not unfrequently the divine word was found to coincide with the advice which Mohammed had received from his most intimate disciples. "Omar was many a time of a certain opinion," says one tradition, "and the Koran was then revealed accordingly."

The contents of the different parts of the Koran are extremely varied. Many passages consist of theological or moral reflections. We are reminded of the greatness, the goodness, the righteousness of God as manifested in Nature, in history, and in revelation through the prophets, especially through Mohammed. God is magnified as the One, the All powerful. Idolatry and all deification of created beings such as the worship of Christ as the Son of God, are unsparingly condemned. The joys of heaven and the pains of hell are depicted in vivid sensuous imagery, as is also the terror of the whole creation at the advent of the last day and the judgment of the world. Believers receive general moral instruction, as well as directions for special circumstances. The lukewarm are rebuked, the enemies threatened with terrible punishment, both temporal and eternal. To the sceptical the truth of Islam is held forth and a certain, not very cogent, method of demonstration predominates. In many passages the sacred book falls into a diffuse preaching style, others seem more like proclamations or general orders. A great number contain ceremonial or civil laws, or even special commands to individuals down to such matters as the regulation of Mohammed's harem. In not a few, definite questions are answered which had actually been propounded to the Prophet by believers or infidels. Mohammed himself too, repeatedly receives directions, and does not escape an occasional rebuke. One súra (i.) is a prayer, two (cxiii., cxiv.) are magical formulæ. Many súras treat of a single topic, others embrace several.

From the mass of material comprised in the Koran and its account we have given it (far from exhaustive) we should select the histories of the ancient prophets and saints as possessing a peculiar interest. The purpose of Mohammed is to show from these histories how God in former times had rewarded the righteous and punished their enemies. For the most part the old prophets only serve to introduce a little variety in point of form, for they are almost in every case facsimiles of Mohammed himself. They preach exactly like him, they have to bear the very same charges against their opponents, who on their part behave exactly as the unbelieving inhabitants of Mecca. The Koran even goes so far as to make Noah contend against the worship of certain tabu gods, enumerated by name, who were worshipped by the Arabs of Mohammed's time. In an address which is put in the mouth of Abraham (xxvi. 75 *sqq.*) the reader quite forgets that it is Abraham, and not Mohammed (or God himself) who

peaking. Other narratives are intended rather for amuse-
ment, although they are always well seasoned with edifying
hrases. It is no wonder that the godless Koraishites
hought these stories of the Koran not nearly so entertain
ng as those of Rostam and Espandiar related by Nadr the
on of Harith, who had learned on the Euphrates the
eroic mythology of the Persians. But the Prophet was
o exasperated by this rivalry that when Nadr fell into his
ower after the battle of Bedr, he caused him to be executed;
although in all other cases he readily pardoned his fellow
ountrymen.

The stories are chiefly about Scripture characters,
pecially those of the Old Testament. But the deviations
rom the Biblical narratives are very marked. Many of
he alterations are found in the legendary anecdotes of the
ewish Haggada and the New Testament Apocrypha, but
many more are due to mis-conceptions such as only a listener
not the reader of a book) could fall into. The most ignor-
ant Jew could never have mistaken Haman (the minister
f Ahasuerus) for the minister of Pharaoh, or identified
braham's sister of Moses with Mary (Miriam) the
other of Christ. In addition to such misconceptions
here alteration, some of them very
rotesque, due to Mohammed himself. For instance, in
is ignorance of everything out of Arabia, he makes the
ertility of Egypt where rain is almost never seen and never
issed depend on rain instead of the inundations of the
Nile (xii. 49). It was through the Jews also that he
orrowed his account of Alexander "the Horned"; an
pithet which is to be explained, after old Hottinger, from
he great multitude of coins where Alexander is represented
with the ram's horn of Ammon. Besides Jewish and
Christian history there are a few about old Arabian
prophets. In these he seems to have handled his materials
even more freely than in the others.

The opinion has already been expressed that Mohammed
did not make use of written Coincidences and
divergences alike can always be accounted for by oral com-
munications from Jews who knew a little and Christians
who knew next to nothing. Even in
where we can trace direct resemblances to the text of the
Old Testament (comp. xxi. 105 with Ps. xxxvii. 29, i. 5 with
Ps. xxxvii. 11) or the New (comp. vi. 18 with Luke xvi. 24,
xlvi. 19 with Luke xvi. 25), there is nothing more than
might readily have been picked up in conversation with
any Jew or Christian. In Medina, where he had the
opportunity of becoming acquainted with Jews of some
culture, he learned some things out of the Mishna, *e.g.*
v. 35 corresponds almost word for word with Mishna *Sanh.*
v. 5, compare also ii. 183 with Mishna *Ber.* i. 2. That
here are only cases of oral communication will be admitted
by no one with the slightest knowledge of the circum-
stances. Otherwise we might even conclude that Moham-
med had studied the Talmud; *e.g.* the regulation as to
ablution by rubbing with sand, where water cannot be
obtained (iv. 46), corresponds to a talmudic ordinance
(*Ber.* 15 *a*). Of Christianity he can have been able to learn
very little even in Medina, as may be seen from the absurd
travesty of the institution of the Eucharist in v. 112 *sqq.*
For the rest, it is highly improbable that before the Koran
any real literary production anything that could be
strictly called a book existed in the Arabic language.

In point of style and artistic effect, the different parts
of the Koran are of very unequal value. An unprejudiced
and critical reader will certainly find very few passages
where his aesthetic susceptibilities are thoroughly satisfied.
But he will often be struck especially in the older pieces,
by a wild force of passion, and a vigorous, if not rich,
imagination. Descriptions of heaven and hell, and allu
sions to God's working in Nature, not unfrequently show
a certain amount of poetic power. In other places als
the style is sometimes lively and impressive; though it
rarely indeed that we come across such strains of touchin
simplicity as in the middle of xciii. The greater part of th
Koran is decidedly prosaic; much of it indeed is stiff in style
Of course, with such a variety of material, we cannot expec
every part to be equally vivacious, or imaginative, o
poetic. A decree about the right of inheritance, or
point of ritual, must necessarily be expressed in prose,
it is to be intelligible. No one complains of the civil law
in Exodus or the sacrificial ritual in Leviticus, becaus
they want the fire of Isaiah or the tenderness of Deute
onomy. But Mohammed's mistake consists in persisten
and slavish adherence to the semi-poetic form which h
had at first adopted in accordance with his own taste an
that of his hearers. For instance, he employs rhyme i
dealing with the most prosaic subjects, and thus produce
the disagreeable effect of incongruity between style an
matter. It has to be considered, however, that many o
those sermonizing pieces which are so tedious to us, espec
ally when we read two or three in succession (perhaps i
a very inadequate translation), must have had a quit
different effect when recited under the burning sky an
on the barren soil of Mecca. There, thoughts abou
God's greatness and man's duty, which are familiar to u
from childhood, were all new to the hearers—it is heare
we have to think of in the first instance, not readers—t
whom, at the same time, every allusion had a meanin
which often escapes our notice. When Mohammed spok
of the goodness of the Lord in creating the clouds, an
bringing them across the cheerless desert, and pourin
them out on the earth to restore its rich vegetation, th
must have been a picture of thrilling interest to the Arab
who are accustomed to see from three to five years elap
before a copious shower comes to clothe the wilderne
once more with luxuriant pastures. It requires an effo
for us, under our clouded skies, to realize in some degr
the intensity of that impression.

The fact that scraps of poetical phraseology are sp
cially numerous in the earlier súras, enables us to unde
stand why the prosaic mercantile community of Mec
regarded their eccentric townsman as a "poet," or even
"possessed poet." Mohammed himself had to disclai
such titles, because he felt himself to be a divinely-inspire
prophet; but we too, from our standpoint, shall ful
acquit him of poetic genius. many other predom
nantly religious characters, he had no appreciation of poet
beauty; and if we may believe one anecdote related
him, at a time when every one made verses he affecte
ignorance of the most elementary rules of prosody. Hen
the style of the Koran is not poetical but rhetorical; an
the powerful effect which some portions produce on us
gained by rhetorical means. Accordingly the sacred boo
has not even the artistic form of poetry; which, amon
the Arabs, includes a stringent metre, as well as rhym
The Koran is never metrical, and only a few exceptional
eloquent portions fall into a sort of spontaneous rhythm. O
the other hand, the rhyme is regularly maintained; althoug
especially in the later pieces, after a very slovenly fashio
Rhymed prose was a favourite form of composition amon
the Arabs of that day, and Mohammed adopted it; b
it imparts a certain sprightliness to some passages,
proves on the whole a burdensome yoke. The Mosle
themselves have observed that the tyranny of the rhy
often makes itself apparent in derangement of the ord
of words, and in the choice of verbal forms which wou
not otherwise have been employed; *e.g.* an imperfect inste
of a perfect. In one place, to save the rhyme, he ca
Mount Sinai *Sinín* (xcv. 2) instead of *Sináa* (xxiii. 20
in another Elijah is called *Ilyásín* (xxxvii. 130) instead

lyás (vi. 85; xxxvii. 123). The substance even is modified to suit exigencies of rayme. Thus the Prophet would carcely have fixed on th unusual number of *eight* angels ound the throne of God (lxix. 17) if the word *thamánigah*, eight," had not happened to fall in so well with the hyme. And when lv. speaks of *two* heavenly gardens, ach with *two* fountains and *two* kinds of fruit, and again f *two* similar gardens, all this is simply because the dual ermination (*án*) corresponds to the syllable that controls he rhyme in that whole súra. In the later pieces, Mohammed often inserts edifying remarks, entirely out of eeping with the context, merely to complete his rhyme. n Arabic it is such an easy thing to accumulate masses f words with the same termination, that the gross neglience of the rhyme in the Koran is doubly remarkable. One may say that this is another mark of the Prophet's want of mental training, and incapacity for introspective riticism.

On the whole, while many parts of the Koran undoubtedly have considerable rhetorical power even over an unbelieving reader, the book, aesthetically considered, s by no means a first-rate performance. To begin with what we are most competent to criticize, let us look at some of the more extended narratives. It has already been noticed how vehement and abrupt they are where they ought to be characterized by epic repose. Indispensable links, both in expression and in th events, are often omitted, so that to understand these histories is sometimes far easier for us than for those who heard them first, because we know most of them from better sources. Along with this, there is a great deal of superfluous verbiage; and nowhere do we find a steady advance in the narration. Contrast in these respects the history of Joseph (xii.) and its glaring improprieties, with the admirably-conceived and admirably executed story in Genesis. Similar faults are found in the non-narrative portions of the Koran. The connexion of ideas is extremely loose, and even the syntax betrays great awkwardness. Anacoluthia are of frequent occurrence, and cannot be explained as conscious literary devices. Many sentences begin with a "when" or "on the day when" which seems to hover in the air, so that the commentators are driven to supply a "think of this" or some such ellipsis. Again, there is no great literary skill evinced in the frequent and needless harping on the same words and phrases; in xviii., for example, "till that" (*hatta idhá*) occurs no fewer than eight times. Mohammed in short, is not in any sense a master of style. This opinion will be endorsed by any European who reads through the book with an impartial spirit and some knowledge of the language, without taking into account the tiresome effect of its endless iterations. But in the every pious Moslem such a judgment will sound almost as shocking as downright atheism or polytheism. Among the Moslems, the Koran has always been on as the most perfect model of style and language. This feature of it is in their dogmatic the greatest of all miracles, the incontestable proof of its divine origin. Such a view on the part of men who knew Arabic infinitely better than the most accomplished European Arabist will ever do, may well startle us. In fact, the Koran boldly challenged its opponents to produce ten súras, or even a single one, like those of the sacred book, and they never did so. That, to be sure, on calm reflexion, is not so very surprising. Revelations of the kind which Mohammed uttered, no unbeliever could produce without making himself a laughing-stock. However little real originality there is in Mohammed's doctrines, as against his own country he was thoroughly original, even in the form of his oracles. To compose such revelations at will was beyond the power of the most expert literary artist; it would have required either a prophet, or a shameless impostor. And if such a character appeared *after* Mohammed, still he could never be anything but an imitator, like the false prophets who arose about the time of his death and afterwards. That the adversaries should produce any sample whatsoever of poetry or rhetoric equal to the Koran is not at all what the Prophet demands. In that case he would have been put to shame, even in the eyes of many of his own followers, by the first poem that came to hand. Nevertheless, it is on a false interpretation of this challenge that the dogma of the incomparable excellence of the style and diction of the Koran is based. The result has been accomplished by dogmatic prejudice, which is quite capable of working other miracles besides turning a defective literary production into an unrivalled masterpiece in the eyes of believers. This view once accepted, the next step was to find everywhere evidence of the perfection of the style and language. And if here and there scarcely a doubt, there was among the old Moslems a lover of poetry who had his difficulties about the doctrine, he had to beware of uttering an opinion which might have cost him his head. We know of at least one rationalistic theologian who defined the dogma in such a way that we can see he did not believe it (Shahrastání, p. 39). The truth is, it would have been a miracle indeed if the style of the Koran had been perfect. For although there was at the time a recognized poetical style, already degenerating into mannerism, a prose style did not exist. All beginnings are difficult, and it can never be counted a serious charge against Mohammed that his book, the first prose work of a high order in the language, is inferior to the awkwardness of the beginner. And further, we must always remember that entertainment and aesthetic effect were the most subsidiary objects. The great aim was persuasion and conversion; and, say what we will, that aim has been realized on the most imposing scale.

Mohammed repeatedly calls attention to the fact that the Koran is not written, like other sacred books, in a strange language, but in Arabic, and therefore intelligible to all. At that time, along with foreign ideas, many foreign words had crept into the language, especially Aramaic terms for religious conceptions of Jewish or Christian origin. Some of these had already passed into general use, while others were confined to a more limited circle. Mohammed, who could not fully new ideas the common language of his countrymen, but had frequently to find out new terms for himself, made free use of such Jewish and Christian words, as was done though perhaps in a smaller extent, by certain thinkers and poets of that age who had more or less risen above the level of heathenism. In Mohammed's case this is the wonderful, because he was indebted to the instruction of Jews and Christians whose Arabic as the Koran pretty clearly intimates with regard to one them was by defective. Nor is it very surprising to find that his use of these words is sometimes as much at fault as his comprehension of the histories which he learned from the same people that applies Aramaic expressions as incorrectly as many uneducated persons now employ words derived from the French. Thus, *furkán* means really "redemption," but Mohammed (misled by the Arabic meaning of the root فرق "to decide") uses it for "revelation." *Millat* is properly "Word" but in the Koran "religion." *Ilâhun* (lxxxvi. 18, 19) is apparently the Hebrew name of God, *Elyon* "the Most High"; Mohammed uses it of a heavenly host (see S. Fraenkel, *De vocabulis in antiquis Arabum carminibus et in Corano peregrinis*, Leyden, 1880, p. 23). So again the word *mathání* is, as Geiger has conjectured,

regular plural of the Aramaic *mathnithá*, which is the same as the Hebrew *Mishna*, and denotes, in Jewish usage, a legal decision of some of the ancient Rabbins. But in the Koran "the seven *Mathání*" (xv. 87) are probably the seven verses of sura 1., so that Mohammed appears to have understood it in the sense of "saying," or "sentence" (comp. xxxix. 24). Words of Christian origin are less frequent in the Koran. It is an interesting fact that of these a few have come over from the Abyssinian, such as *hawárayún*, "apostles," *má'ida*, "table," and two or three others; these all make their first appearance in sura of the Medina period. The word *shaitán*, "Satan," which was likewise borrowed, at least in the first instance, from the Abyssinian, had probably been already introduced into the language. Sprenger has rightly observed that Mohammed makes a certain parade of these foreign terms, as of other peculiarly constructed expressions; in this he followed a favourite practice of contemporary poets. It is the tendency of the imperfectly educated to delight in out of the way expressions, and on such minds they readily produce a remarkably solemn and mysterious impression. This was exactly the kind of effect that Mohammed desired, and to secure it he seems even to have invented a few odd vocables, as *abáribu* (lxix. 36), *ghislin* (lxxviii. 7, 8), *ta'ísan* (lxxxix. 27), and *salsabíl* (lxxvi. 18). But, of course, the necessity of enabling his hearers to understand ideas which they must have found sufficiently novel in themselves, imposed tolerably narrow limits on such eccentricities.

The constituents of our present Koran belong partly to the Mecca period (before 622 A.D.), partly to the period commencing with the flight to Medina (from the autumn of 622 to 8th June 632). Mohammed's position in Medina was entirely different from that which he had occupied in his native town. In the former he was from the first the leader of a powerful party, and gradually became the autocratic ruler of Arabia; in the latter he was only the despised preacher of a small congregation. This difference, as was to be expected, appears in the Koran. The Medina pieces, whether entire suras or isolated passages interpolated in Meccan suras, are accordingly pretty broadly distinct, as to their contents, from those composed in Mecca. In the great majority of cases there can be no doubt whatever whether a piece first saw the light in Mecca or in Medina; and for the most part the internal evidence is borne out by Moslem tradition. And now the revelations given in Medina frequently take notice of events about which we have pretty accurate information, and whose dates are at least approximately known, we are often in a position to fix their date with at any rate considerable certainty, here again tradition renders valuable assistance. Even with regard to the Medina passages, however, a great deal remains uncertain, partly because the allusions to historical events and circumstances are generally rather obscure, partly because traditions about the occasion of the revelation of the various pieces are often fluctuating, and often rest on mere understanding or arbitrary conjecture. But at all events it is far easier to arrange in some sort of chronological order the Medina suras than those composed in Mecca. There is, indeed, one tradition which professes to furnish a chronological list of all the suras. But not to mention that it occurs in several divergent forms, and that it takes no account of the fact that our present suras are partly composed of pieces of different dates, it contains so many suspicious or undoubtedly false statements, that it is impossible to attach any great importance to it. Besides, it is *a priori* unlikely that a contemporary of Mohammed could have drawn up such a list; and if any one had made the attempt, he would have found it almost impossible to obtain reliable information as to the order of the earlier Meccan suras. We have in this list no genuine tradition, but rather the lucubrations of an undoubted conscientious Moslem critic, who may have lived about a century after the Flight.

Among the revelations put forth in Mecca there is a considerable number of (for the most part) short suras which strike every attentive reader as being the oldest. They are in an altogether different strain from many others, and in their whole composition they show least resemblance to the Medina pieces. It is no doubt conceivable—as Sprenger supposes—that Mohammed might have returned at intervals to his earlier manner; but since this group possesses a remarkable similarity of style, and since the gradual formation of a different style is on the whole an unmistakable fact, the assumption has little probability, and we shall therefore abide by the opinion that these form a distinct group. At the opposite extreme from them stands another cluster, showing quite obvious affinities with the style of the Medina suras, which must therefore be assigned to the later part of the Prophet's work in Mecca. Between these two groups stand a number of other Meccan suras, which in every respect mark the transition from the first period to the third. It need hardly be said that the three periods which were first distinguished by Professor Weil are not separated by sharp lines of division. With regard to some suras, it may be doubtful whether they ought to be reckoned among the middle group, or with one or other of the extremes. And it is altogether impossible, within these groups, to establish even a probable chronological arrangement of the individual revelations. In default of clear allusions to well known events, or events whose date can be determined, we might indeed endeavour to trace the psychological development of the Prophet by means of the Koran and arrange its parts accordingly. But in such an undertaking one is always apt to take subjective assumptions or mere fancies for established data. Good traditions about the origin of the Meccan revelations are not very numerous. In fact the whole history of Mohammed previous to the Flight is so imperfectly related that we are not even sure in what year he appeared as a prophet. Probably it was in A.D. 610; it may have been somewhat earlier, but scarcely later. If, as one tradition says, xxx. 1–5 ("The Romans are overcome in the nearest neighbouring land") refers to the defeat of the Byzantines by the Persians, not far from Damascus, about the spring of 614, it would follow that the third group, to which this passage belongs, covers the greater part of the Mecca period. And it is not in itself unlikely that the passionate vehemence which characterizes the first group was of short duration. Nor is the assumption contradicted by the tolerably well attested, though far from incontestable statement, that when 'Omar was converted (A.D. 615 or 616) xx., which belongs to the second group, already existed in writing. But the reference of xxx. 1 *sq.* to this particular battle is by no means so certain that positive conclusions can be drawn from it. It is the same with other allusions in the Meccan suras to occurrences whose chronology can be partially ascertained. It is better, therefore, to rest satisfied with a merely relative determination of the order. Even the three great clusters of Meccan revelation

In the pieces of the first period the convulsive excitement of the Prophet often expresses itself with the utmost vehemence. He is so carried away by his emotion that he cannot choose his words; they seem rather to burst from him. Many of these pieces remind us of the oracles of the old heathen soothsayers, whose style is known to us from imitations, although we have perhaps not a single genuine specimen. Like those other oracles, the suras of this period, which are never very long, are composed

ort sentences with tolerably pure but rapidly-changing ymes. The oaths, too, with which many of them begin, re largely used by the soothsayers. Some of these ths are very uncouth and hard to understand, some of em perhaps were not meant to be understood, for indeed sorts of strange things are met with in these chapters. re and there Mohammed speaks of visions, and appears n to see angels before him in bodily form. There are ne intensely vivid descriptions of the resurrection and e last day which must have exercised a demoniac power er men who were quite unfamiliar with such pictures. ther pieces paint in glowing colours the joys of heaven d the pains of hell. However, the suras of this period e not all so wild as these; and those which are conceived a calmer mood appear to be the oldest. Yet, one must peat, it is exceedingly difficult to make out any strict ronological sequence. For instance, it is by no means rtain whether the beginning of xcvi. is really what a dely-circulated tradition calls it, the oldest part of the ole Koran. That tradition goes back to the Prophet vourite wife 'Áisha; but as she was not born at the ne when the revelation is said to have been made, it n only contain at the best what Mohammed told her ars afterwards, from his own not very clear recollection, th or without fictitious addition. And, moreover, ere are other pieces mentioned by others as the oldest any case xcvi. 1 *sqq.* is certainly very early. Accord g to the traditional view, which appears to be correct, treats of a vision in which the Prophet receives an junction to recite a revelation conveyed to him by the gel. It is interesting to observe that here already two ings are brought forward as proofs of the omnipotence d care of God: one is the creation of man out of a minal drop—an idea to which Mohammed often recurs; e other is the then recently introduced art of writing, hich the Prophet instinctively seizes on as a means of opagating his doctrines. It was only after Mohammed countered obstinate resistance that the tone of the revel tions became thoroughly passionate. In such cases he as not slow to utter terrible threats against those who diculed the preaching of the unity of God, of the resur ction, and of the judgment. His own uncle Abú Lahab d rudely repelled him, and in a brief special sura (cxi.) e and his wife are consigned to hell. The suras of this eriod form almost exclusively the concluding portions of e present text. One is disposed to assume, however, at they were at one time more numerous, and that many f them were lost at an early period.

Since Mohammed's strength lay in his enthusiastic and ery imagination rather than in the wealth of ideas and earness of abstract thought on which exact reasoning epends, it follows that the older suras, in which the ormer qualities have free scope, must be more attractive o us than the later. In the suras of the second period he imaginative glow perceptibly diminishes; there is still re and animation, but the tone becomes gradually more rosaic. As the feverish restlessness subsides, the periods re drawn out, and the revelations as a whole become onger. The truth of the new doctrines is proved by accu mulated instances of God's working in nature and in istory; the objections of opponents, whether advanced n good faith or in jest, are controverted by arguments ut the demonstration is often confused or even weak. The histories of the earlier prophets, which had occasion lly been briefly touched on in the first period, are now elated, sometimes at great length. On the whole, the harm of the style is passing away.

There is one piece of the Koran, belonging to the begin ing of this period, if not to the close of the former, which laims particular notice. This is i., the Lord's Prayer of the Moslems, and beyond dispute the gem of the Koran. The words of this sura, which is known as *al fatiha*[1] ("the opening one") are as follows:

(1) In the name of God, the compassionate compassioner. (2) Praise be [literally "is"] to God, the Lord of the worlds, (3) the compassionate compasser, (4) the Sovereign of the day of judgment. (5) Thee do we worship and of Thee do we beg assistance. (6) Direct us in the right way, (7) in the way of those to whom Thou hast been gracious, on whom there is no wrath, and who go not astray.

The thoughts are so simple as to need no explanation, and yet the prayer is full of meaning. It is true that there is not a single original idea of Mohammed's in it. Several words and turns of expression are borrowed directly from the Jews, in particular the designation of God as the 'Compassioner,' *Rahmán*. This is simply the Jewish *Rahmana*, which was a favourite name for God in the Talmudic period. Mohammed seems for a while to have entertained the thought of adopting *al Rahman* as a proper name of God, in place of *Allah*, which was already used by the heathens.[1] This purpose he ultimately relinquished, but it is just in the suras of the second period that the use of *Rahmán* is specially frequent. It was probably in this first sura also that Mohammed first introduced the formula 'In the name of God, etc.' It is to be regretted that this prayer must lose its effect through too frequent use, for every Moslem who says his five prayers regularly as the most of them do repeat it not less than twenty times a day.

The suras of the third Meccan period, which form a pretty large part of our present book, are not entirely prosaic. Some of the revelations are of considerable extent, and the single verses also are much longer than in the older suras. Only now and then a gleam of poetic power flashes out. A sermonizing tone predominates. The suras are very edifying for one who is already reconciled to their import, but to neutral hearers they do not seem very well fitted to carry conviction to the minds of unbelievers. That impression, however, is not correct, for in reality the demonstration of the once longer Meccan suras appear to have been peculiarly influential for the propagation of Islam. Mohammed's mission was not to Europeans, but to a people who, though quick witted and receptive, were not accustomed to logical thinking, while they had outgrown their ancient religion.

When we reach the Medina period it becomes, as has been indicated, much easier to understand the revelations in their historical relations, since our knowledge of the history of Mohammed in Medina is tolerably complete. In many cases the historical occasion is perfectly clear, in others we can at least recognize the general situation from which they arose, and that approximately as to time. There still remain, however, a remnant, of which we can only say that it belongs to Medina.

The style of this period bears a pretty close resemblance to that of the latest Meccan period. It is for the most part pure prose, enriched by occasional rhetorical embellishment. Yet even here there are many bright and impressive passages, especially in those sections which may be recorded as proclamations to the army of the faithful. In the short, hortatory Medinese suras many different messages. At one time it is a summons to do battle for the faith; another, a word of reflection on recently experienced success or misfortune, or a rebuke for their weak faith, or an exhortation to virtue, and so on. He often addresses himself to the 'doubters,' some of whom vacillate between faith and unbelief, others make a pretence of faith, while others

[1] Since in Arabic also the ... 'to have pity,' ... Arabs must have at once perceived the force of the re...

carcely take the trouble even to do that. They are no onsolidated party, but to Mohammed they are all equally exations, because, as soon as danger has to be encountered, r a contribution is levied, they all alike fall away. There re frequent outbursts, ever increasing in bitterness, against he Jews, who were very numerous in Medina and its eighbourhood when Mohammed arrived. He has much s to say against the Christians, with whom he never ame closely in contact; and as for the idolaters, there was ittle occasion in Medina to have many words with them. A part of the Medina pieces consists of formal laws belong g to the ceremonial, civil, and criminal codes; or directions bout certain temporary complications. The most objec ionable parts of the whole Koran are those which treat of Mohammed's relations with women. The laws and regula ions were generally very concise revelations, but most of hem have been amalgamated with other pieces of similar r dissimilar import, and are now found in very long suras. Such is an imperfect sketch of the composition and the ternal history of the Koran, but it is probably sufficient o show that the book is a very heterogeneous collection. t only those passages had been preserved which had a ermanent value for the theology, the ethics, or the juris rudence of the Moslems, a few fragments would have been mply sufficient. Fortunately for knowledge, respect for he sacredness of the letter has led to the collection of all he revelations that could possibly be collected, the "abro gating" along with the "abrogated," passages referring to assing circumstances as well as those of lasting importance. Every one who takes up the book in the proper religious rame of mind, like most of the Moslems, reads pieces directed against long obsolete absurd customs of Mecca ust as devoutly as the weightiest moral precepts, perhaps ven more devoutly, because he does not understand them o well.

At the head of twenty-nine of the suras stand certain mysterious letters, from which no clear sense can be obtained. Thus, before ch. xxxi. xxxii. we find *Alif Lam Mim*, before ch. xlvi. *Ha Mim*. Noldeke at one time suggested that these initials did not belong to Mohammed's text, but might be the monogrammatic possessors of codices which, through neglect on the part of the editors, were incorporated in the final form of the Koran; now deems it more probable that they are to be traced to the Prophet himself, as Sprenger, both the other suppose. One cannot indeed admit the truth of Loth's statement that in the majority opening words of these suras we may generally find an allusion to the accompanying initials; but it can scarcely be accidental that the first verse of the great majority of them, namely, in the second sura, contains the word "book," "revelation," or some equivalent. They usually begin with "This is the book," or "Revelation down-sending of the book," or something similar. Of suras which commence in this way only a few (xxviii. xl. xli. xxx. xxxiv.) want the initials, while only xxix. and xxx. have the initial and no mediate. These few exceptions may easily have proceeded from an early corruption; at all events they cannot destroy the evidence of the greater number. Mohammed seems to have meant these letters to be a mysterious reference to the archetypal text in heaven. To one who regarded the art of writing, of which at first he had but a very imperfect knowledge, as something supernatural, and who lived among illiterate people, an A B C may well have seemed more significant than to us who have been initiated into the mysteries of this art from our childhood. The Prophet himself can hardly have attached any particular meaning to these symbols, they served their purpose if they conveyed an impression of divinity and enigmatical obscurity. In fact the Koran admits that it contains many things which neither can nor were intended to be understood (iii. 5). To regard these letters as ciphers is a precarious hypothesis, for the simple reason that cryptography is not to be looked for in the very infancy of Arabic writing. If the letters are actually ciphers, the multiplicity of possible explanations at once precludes the hope of a plausible interpretation. None of the efforts in this direction, whether by Moslem scholars or by Europeans, have led to convincing results. This remark applies even to the ingenious conjecture of Sprenger, that the letters كهيعص *Kaf He Ye Ain Sâd* before xix. (which treats of John and Jesus, and, according to tradition, was sent to the Christian king of Abyssinia) stand for *Jesus Nazarenus Rex Judæorum*. Sprenger arrives at this explanation by a very artificial method; and besides, Mohammed was not so simple as the Moslem traditionalists, who imagined that the Abyssinians could read a piece of the Arabic Koran. It need hardly be said that the Moslems have from of old applied themselves with great assiduity to the decipherment of these initials, and have sometimes found the deepest mysteries in them. Generally, however, they are content with the prudent conclusion, that God alone knows the meaning of these letters.

When Mohammed died, the separate pieces of the Koran, notwithstanding their theoretical sacredness, existed only in scattered copies; they were consequently in great danger of being partially or entirely destroyed. Many Moslems knew large portions by heart, but certainly no one knew the whole; and a merely oral propagation would have left the door open to all kinds of deliberate and inadvertent alterations. Mohammed himself had never thought of an authentic collection of his revelations; he was usually concerned only with the object of the moment, and the idea that the revelations would be destroyed unless he made provision for their safe preservation, did not enter his mind. A man destitute of literary culture has some difficulty in anticipating the fate of intellectual products. But not long after the death of the Prophet, most of the Arabs revolted against his successor, and had to be reduced to submission by force. Especially sanguinary was the contest against the prophet Maslama (Mubarrad, *Kâmil* 443, 5), an imitator of Mohammed, commonly known by the derisive diminutive Mosailma. At that time (A.D. 633) many of the most devoted Moslems fell, the very men who knew most Koran pieces by heart. 'Omar then began to fear that the Koran might be entirely forgotten, and he induced the Caliph Abubekr to undertake the collection of all the parts. The Caliph laid the duty on Zaid, the son of Thabit, a native of Medina, then about twenty-two years of age, who had often acted as amanuensis to the Prophet, in whose service he is even said to have learned the Jewish letters. The account of this collection of the Koran has reached us in several substantially identical forms, all of which goes back to Zaid himself. According to it, he collected the revelations from copies written on flat stones, pieces of leather, ribs of palm leaves (not palm leaves themselves, as Weil and such like material, but chiefly "from the breasts of men," *i.e.* from their memory. From these he wrote a certain copy, which he gave to Abúbekr, from whom it came to his successor 'Omar, who again bequeathed it to his daughter Hafsa, one of the widows of the Prophet. This redaction, commonly called *al sohof* ("the leaves"), has from the first no canonical authority; and its internal arrangement can only be conjectured.

The Moslems were as far as ever from possessing a uniform text of the Koran. The bravest of their warriors sometimes knew deplorably little about it; distinction on the field they cheerfully accorded to pious men like Ibn Mas'úd. It was inevitable, however, that discrepancies should emerge between the texts of professed scholars, and as these men in their several localities were authorities on the reading of the Koran, quarrels began to break out between the levies from different districts about the true form of the sacred book. During a campaign in A.H. 30 (A.D. 650-1), Hodhaifa, the victor in the great and decisive battle of Nehawend which was to the empire of the Sásánids what Gaugamela was to that of the Achæmenidæ—perceived that such disputes might become dangerous, and therefore urged on the Caliph 'Othmán the necessity for a universally binding text. The matter was entrusted to Zaid, who had made the former collection, with three leading Koraishites. These brought together as many copies as they could lay their hands on, and prepared an edition which was to be canonical for all Moslems. To prevent any further disputes, they burned all the other codices except that

afsa, which, however, was soon afterwards destroyed by
erwán, the governor of Medina. The destruction of the
rlier codices was an irreparable loss to criticism; but, for
e essentially political object of putting an end to con-
oversies by admitting only one form of the common book
religion and of law, this measure was necessary
The result of these labours is in our hands; as to how
ey were conducted we have no trustworthy information,
adition being here too much under the influence of dog
atic presuppositions. The critical methods of a modern
ientific commission will not be expected of an age when
e highest literary education for an Arab consisted in
bility to read and write. It now seems to me highly
obable that this second redaction took this simple form
aid read off from the codex which he had previously
ritten, and his associates, simultaneously or successively,
rote one copy each to his dictation. It certainly cannot
ve been by chance that, according to sure tradition, they
rote exactly four copies. Be that as it may, it is impos-
ble now to distinguish in the present form of the book
hat belongs to the first redaction from what is due to
e second.

In the arrangement of the separate sections, a chronolo-
on according to contents was impracticable because of the
ariety of subjects often dealt with in one sura. A chrono
gical arrangement was out of the question because the
hronology of the older pieces must have been imperfectly
nown, and because in some cases passages of different
ates had been joined together. Indeed, systematic prin
ples of this kind were altogether disregarded at that
eriod. The pieces were accordingly arranged in rudimen
inate order, the only rule observed being to place the
ng súras first and the shorter toward the end, and even
at was far from strictly adhered to. The short opening
ra is so placed on account of its superiority to the rest,
nd two magical formulæ are kept for a sort of protection
the end; these are the only special traces of design
he combination of pieces of different origin may proceed
artly from the possessors of the codices from which Zaid
ompiled his first complete copy, partly from Zaid himself.
he individual súras are separated simply by the super-
ription—"In the name of God, the compassionate Com
assioner," which is wanting only in the ninth. The
dditional headings found in our texts (the name of the
ra, the number of verses, etc.) were not in the original
odices, and form no integral part of the Koran.

It is said that 'Othmán directed Zaid and his associates,
cases of disagreement, to follow the Koraish dialect;
ut, though well attested, this account can scarcely be
orrect. The extremely primitive writing of those days
as quite incapable of rendering such minute differences
s can have existed between the pronunciation of Mecca
nd that of Medina.

'Othmán's Koran was not complete. Some passages are
vidently fragmentary; and a few detached pieces are still
xtant which were originally parts of the Koran, although
hey have been omitted by Zaid. Among these are some
which there is no reason to suppose Mohammed desired to
uppress. Zaid may easily have overlooked a few stray
ragments, but that he purposely omitted anything which
e believed to belong to the Koran is very unlikely. It
as been conjectured that in deference to his superiors he
ept out of the book the names of Mohammed's enemies,
f they or their families came afterwards to be respected.
But it must be remembered that it was never Mohammed's
ractice to refer explicitly to contemporary persons and
ffairs in the Koran. Only a single friend, his adopted
on Zaid (xxxiii. 37), and a single enemy, his uncle Abú
Lahab (cxi.)—and these for very special reasons—are men
ioned by name; and the name of the latter has been left
in the Koran with a fearful curse annexed to it, although
his son had embraced Islam before the death of Mohammed.
So, on the other hand, there is no single verse or clause
which can be plausibly made out to be an interpolation by
Zaid at the instance of Abubekr, 'Omar, or 'Othman. Slight
clerical errors there may have been, but the Koran of
'Othmán contains none but genuine elements, though
sometimes in very strange order.

Of the four exemplars of 'Othman's Koran, one was kept
in Medina, and one was sent to each of the three metro
politan cities, Cufa, Basra, and Damascus. It can still be
pretty clearly shown in detail that these four codices
deviated from one another in points of orthography, in the
insertion or omission of a *wa* ("and"), and such like
minutiæ. But these variations nowhere affect the sense.
All later manuscripts are derived from these four originals.

At the same time, the other forms of the Koran did
not at once become extinct. In particular we have
some information about the codex of Obay. If this
had which gives the order of the súras correct, it must
have contained substantially the same materials as our text
in that case Obay must have used the original collection
of Zaid. The same is true of the codex of Ibn Ma'súd,
of which we have also a catalogue. It appears that the
principle of putting the longer súras before the shorter was
more consistently carried out by him than by Zaid. He
omits 1, and the magical formulæ of cxiii. cxiv. Obay,
on the other hand, had embodied two additional short
prayers, which we may regard as Mohammed's. One
can easily understand that differences of opinion may have
existed as to whether and how far formularies of this kind
belonged to the Koran. Some of the divergent readings
of both these texts have been preserved, as well as a con
siderable number of other ancient variants. Most of these
are decidedly inferior to the received reading, but some
are quite as good, and a few deserve preference.

The only man who appears to have strongly opposed
the general introduction of 'Othman's text is Ibn Mas'úd.
He was one of the oldest disciples of the Prophet, and had
often rendered him personal service; but he was a man of
contracted views, although he became one of the pillars of Mo
lem theology. His opposition had no effect. Now when
we consider that at that time there were many Moslems
who had heard the Koran from the mouth of the Prophet,
that other measures of the rabeede 'Othman met with
the most vehement resistance on the part of the bigoted
champions of the faith, that there were till further merits
against him by some of his ambition, old comrades until
at last they murdered him, and finally that in the civil
wars after his death the several parties were glad of any
pretext for branding their opponents as infidels; when
we consider all this, we must regard it as a strong testi
mony in favour of 'Othman's Koran that no party, not
even that of 'Ali, found fault with his conduct in this
matter, or repudiated the text framed by Zaid, who was
one of the most devoted adherents of 'Othman and his
family.

But the relation to not the close of the textual history of the
Koran. The ancient Arabic alphabet was very imperfect, at first
only wanted marks for the short and in part even for the long
vowels, but it often expressed several consonants by the same sign.
Hence there were many words which could be read in very different
ways. The variety of possible readings was at first very great, and
many readers seem to have actually made it their object to discover
pronunciations which were new, provided they were at all appro
priate to the ambiguous text. There was also a drift to the license
grammatical forms, which had not as yet been exactly restricted.
An effort was made by many to establish a more refined pronuncia
tion for the Koran than was usual in common life or in secular
literature. The various schools of "readers" differed very widely
from one another; although for the most part there was no im
portant divergence as to the sense of words. A few of them grad

ally rose to special authority, and the rest disappeared. Seven reader[illegible] are generally reckoned chief authorities, but for practical purposes this number was continually reduced in process of time, so that at pre[illegible]ent only two "reading-styles" are in actual use, – the common style of Hafs, and that of Nafi', which prevails in Africa to the west of Egypt. There is, however, a very comprehensive mas[illegible]oretic literature in which a number of other styles are indicated. The invention of vowel-signs, of diacritic points to distinguish consonants formed com[illegible]onants, and of other orthographic signs soon put a stop to arbitrary conjectures on the part of the readers. Many scribes objected to the introduction of these innovations in the sacred text, but theological consistency had to yield to practical necessity. In accurate copies, indeed, all such additions, as well as the title of the sūras etc., are written in coloured ink, while the black character professes to represent exactly the original of Othman. But there is probably no copy quite faithful in this respect.

In European libraries, besides innumerable modern manuscripts of the Koran, there are also codices or fragments, of high antiquity, some of them probably dating from the 1st century of the Flight. For the restoration of the text, however, the works of ancient scholars on its readings and modes of writing are more important than the manuscripts, which however elegantly they may be written and ornamented proceed from more or less unskilful copyists. The original, written by Othman himself, has indeed been exhibited in various parts of the Mohammedan world. The library of the India Office contains one such manuscript, bearing the subscription: "Written by Othman the son of 'Affan." These, of course, are fabulous forgeries, although of very ancient date, as are those which profess to be from the hand of 'Ali, one of which is preserved in the same library. In recent times the Koran has been often printed and lithographed, both in the East and the West.

Shortly after Mohammed's death certain individuals applied themselves to the exposition of the Koran. Much of it was obscure from the beginning to other sections were unintelligible apart from a knowledge of the circumstances of their origin. Unfortunately, those who took possession of this field were not very honourable. Ibn 'Abbas, cousin of Mohammed, and the chief source of the traditional exegesis of the Koran, has, on theological and other grounds, given currency to a number of falsehoods, and at least some of his pupils have emulated his example. These earliest expositions deal more with the sense and connection of whole verses than with the separate words. Afterwards, as the knowledge of the old language declined, and the study of philology arose, more attention began to be paid to the explanation of vocables. A good many fragments of this older theological and philological exegesis have survived from the first two centuries of the Flight, although we have no complete commentary of this period. Most of the exposition must still be found in the very large commentary of the celebrated Tabari (A.D. 839-923), of which an almost complete copy is in the Viceregal library at Cairo. Another very famous commentary is that of Zamakhshari (A.D. 1075-1144), edited by Nassau Lees (Calcutta, 1856), but this scholar, with his great insight and still greater subtlety, is too apt to read his own scholastic ideas into the Koran. The favourite commentary of Baidawi (*ob.* A.D. 1286), edited by Fleischer, Leipsic, 1846-1848, is little more than an abridgment of Zamakhshari's. Thousands of commentaries on the Koran, some of them of prodigious size, have been written by Moslems; and even the number of those still extant in manuscript is by no means small. Although these works all contain much that is useless or false, yet they are invaluable aids to our understanding of the sacred book. An unbiassed European can, no doubt, see many things at a glance more clearly than a good Moslem who is under the influence of religious prejudice; but we should still be helpless without the exegetical literature of the Mohammedans. Nevertheless, a great deal remains to be accomplished by European scholarship for the correct interpretation of the Koran. We want, for example, an exhaustive discussion and discussion of all the Jewish elements in the Koran; a praiseworthy beginning has already been made in Geiger's youthful essay *Was hat Mahomet aus dem Judenthume aufgenommen?* (Bonn, 1833). We want especially a thorough commentary, executed with the methods and resources of modern science. No European language, it would seem, can even boast of a translation which completely satisfies modern requirements. The best are in English: where we have the extremely paraphrastic, but for its time admirable translation of Sale (repeatedly printed), that of Rodwell (1861), which seeks to give the pieces in chronological order, and that of Palmer (1880), who wisely follows the traditional arrangements. The introduction which accompanies Palmer's translation is not in all respects abreast of the most recent scholarship. Considerable extracts from the Koran are well translated in E. W. Lane, *Selections from the Kur-an*.

Besides commentaries on the whole Koran, or on special parts and topics, the Moslems possess a whole literature bearing on the sacred book. There are works on the spelling and right pronunciation of the Koran, works on the beauty of its language, on the number of its verses, words, and letters, etc.; nay, there are even works which would nowadays be called "historical and critical introduction." Moreover, the origin of Arabic philology is intimately connected with the recitation and exegesis of the Koran. To exhibit the importance of the sacred book for the whole mental life of the Moslems would be simply to write the history of that life itself, for there is no department in which its all pervading but unfortunately not always salutary influence has not been felt.

The unbounded reverence of the Moslems for the Koran reaches its climax in the doctrine that this book, as the divine word, *i.e.* as thought as remanent in God, and consequently *eternal* and *uncreated*. That doctrine has been accepted by almost all Mohammedans since the beginning of the 3d century. Some theologians did indeed protest against it with great energy; it was in fact too preposterous to declare that a book composed of unstable words and letters, and full of variants, was absolutely divine. But what were the distinctions and sophisms of the theologians for, if they could not remove such contradictions, and convict their opponents of heresy!

The following works may be specially consulted: Weil, *Einleitung in den Koran*, 2d ed., 1878; Th. Nöldeke, *Geschichte des Qorân's* (Göttingen, 1860), and the Lives of Mohammed by Muir and Sprenger. (TH. N.)

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Zaid b. 'Ali, 575.
Ziyad, 566, 567.

Note. Arabic has only three short vowels, *a*, *i*, *u*, which are pronounced between the short sounds of *a* and *e*, *e* and *i*, *o* and *u* respectively. In the transcription adopted these are represented by *a* or *e*, *i* or *e*, and *o* or *u* respectively. The corresponding long vowels are *ā*, *ī*, *ū*. The letter *w* (*wāw*) has the sound of English *w*, and *y* (*yā*) that of English *y*. The diphthongs *aw* and *ay* are pronounced by English scholars as in *now* and *day*. In the transcription of consonantal *th* is as the *th* in *thin*, *dh* the *th* in *the*, *dh* and *z* are pronounced as in English, *s* is always sharp as in *sin*, *sh* is equivalent to English *sh*, *kh* (often written *ch*) nearly the Scottish or German *ch*, *h* is a deep breathing, seldom pronounced by Europeans; *gh* a guttural something like the modern Greek γ or the Northumberland burr. In a few names the conventional spelling is used. In proper names *b.* stands for *ibn*, "son of."

H, Jules (1800-1876), Orientalist, was born at
rt 25th October 180 , and educated for the Lutheran
at Tübingen; bu his inclinations carried him from
y through Hebre to Oriental studies, and in 1823
ook himself to Paris, at that time under De Sacy
nt European school of Eastern letters. He soon ac
reputation, and from 1826 to 1833 was nominally
or at Tübingen, with permission to continue his
in France, but he never entered on the duties of
lice, Paris having become his second home. In
e was charged by the French Government with the
tion of an edition of the *Shah Nameh*, the first
of which appeared in 1838, while the seventh and
s left unfinished at his death, in 1844. He was
ted to the Institut, and in 1847 he became pro
f Persian at the College de France. But his know
nd interest extended to all departments of Oriental
, and this catholicity of taste, united to a singular
ality of judgment and breadth of view, gave him a
emarkable personal influence on the course of East
rning in France. The chief sphere of the influence
Société Asiatique, which he served for many years
tary-adjunct, as secretary, and finally as president
nual reports on Oriental science presented to the
from 1840 to 1867, and collected after his death (4th
y 1876, at Paris) under the title *Vingt-sept Ans des
Orientales* (Paris, 1879), are an admirable history
progress of Eastern learning during the years, and
the high esteem in which he was held by scholars.

HLER, Johann Adam (1796-1838), Roman Catholic
ian, was born at the village of Igersheim in Wür
g on 6th May 1796, and, after studying philosophy
eology in the Lyceum at Ellwangen, entered the
nstift in the university of Tübingen in 1817.
d to the priesthood in 1819, he was appointed to
at Riedlingen, but speedily returned as "repetent"
ngen, where he became privat docent in 1822, ex
nary professor of theology in 1826, and ordinary in
The controversies excited by his *Symbolik* (1832)
so unpleasant that in 1835 he accepted a call to
versity of Munich. In 1838 he was appointed to
anery of Würzburg, but died shortly afterwards
pril 1838).

r wrote *Die Einheit in der Kirche* (Tübingen, 1825),
*ius der Grosse u. d. Kirche seiner Zeit im Kampfe mit d.
nus* (2 vols., Mainz, 1827); *Symbolik, oder Darstellung der
schen Gegensätze der Katholiken u. Protestanten nach ihren
en Bekenntnisschriften* (Mainz, 1832, 8th ed., 1874-75,
nsl. by J. B. Robertson, 1843), and *Neue Untersuchungen
egensätze zwischen den Katholiken u. Protestanten* (1834).
ammelte Schriften u. Aufsätze were edited by Döllinger in
is *Patrologie* by Reithmayr, also in 1839, and a *Biographie*
ner was published at Ratisbon in 1866. It is with the
e that his name is chiefly associated, the interest excited
Protestant circles is shown by the fact that within two
its appearance it had elicited three replies of considerable
ne, those namely of Baur, Marheineke, and Nitzsch. But
characterized by abundant learning and acuteness, as well
siderable breadth of spiritual sympathy, and thus a stimula
suggestive work, it cannot be said to have been accepted
olics themselves as embodying an accurate objective view
ctual doctrine of their church. The liberal school of
of which Möhler was a prominent exponent was dis-
in official circles, while Protestants, on the other hand
n that the author has failed to grasp the vast significance
Reformation as a great movement in the spiritual history
nd, while expending needless pains on an exposition of
rinal shortcomings, inconsistencies, and contradictions of
viduals who were its leaders.

IR, Karl Friedrich (1806-1879), a philosopher
greatest claims to scientific distinction are as yet,
indubitable, only partially admitted, was the son
ell-to-do druggist in Coblentz, and was born 4th
ber 1806. Being a delicate child, he received much
arly education at home, in great part in his father's
laboratory. To this may be traced much of the sk
showed in devising instruments and methods of ap
which are still in common use in chemical and pharm
tical laboratories. At the age of 21 he studied chem
under Gmelin, and, after five years spent in Heide
Berlin, and Bonn, returned with the degree of Ph.D. t
his father's establishment. On the death of his fath
1840 he succeeded to the business, retiring from it for
the bar in 1857. Serious pecuniary losses led h
the age of 57 to become a privat docent in Bonn, whe
was soon after appointed, by the direct influence o
Emperor, extraordinary professor of pharmacy. In
vate and domestic life he was a man of singularly wi
manners, intensely fond of music and poetry, to the
of which he showed wonderful memory. But his m
prominent spirit perhaps we might even in some
say his wrongheadedness in matters of scientific and
logical authority had raised such a host of enemies
even royal influence could not secure his further adv
ment. Although he stood at the very head of the
the pharmacists of Germany, his name was deliber
omitted from the list of the commission entrusted
the preparation of the *Pharmacopoea Germanica*,
in that work many of his ideas and processes were
porated by the very men who had previously denou
them. He died in October 1879.

Mohr's best known work is his *Lehrbuch der chemisch-analy
Titrirmethode* (1855) which has already run through many ed
and which was specially commended by Liebig. His improve
in methods of chemical analysis or apparatus fill scores of
extending over some fifty years. He also published a numb
physical papers on subjects such as Hail, St Elmo's Fire, Geom
&c., and a curious notice of the critical position of Ozone
shows that Homer, on four different occasions, mentions th
pharous smell produced by lightning, and employs the very
from which the name of Ozone was long afterwards coined
1866 appeared his *Geschichte der Erde, ein Versuch auf
Grundlage*, which has obtained a wide circulation.

But he will be remembered in future time mainly on acc
a paper *Ueber die Vorstellung der Kraft* published in 1837
unfortunately has not yet appeared in full in English trans
The history of this paper is remarkable. It was rejected ad
into *Poggendorff's Annalen* and was then sent to Baumgart
Vienna, in whose *Zeitschrift für Physik &c.* it was at once publ
As no proof-sheets reached Mohr, he concluded that his pap
been lost or rejected and contented himself with publishing
analysis in the *Annalen der Pharmacie* of which he was an
This analysis is only true to a very inadequate idea of the scope and
of the paper. In 1861 Dr Ahrens unearthed the paper fro
forgotten pages of the *Zeitschrift* and the author was glad
reprint it with notes, while the recent discussions as to the h
of Conservation of Energy were still being carried on. Alon
it he issued a number of other papers of scientific interest mainly

Unless some still further author should be discovered, the
be no doubt that Mohr is to be recognized as the first to enu
in its generality what we now call the conservation of energy.
the title of his paper must be stated in his own words, "Ein
the 54 known chemical elements there is but one physical
one agent only, called Kraft (energy)." It may a
according to circumstances as motion, chemical affinity, coh
electricity, light, and magnetism, and from any one of
forms it can be transformed into any of the others." Even
after nearly half a century of rapid advance it would be
be difficult to improve this statement except by omitting, as
transformation of energy is one such guarding expression
whose origin in part.' But if Mohr has asserted the principle
has claim to be the 'discoverer of energy' (as Meikle's epitaph
appears to have been the discovery (by Forbes) of the polari
of radiant heat. He goes through the whole of the theore
physics, pointing out the explanation of each experimental re
a transformation of energy mentioning even the electric cu
produced by electro-magnetic induction as a transformation
energy required to draw the coil from the magnet, one of the
method used by Joule for quantitative determination. H
merical results, based on data quoted from various books, ar

[1] It is to be remembered that even the most eminent author
Germany—as for instance, Von Helmholtz in his *Erhaltung der Kraft* of 1847
till quite recently the word Kraft in the sense of Energy.

very inaccurate; the correct experimental determinations we Joule. But it must be remembered that these speculations, as they were and accurate on the whole) as they have been to be required the confirmation which they received from the mental work of Colding and Joule, or from the *Essay* of Von holtz, whose basis also is wholly experimental, being the fact "perpetual motion" is recognized as unattainable.

OIR, David Macbeth (1798-1851), the "Delta" of *Magazine*, one of its most popular contributors early days, was born at Musselburgh 5th January and was a physician in active practice there from his od to his death (6th July 1851). He seems to have a man of winning manners and noble integrity of ter, and the intrinsic value of his poetry has been in quence somewhat over-estimated by critics of repute njoyed his personal acquaintance. He had no indis nt vein as a writer of serious verse, and his technical e as a poet do not bear examination. But his verses undoubtedly popular with the readers of the magazine time. A collection of them was edited by Thomas n 1852. As a kindly humourist "Delta" had a more l turn. His *Autobiography of Mansie Wauch*, pub separately in 1828, is a Scotch classic. And some satirical squibs on passing events were written with the life and spirit. His *Outlines of the Ancient y of Holland* (1831) evidence his industry and ver of talent. His *Sketch of the poetical literature of st Half Century* (1851) is more remarkable for the of it rhetorical ornaments than for depth or fresh l insight.

OIR, George (1800-1870), author of the treatises on ry" and "Romance" in the seventh edition of the *Encyclopædia Britannica*, and born at Aberdeen in 1800, n Edinburgh lawyer of very varied accomplishments. as appointed professor of rhetoric in 1835, professor ts law in 1861; he had a considerable success at the sh Bar, was successively sheriff of Ross and sheriff ling, and was a frequent contributor to *Blackwood's ine*. Moir honourably maintained the literary tradi of Edinburgh law. He was a man of very wide g, catholic sympathy, and fastidious taste, alive to arious degrees and kinds of excellence in literature, critical and hard to please to do justice to his own of ideas. He died in 1870.

OISSAC, chief town of an arrondissement in the ment of Tarn-et-Garonne, France, is situated on the ank of the Tarn, and on the railway line from Bor to Cette, 17 miles west-north-west of Montauban. The of St Peter, belonging to the 15th century, has a y of the 12th century, remarkable for its elaborate eautiful sculpture, representing Scriptural scenes. cted with the choir of the church is a cloister dating the beginning of the 12th century, and one of the specimens of this kind of building in France, the d arches are supported by small columns with ured capitals. The town has a large trade in corn our, and the mills afford employment to a considerable r of persons. The population in 1881 was 9202.

town owes its origin to an abbey founded between 630 40 by St Amand, the friend of Dagobert. After being ted to the saracens, the abbey was restored by Louis of me, son of Charlemagne. Subsequently it was made de- nt on Clairac; but in 1618 it was secularized by Pope Paul d replaced by a house of Augustinian monks, which was ssed at the Revolution. The town, which was erected into mune in the 12th century, was taken by Richard Cœur de and by Simon de Montfort.

OKADDASI. Shams al-Dín Abú Abdallah Moham- on Ahmad al-Mokaddasi, *i.e.*, of Jerusalem, also called hshari, was the author of a famous description of the of Islam, which much surpasses the earlier works of me kind. His paternal grandfather was an architect mence, who constructed many public works in Pales- tine, and his mother's family was opulent. He was hi a well-educated and talented man, with an exorbitant of his own qualities, and some curious affectations, suc that of imitating for each region the dialect of its inh ants. His descriptions rest on very extensive tra continued through a long series of years. His first pilg age was made at the age of twenty, but his book was published till A.H. 375 (985-6 A.D.), when he was years old. The two MSS. (at Berlin and Constantino represent a later recension (A.H. 378). The book bec known in Europe through the copy brought from I by Sprenger, and was edited by De Goeje in 1877 as third part of his *Biblioth. Geographorum Arabicorum*.

MOKANNA (*Al Mokanna'*, "the veiled") was explained above, p. 580, the surname given to Hakim 'Ata, a man of unknown parentage, originally a fulle Merv, who posed as an incarnation of Deity, and hea a revolt in Khorasan against the caliph Mahdí. Mu related of his magical arts, especially of a moonlike visible for an enormous distance which he made to rise a pit near Nakhshab. He died by poison in A.H. (779-80 A.D.).

MOKSHAN, a town of Russia, situated in the gov ment of Penza, 27 miles to the north-west of the capit the province, and 18 miles from the Ranzay railway sta It has 14,500 inhabitants, who are engaged in agricul or work in flour mills, oil works, tanneries, and pot works. A few merchants export corn and flour. Moks which was built in 1535 as a fort to protect the cou from the raids of the Tatars and Kalmuks, is suppo to occupy the site of the town of Mescheryaks, Murun mentioned as early as the 9th century. It has be rapidly to increase since the railway between Moscow Penza was made.

MOLA, or Mola di Bari, a seaport town of Italy, in province of Bari, 13 miles from Bari on the railwa Brindisi. It is an old-fashioned place with irregular str but outside of the walls several new districts have gr up. The foreign, and to some extent also the coas trade has considerably declined since 1863, and the munal population has decreased from 12,574 in 186 12,135 in 1881. Little is known about the early his of Mola; it was sold by Alphonso I. to Laudolfo Maram in 1436, and ten years afterwards to Niccolo Tovaldo.

MOLASSES. See Sugar.

MOLAY, Jacques de, a native of Burgundy, bec grand-master of the order of the Temple in 1298, was the last who held that dignity. He was burned at stake in 1314. See Templars.

MOLDAVIA. See Roumania.

MOLE (contracted form of mould-warp, *i.e.*, mo caster), a term restricted in England to the common (*Talpa europæa*), a small, soft-furred, burrowing mam with minute eyes, and broad fossorial fore feet, belon to the order *Insectivora* and family *Talpidæ*, but gene applied elsewhere to any underground burrowing an of the class Mammalia. Thus, in North America we representing the same family, the star-nosed moles (*dalura*), and the shrew moles (*Scalops* and *Scapanus*) South Africa, the golden moles of the far-removed fa *Chrysochlorida*; and in South-East Europe, Asia, South Africa, the rhizophagous rodent moles of the *Rodentia* and families *Spalacidæ* and *Muridæ* (see M MALIA, vol. xv. pp. 405, 419, figs. 64 and 96).

Talpa europæa, the Common Mole, type of the g *Talpa*,[1] is about six inches in length, of which the measures somewhat more than an inch; the body is

[1] Eight species may be recognized, and arranged, according to dentition, as follows:—

lindrical, and, owing to the very anterior position of relimbs, the head appears to rest between the ers; the muzzle is long and obtusely pointed, terd by the nostrils, which are close together in front; nute eye is almost hidden by the fur, the ear is t a conch, opening on a level with the surrounding ment; the forelimbs are rather short and very muscermmating in broad, naked, shovel-shaped feet, the normally directed outwards, each with five subequal rmed with strong flattened claws, the hind feet, on trary, are long and narrow, and the toes are provided ender claws. The body is densely covered with rect, velvety fur, the hairs uniform in length and ss, except on the muzzle and short tail, the former some straight vibrissae on its sides, while the s clothed with longer and coarser hairs. The fur is ly black, with a more or less greyish tinge, or sh black, but various paler shades up to pure have been observed.

food of the mole consists chiefly of the common orm, in pursuit of which it forms its well-known ound excavations. Its habits, so difficult to observe, any years ago most patiently studied and described Henri le Court. Like many other mammals the as a lair or fortress to which it may retire for . This is constructed with much ingenuity. It s of a central nest formed under a hillock which is in some protected situation, as under a bank, or the roots of trees. The nest, which is lined with rass or leaves, communicates with the main run by ssages, one of which only joins it directly, leading ards for a short distance and then ascending again. er three are directed upwards and communicate at intervals with a circular gallery constructed in the part of the hillock, which in turn communicates by sages leading downwards and outwards with another urger gallery placed lower down on a level with the nest, from which passages proceed outwards in t directions, one only communicating directly with in run, while the others, curving round, soon join, in culs-de sac. The main run is somewhat wider e animal's body, its walls are smooth, and formed ly compressed earth, its depth varying according nature of the soil, but ordinarily from four to six Along this tunnel the animal passes backwards and ds several times daily, and here traps are laid by tchers for its capture. From the main run numerous es are formed on each side, along which the animal ts prey, throwing out the soil in the form of mole The mole is the most voracious of mammals, and, ived of food, is said to succumb in from ten to hours. Almost any kind of flesh is eagerly devoured ive moles, which have been seen by various observers, naddened by hunger, to attack animals nearly as s themselves, such as birds, lizards, frogs, and even ; toads, however, they will not touch, and no form etable food attracts their notice. If two moles be d together without food, the weaker is invariably ed by the stronger. They take readily to the water respect, as well as in external form, re-emuling their

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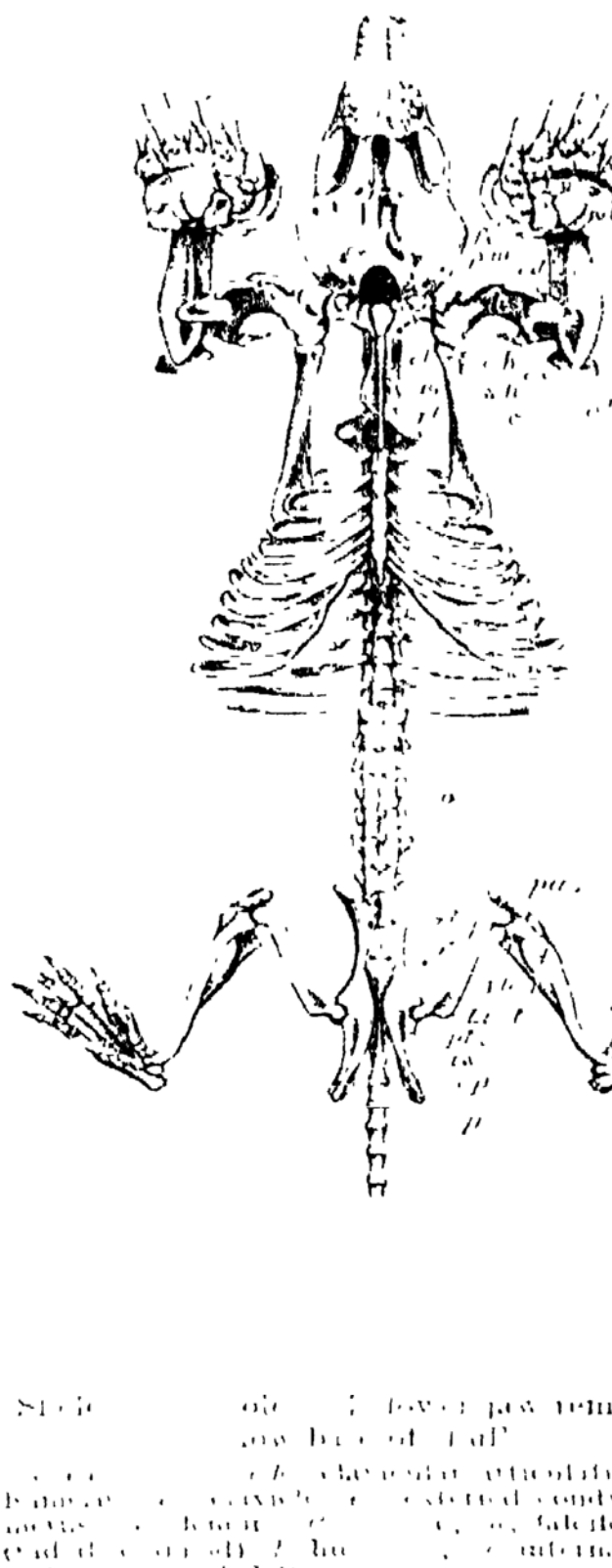
i. $\frac{3}{3}$, c. $\frac{1}{1}$, prm. $\frac{4}{4}$, m. $\frac{3}{3}$ × 2 (*T. wogura*).
i. $\frac{3}{3}$, c. $\frac{1}{1}$, prm. $\frac{4}{4}$, m. $\frac{3}{3}$ × 2 (*T. europæa, caca, longura, tal. micrura*).
i. $\frac{3}{3}$, c. $\frac{1}{1}$, prm. $\frac{3}{3}$, m. $\frac{3}{3}$ × 2 (*T. leucura, leptura*).
i. $\frac{3}{3}$, c. $\frac{1}{1}$, prm. $\frac{3}{3}$, m. $\frac{3}{3}$ × 2 (*T. moschata*).

t in *T. europæa*, the eyes are covered by a membrane. In *ura* the short tail is concealed by the fur. *T. europæa* ex- om England to Japan. *T. caca* is found south of the Alps, the g species are all Asiatic, and of them two only *T. micrura* —occur south of the Himalayas. (See Dobson, *Mono the Insectivora*, Part ii., 1883.)

representatives on the North American continent. writing in 1793, remarks that he saw a mole p towards a small island in the Loch of Clunie, 18 from land, on which he noticed molehills.

The sexes come together about the second w March, and the young generally from four to number which are brought forth in about six quickly attain their full size.

The mole exhibits in its whole organization the most adaptation to its peculiar mode of life. In the structu



skeleton very strikin departure from the typical mammalian form are noticeable. The first dorsal bone is so much produced anteriorly as to extend forward as far as a vertical line let down from the second cervical vertebra carrying with it the very short almost quadrate cla

culated with it inferior extremity and distally with the humerus being also connected ligamentously with the scapula. The forelimbs are thus brought opposite the ends of the neck and from this position a three-fold advantage is derived. In the first place, as this is the narrowest part of the body, they add but little to the general width, which if increased, would lessen the power of movement in a confined space; secondly, this position allows of a longer forelimb than would otherwise be possible, and so increases its lever power; and thirdly, although the entire limb is relatively very short, its anterior portion enables the animal when

burrowing, to thrust the claws so far forward as to be in a line with the end of the muzzle, the importance of which is evident. Posteriorly, we find the hind limbs similarly removed out of the way by approximation of the hip joint to the centre line of the body. This is effected by inward curvature of the innominate bones at the ischia to such an extent that they almost meet in the centre, while the pubic bones are widely separated behind. The shortne

It is very interesting to observe how, in the golden (*Chrysochloris*) of South Africa, the necessary modifications in the more posterior parts of the body and limbs fit them for action and meet ground pressure have been brought about in a totally different manner. In them the manubrium sterni is anteriorly elongated, neither are the clavicles shortened in order to be made up for by a deep hollowing out of the anterior end of the thorax, the ribs in these parts and the sternum being convex. The long clavicles have their distal extremities pushed forward and convexities on the side and internal surface of the thorax for the thick muscular arms.

In Jacobs's *Tabulæ Europæ Anatomicæ* (Jena, 1816) the pa pelvic wall marked *pl* in the figure was identified with the s

is due to the humerus, which, like the clavicle, is so duced in length as to present the appearance of a X-shaped bone, with prominent ridges and deep depres- the attachments and origins of the powerful muscles d with it. Its proximal extremity presents two rounded ne: the smaller, the true head of the bone, articulates as h the scapula; the larger, which is really the external rounded off, forms a separate synovial joint with the end vich. This double articulation gives to a naturally loose rigidity necessary to support the great lateral pressure by the forelimb in excavation. The forearm bones are ut those of the forefoot are much flattened and laterally . The great width of the forefoot is also partly due to nce of a peculiar tabiform bone, lying on the inner side of and articulating by its proximal extremity with the wrist radial side and under surface of this bone is inserted a rived from that of the palmaris longus muscle, which, on it as in deluctor, operates it from the side of the l so increases the width of the latter, at the same time the palmar integument to e

ch acting on these remarkably modified limbs are ill n with those of the ordinary mammalian forelimb, differing only relative development. The tendon of the biceps flexor cu sors tunnels, formed by the great expansion of the internal epital crest for the insertion of the large pectoralis major the internal division of the latter muscle is connected sternum, extending across a muscular band between the nd co-ordinating the motions of the forelimbs. The true d latissimus dorsi muscles are of enormous size, probably larger than in any other mammal, and are inserted to to the prominent ridge below the pectoral attachment, the principal agent in the excavating action of the limb eal muscles connecting the slender scapula and through forelimb with the centre line of the neck and with the are large, and the ligamentum nuchæ between them is as in all true moles); the latter condition appears to be due to the prolongation forwards of the sternum (described above), preventing all flexion of the head downwards; and, accordingly, the normal office of the ligament being lost, it ossifies, and so affords a more fixed point for the origins of the superficial cervical muscles.

The skull is long, with slender zygomatic arches; the nasal bones are strong and early become united, and in front of them the nostrils are continued forwards in tubes formed of thick cartilage, the septum between which becomes partially or wholly ossified beneath. There are 7 cervical, 13 dorsal, 6 lumbar, 6 sacral, and 10-12 caudal vertebræ; of the dorsal and lumbar there may be one vertebra more or less. The sacral vertebræ are united by their greatly expanded and laterally compressed spinous processes, and all the others, with the exception of the cervical, are very closely and solidly articulated together, so as to support the powerful propulsive and torsional actions of the limbs. Dentition: i. $\frac{3}{3}$, c. $\frac{1}{1}$, prm. $\frac{4}{4}$, m. $\frac{3}{3}$, = 44 teeth. The upper incisors are simple chisel-edged teeth; the canines are long and two-rooted, then follow three subequal conical premolars and a fourth, much larger, and like a canine; the canines are preceded by three molars with W-shaped cusps. In the lower jaw the three incisors on each side are slightly smaller, and stand more forwards, close behind them is a tooth which, though quite like them, must, from its position in front of the upper canines when the jaws are closed, be considered as the canine; behind it, but separated by an interval, is a large double-rooted conical tooth, the first premolar; the three following premolars are like the corresponding teeth above, but smaller, and are succeeded, as above, by three molars.

The *geographical distribution* of the common mole may be said to exceed that of all the other known species of the genus to which it belongs taken together. It extends from England to Japan, and from the Dovre-Fjeld Mountains in Scandinavia and the Middle Denmark countries in Russia to southern Europe and the southern slopes of the Himalaya, where it occurs at an elevation of 10,000 feet. In Great Britain it is found as far north as Caithness, but in Ireland and in the Western Isles of Scotland (except Mull) it is altogether unknown. (G. E. D.)

MOLECULE

conception of the atomic as opposed to the con nous and infinitely divisible constitution of matter, posed that portions of matter called *atoms* exist, re separated, or are capable of being separated, from er by empty space. (See ATOM.) It may be that t each atom has unchangeable shape and volume as unchangeable mass, but such a conception of is not essential to the hypothesis. It is not even y, as explained in the article ATOM (vol. iii., pp. to maintain that no part of space can be in two the same time. But one attribute of the atom hich its permanence, or, so to speak, its personal depends, is its constituent mass, and this remains , unchanged and unchangeable, through all time vich, indeed, goes so far as to regard the atom as centre of force, the result of whose existence is that atoms or centres can approach each other within a distance, while other physicists regard the atom as a distinct portion of space occupied by that the exclusion of every other, and consisting t matter ideally infinitely divisible, but the parti- h in fact never have been, and never can be, d from each other. In this latter mode of viewing ject, all the conclusions of mechanics which are the conception of the continuity and infinite divi of matter may be applied to the equilibrium or of each individual atom; the atomic theory merely ving the additional hypothesis that, in fact, the separ entities called atoms do exist, and that out of them stances which affect our senses are constructed ory of universal gravitation requires us to believe xistence of forces or actions between every portion of matter and every other portion, determinate in magnitude and direction, and such that, when on the infinitely divisible hypothesis the volumes of these portions are indefinitely diminished, these mutual forces are inversely proportional to the square of the distance between the portions (the distance between any two points, one in the volume of each portion, being in this case taken as the distance between the portions), and directly proportional to the products of the masses, or quantities of the two portions of matter, such forces being regarded provisionally as ultimate facts, while inviting further analysis and explanation. Chemical and chemico-physical investigations indicate the existence of other actions between portions of matter, following other and for the most part unknown laws, and rapidly becoming inappreciable as the distance between the reacting portions is increased. All these hypotheses are to be retained on the hypothesis of discrete atoms as above enunciated, the mutual actions between atoms being the resultant of the actions between the various portions of their constituent matter. The volumes of the atoms are so small that, for any sensible distances apart, the line of the resultant mutual action between them may be taken as coincident with the line joining any point in the volume of one to any point in the volume of the other, but, for distances or parts comparable with the linear dimensions of the atoms, the size and shape of their bounding surfaces must be taken into consideration, and perhaps also the law of distribution of their constituent matter within that surface. In all respects, unless we accept the Boscovichian hypothesis, we simply regard the atom as made up, so to speak, of infinitely divisible matter, while substances, as we know them, are built up of indestructible and unchangeable atoms.

With this conception of an atom, as thus explained, we might be content to rest, confessing our total ignorance of the mode in which such atoms are built up into actual substances, being satisfied to regard such substances as

whereas the true radius bore is widely separated (as shown at this mistake he has been followed by most comparative anatomd hence the mole is generally believed to present the unique y that the outlets of the urinary, generative, and digestive not pass through the arch of the pelvis.

nposed of these distinc portions of matter separated, or able of being separated, by empty space from other tions. But the *molecular* hypothesis of the constitution different kinds of substances aims at analysing this cess by which such substances are built up out of their stituent atoms. The *molecule* of any substance is, by ne chemists, defined as being the smallest portion of that stance to which can be attributed all the chemical pro ties of the substance; by others, as the smallest portion ch, so long as the substance is chemically unchanged, ps together without complete separation of its part he language of Clausius's theorem, if the parts of the ecule have internal motion, the kinetic energy of such rnal motion is equal to the virial of the mutual attrac forces of the parts. Thus the formation of the mole of each particular substance is viewed as an essential in the process of building up that substance out of constituent atoms. The molecule is first built up out atoms arranged in its formation according to a definite e, and then the substance itself is constituted of the ecules. Of course molecules may be, and in fact in y particular substances are, supposed to be more nic; that is to say, the intermediate steps of building he molecule out of the atoms have, in these particular stances, been omitted, the atoms and molecules be com hen identical. The particular arrangement of the ed molecules in the building up of the substance de ines the physical state of that substance—that is, fluid, solid, gaseous, crystalline, or amorphous state, the chemical properties of the substance depend upon constitution of the molecule. As the investigations theories of chemistry appear to indicate not merely existence of permanent atoms, so do they also lead ost as necessarily to the conception of the molecule an entity which bears the same relation to special stances that the atoms bear to matter generally. So as the molecule endures, the substance of which it he molecule retains its chemical properties, with the olution of the molecule, the substance, as that special stance, perishes; the atoms alone continue, and are free nter into other combinations. The permanence of the ecule is relative, that of the atom absolute. The con- ion of the molecular constitution of substances sug s physical questions of great interest, such as the shape, ume, and mass of the constituent molecules, and the tive motions of which their parts are susceptible; and answers to these questions cannot fail to be of great e in chemical and chemico-physical investigations, as as in the theories of light and electricity.

Now, whatever differences may exist between the proper of different substances in the solid and liquid states, re are certain properties which, in the gaseous state, ifest themselves with no variation whatever in all gases alike. Hence the explanation of these common perties—or gaseous laws, as they are called—has ssed a peculiar fascination for physicists. The ten y to expand or fill all accessible space, manifested by gases, proves that on the molecular hypothesis their pound atoms or molecules must be continually tending y apart. We must conceive gases as constituted of mole s, not only separable but actually separated by space l of the matter of which these gases consist; and it may most reasonably expected, therefore, that any general s to which substances in this state conform may afford valuable insight into the constitution of these separate ecules.

Now the general laws to which all gases conform are— *Boyle's law*—that, in a given mass of any gas kept at stant temperature, the pressure per unit of area upon containing surface increases in the same proportion as the volume occupied by the gas is diminished, or at with very slight deviation from exact proportionality *Charles's law*—that, if the temperature be varied whil pressure upon the gas remains the same, the gas incr by $\frac{1}{273}$d of its volume at zero centigrade for every d of centigrade added to the temperature, or, which in bination with Boyle's law is the same thing, that i density be constant, the pressure is directly proportion the temperature measured from the point −273 centig this point being called the zero of absolute tempera (3) *Avogadro's law*—which asserts that all gases a same temperature and pressure contain the same numb molecules in the same volume, and (4) *Dalton's law*— in a mixture of different gases, when there is equilibr each gas behaves as a vacuum to all the rest.

It was at one time considered that these phenom might be explained on the hypothesis of mutual repu forces between the parts of which the gas is compo whether they were regarded as constituted of molecul of infinitely divisible continuous matter,[1] but it has shown in the article ATOM (vol. iii. p. 39 sq.) that t are at least two absolutely conclusive reasons why thi planation cannot be accepted. These objections, toge with the experimental fact proved by Joule that gases, any rate atmospheric air, expand into vacuum without any appreciable change of temperature, must be consi fatal to any mutual force theory of gaseous action, accordingly, physicists have been driven to seek for e method of explaining these laws. The explanation w has been more developed than any other is that know the kinetic theory of gases, which regards the inte energy of a gaseous mass as residing, not in the poten energy of intermolecular forces, but mainly in the ki energy of the molecules themselves, which are assum to be in a state of continual relative velocity, admitting the same time a possible small intermolecular poten energy, and it may be also an interatomic energy, bet the atoms of the individual molecules. That some persistent relative motion does exist in every gaseous is evident from the rapidity with which odours pene the still air where no breath of wind—that is, of abs motion of translation of the mass as a whole or any po of finite size—is perceptible. It becomes an interes question whether the laws of mechanics admit of a thus constituted ever settling at a state of permane that is to say, whether consistently with the hypothes infinite irregularities in the directions and magnitud velocities of individual molecules, there may be found properties of the mass in the aggregate which re

[1] An argument in favour of the corpuscular constitution of ga which attention was recently directed by Professor Osborne Rey (Memoir "On the Dilatancy and Properties of Matter in the G State," *Phil. Trans.*, 1886) is derived from certain phen [illegible] that in the transportation of [illegible] according to this argument, we ha [illegible] such that every portion [illegible] these properties must exist [illegible] contained in any space all [illegible] could be increased or diminished by a va [illegible] argument. Further, certain properties of a gas depe [illegible] of the vessel is worked, and on the qu [illegible] we have proof that gases not contr [illegible] other words, possess dimensional structure. Such pro [illegible] defined in highly-exhausted gases, e.g. for instance in the p [illegible] of Crookes' radiometer. The motion of the vanes whe [illegible] by incident rays appears to depend on the di [illegible] between the vane and the containing wall of the vessel bearing not very high ratio to the distance between the parts [illegible] or mol [illegible] of the gas. At least no satisfactory explanation [illegible] the pheno [illegible] consistent with the gas being continuous has yet [illegible] suggested.

Again, Professor O. Reynolds, from his experiments on the [illegible] piration of gases through porous plate, finds a relation betwe [illegible] gas and the coarseness or fineness of the plate, which would no [illegible] were the gas continuous.

ant, and in agreement with the accepted laws common gases. Now the physical theory of heat compels us gard the intrinsic energy of any gaseous mass as de nt entirely or almost entirely upon the temperature. erefore, this intrinsic energy is to be sought for in inetic energy of the moving molecules, it follows he average value of the kinetic energy of the mole- taken throughout the mass must be also a function temperature.

will proceed to investigate the condition of per e of a number of molecules moving about irregu n any bounded space; and, for simplicity's sake, we fir t of all restrict ourselves to the case of monatomic ules.

know nothing of the size or shape of these atoms, that the volume of each one must be incomparably r than that of the containing region. In shape we as the simplest hypothesis, regard them as spherical, all suppose that there are no intermolecular forces en any two such atoms, except of such a nature as practically insensible when the atoms are not geo ally in contact, and similarly as regards the forces en the atoms and the material bounding surface, orces being of the nature called "conservative." So point of fact we are investigating the mechanical ies of an infinitely large number of infinitely small erfectly elastic spheres moving about in a given and subject to frequent collisions.

[illegible] *let us suppose these spheres equal in [illegible] and that a great number of them are [illegible] moving about with various [illegible] and in various relative directions in [illegible] that the average [illegible] of the kinetic energy of [illegible] that such [illegible]*

N be the total num[illegible] spheres, and let

[illegible]

number of spheres who[illegible]ment velocities parallel s, are intermediate bet[illegible]
$u + du$ respectively
be the resultant velo[illegible] of any of these last-mentioned , and if θ be the inclinat[illegible] to the axis of z, and ϕ that plane ϵ to the plane ϵ the last-mentioned expression will , by changes of the independent variables from ϵ, u, v to nd ϵ,

$$\chi(u, v, w)\epsilon^2 \sin\theta \, d\epsilon \, d\theta \, d\phi.$$

spherical surface of radius unity be described about any as centre, and let $d\sigma$ be written for the element $\sin\theta \, d\theta \, d\phi$ of surface, then the last written expression becomes

$$\chi(u, v, w)\epsilon^2 \, d\epsilon \, d\sigma.$$

for the same magnitude of the resultant velocity all direc t motion must be equally probable, it follows that the co t of $d\sigma$ in the last written expression must be a function ly, and therefore the number of spheres having component between u and $u + du$, v and $v + dv$, w and $w + dw$

$$\psi(\epsilon) \, d\epsilon \, d\sigma$$

required to find the form of ψ in order that the value of pression may be unaffected by collisions. The solution is, e number of spheres with component velocities between the u and $u + du$, v and $v + dv$, w and $w + dw$ must be

$$A e^{-h\epsilon^2} \, du \, dv \, dw,$$

$$A e^{-h\epsilon^2} \, \epsilon^2 \, d\epsilon \, d\sigma,$$

ing the notation already used

rating with respect to $d\sigma$ from 0 to 4π, we find for the of spheres with velocities between ϵ and $\epsilon + d\epsilon$ the expression

$$4\pi A e^{-h\epsilon^2} \epsilon^2 \, d\epsilon.$$

since the number with component velocities between u and $u + du$, v and $v + dv$, w and $w + dw$ is

$$A e^{-h(u^2 + v^2 + w^2)} \, du \, dv \, dw,$$

$$\left(\sqrt{A}\, e^{-hu^2} \, du\right) \quad \left(\sqrt{A}\, e^{-hv^2} \, dv\right) \quad \left(\sqrt{A}\, e^{-hw^2} \, dw\right),$$

ws that the number of spheres having velocities intermediate n u and $u + du$ parallel to the x axis is

$$A e^{-hu^2} \, du \int_{-\infty}^{\infty} e^{-hv^2} \, dv \int_{-\infty}^{\infty} e^{-hw^2} \, dw;$$

that is,

$$\frac{\pi}{h} A e^{-hu^2} \, du,$$

where A is to be determined by the equations

$$\frac{\pi}{h} A \int_{-\infty}^{\infty} e^{-hu^2} \, du = N,$$

$$A \frac{\pi^{\frac{3}{2}}}{h^{\frac{3}{2}}} = N;$$

therefore

$$A = \frac{N h^{\frac{3}{2}}}{\pi^{\frac{3}{2}}};$$

that is to say, the number of spheres having velocities betwe $\epsilon + d\epsilon$ is

$$\frac{4h^{\frac{3}{2}}}{\sqrt{\pi}} N \epsilon^2 e^{-h\epsilon^2} \, d\epsilon.$$

Multiplying this expression by ϵ, and integrating the prod regard to ϵ from 0 to ∞, and dividing by N, the mean vel all the spheres becomes

$$\frac{1}{\sqrt{\pi h}},$$

and multiplying by instead of by ϵ, we find the mean squa the velocities to be

$$\frac{3}{2h}.$$

In the preceding investigation no account has been collisions between the spheres and the enclosing boundar region in which they are contained, because in every such the magnitude of the velocity of each sphere is unaltered direction is changed according to the ordinary law of r whence it is evident that the distribution is unaffected collisions. Also, the investigation has been confined to t of spheres colliding in pairs, but since there need be no the smallness of the interval between any pair of colli result really embraces the cases of simultaneous collisions three or more spheres; for if a sphere A collides with an and immediately afterwards with a third C, the resultant of A after this second collision must be the same as if it luded with B and C simultaneously.

The foregoing investigation has been given in some detail e principles upon which it proceeds are essentially the those by which all questions of the distribution of energy great number of moving bodies are determined, although i found, as well as the detailed investigations of the result diately following, in published memoirs and systematic tre the kinetic theory of gases.

If the spheres be not all of equal mass, but if there be wi region N spheres of mass m, N' of mass m', and so on, the be proved, by reasoning exactly similar to the foregoing, th the permanent or stable state of motion has been atta number of spheres of the N set with component velocities and $u + du$, v and $v + dv$, w and $w + dw$ is

$$h^{\frac{3}{2}} \, du \, dv \, dw,$$

and the number of the N' set having component velocities u' and $u' + du'$, v' and $v' + dv'$, w' and $w' + dw'$, is

$$A' e^{-\frac{hm'\epsilon'^2}{2}} \, du' \, dv' \, dw',$$

where $\epsilon'^2 = u'^2 + v'^2 + w'^2$, h is a constant t for both sets and

$$A = \frac{N}{\pi^{\frac{3}{2}}} \cdot \left(\frac{mh}{2}\right)^{\frac{3}{2}}, \qquad A' = \frac{N'}{\pi^{\frac{3}{2}}} \cdot \left(\frac{m'h}{2}\right)^{\frac{3}{2}},$$

on if there be any other sets.

The mean velocity and mean square velocity of each sphe set a

$$\frac{2}{\sqrt{\pi}} \sqrt{\frac{2}{mh}} \text{ and } \frac{3}{mh} \text{ respectively,}$$

and the mean kinetic energy of each of such spheres is

$$\frac{3}{2h},$$

the last result being common to all the sets.

If the spheres in the given region be acted on by any giv tending to fixed centres, and functions of the distances of th of the spheres from the centres of force, we may not in s assume, *a priori*, that the chances of velocities in all direc the same; but we may assume that the number of sphere set (N) with coordinates of their centres intermediate

$+dx$, y and $y+dy$, z and $z+dz$, and component velocities
liate between u and $u+du$, v and $v+dv$, w and $w+dw$, is

$$\psi(x, y, z, u, v, w)\,dx\,dy\,dz\,du\,dv\,dw.$$

state of permanence the form of ψ must be independent
me (t), so long as the sphere is moving free from collisions
y other.

the last-mentioned condition it must follow that, if ϕ_1 u,
&c., be any equations among the variables determining the
and motion of any sphere obtained by the elimination of t
equations of motion of that sphere, then ψ must be of the
ϕ_1, ϕ_2, &c.). With the assumption, then, that the number of
of the given set with variables between the above-mentioned

$$\psi(\phi_1, \phi_2 \ldots)\,dx \ldots dw,$$

for the form of ψ, by reasoning like the foregoing,
$\left(\chi + \frac{mc^2}{2}\right)$, where χ is the potential energy of the sphere in
tion x, y, z, and $c^2 = u^2 + v^2 + w^2$, and h is a constant, the
all the sets.

integrate the expression $Ae^{-h\left(\chi + \frac{mc^2}{2}\right)}dx\,dy\,dz\,du\,dv\,dw$
values of x, y, z within the given region, we find for the
of spheres of any set with component velocities between
$+du$, v and $v+dv$, w and $w+dw$,

$$Be^{-\frac{hmc^2}{2}}du\,dv\,dw,$$

we easily see that the chances of velocities in all directions
same, and that the mean velocity and mean square velocity

phere of this set are $\frac{2\sqrt{2\pi}}{\sqrt{mh}}$ and $\frac{3}{mh}$ respectively, and the mean

energy of any such sphere is $\frac{3}{2h}$, and therefore the same for
sets.

ermore, if we integrate the expression

$$Ae^{-h\left(\chi + \frac{mc^2}{2}\right)}dx\,dy\,dz\,dw$$

values of u, v, and w from $-\infty$ to $+\infty$ respectively, we
result of the form $Ce^{-h\chi}dx\,dy\,dz$, and therefore the number
es of the set in question with centres within the elementary
$dx\,dy\,dz$, or, what is the same thing with the exception of a
t factor, the chance of the centre of any sphere of that set
ithin that elementary volume, is $Ce^{-h\chi}dx\,dy\,dz$, so that the
of the N set of matter in the neighbourhood of the point x, y,
$e^{-h\chi}$.

re now in a position to compare the physical properties of a
composed of monatomic molecules in motion, and free
y intermolecular or interatomic force with those of ordinary
long at least as the atoms are spherical.

der two contiguous portions of such a medium separated by
ne parallel to that of yz, and, since the distribution and
of each set of spheres is independent of all the other sets,
onfine our attention to the spheres of the N set. Suppose
ere are N such spheres per unit volume in the neighbourh
f the point x, y, z, whose component velocities parallel to
s of x are between u and $u+du$. The number of these
which cross the elementary area $dy\,dz$ in time dt will be
ne as the number of the dN spheres whose centres are
d within the elementary parallelepiped $dx\,dy\,dz$, in which
qual to udt, and this number is

$$Nu\,dy\,dz\,dt$$

of these spheres carries across with it a momentum parallel
ual to mu; the total momentum parallel to x transferred
$dy\,dz$ in time dt is therefore

$$mNu^2\,dy\,dz\,dt.$$

positive, this is positive momentum transferred from the
e to the positive side of the plane yz; and if u be negative,
negative momentum similarly transferred from the positive
negative side of that plane. In either case it follow that
mere motion of these spheres across the area $dy\,dz$ the
momentum parallel to the axis of x is diminished by the
$mNu^2\,dy\,dz\,dt$ on the negative side of the plane yz,
reased by the same quantity on the positive side of that
the time dt; m being, as before, the mass of each sphere
on the whole, there is a transference of positive x momentum
ime dt across the area $dy\,dz$ equal to $mdy\,dz\,dt\,\Sigma u^2N$, that
l to

$$dy\,dz\,dt\,pu^2,$$

p is the density of the N matter at the point x, y, z, and u^2
mean square of the x velocities.

either by integration or general reasoning it is easily seen
that $u^2 = \frac{v^2}{3}$, where v^2 is the mean square of the resultan
cities of the N spheres, and is equal, as we have proved, to

$$\frac{3}{mh}.$$

Therefore, there is a transference of positive momentum fr
negative to the positive side of the plane yz across the area
time dt equal to

$$\frac{p\,dy\,dz\,dt}{mh}.$$

Each separate sphere whose component velocities are u v
carries across the same area yz and xz momenta equal to mv
respectively, so that in the time dt there are carried across
$dy\,dz\,u$ and xz momenta equal to $\Sigma mvu\,dy\,dz\,dt$ and Σmwu
respectively. By symmetry it is clear that Σmvu and Σmw
separately zero. Therefore, the resultant mutual action of
portions of the medium under consideration in the time dt
transference across the elementary area $dy\,dz$ of a quantity
momentum equal to $pdy\,dz\,dt\,\frac{v^2}{3}$ from the negative to the
side of the boundary plane. If this mutual action, or, as it is
ally called, the pressure when referred to unit of surface, be
by the symbol p, we get the equation

$$p = \frac{p}{3mh}.$$

Since the momenta parallel to x and z remain unalt
follows that the mutual action or pressure between contigu
tions of the medium in the neighbourhood of any point
to the bounding surface at that point. Since also the ex
for p or $\frac{p}{3mh}$ is independent of the direction of the x axi
low that the pressure at any point of the medium in the
all directions.

If the contiguous portions of the medium be separat
material instead of an ideal plane it will be necessary for th
tenance of equilibrium that there should be an action betw
plane and the adjacent medium equivalent to the transfe
momentum estimated above. But action measured by the
unit of time at which momentum is generally continues
force or statical pressure. Hence the force or pressure betw
plane and medium measured to the plane, independent
direction of the plane through the point and equal to the

$\frac{p}{3mh}$ at the point.

When several sets of spheres are present together in the
under consideration, the distribution of the centres and
velocities of each set is, as we have seen, independent of
existence of the other sets. If therefore ρ_1, ρ_2 &c., be the
of the matter of the different sets in the neighbourhood of t
x, y, z, and if p_1, p_2 &c., be the pressures at that point de
above, and if m_1, m_2 &c., be the masses of the spheres of
the sets, and p the total pressure, we get

$$p = p_1 + p_2 + \&c.$$
$$= \frac{\rho_1}{m_1 h} + \frac{\rho_2}{m_2 h} + \&c.$$

Hence we arrive at the following conclusions: (1) the
physical quantity having the same value for every set of sp
namely, the mean kinetic energy of each sphere, or $\frac{3}{2h}$;
quantity be called τ, (2) the distribution of the positi
velocities of the spheres of each set is independent of the
ence of the remaining sets, and is in all respects the same
particular set existed alone in the region considered,
pressure at any point referred to unit of surface at any
the medium arising from the action of any one of the sets
where ρ_1 the density of that particular set at the point m
and τ is the physical quantity above referred to as common
the set.

This third inference may be expanded into the following
laws: (a) if τ be kept constant, then the pressure arisi
each set varies as the density of that set; (b) if ρ_1 be kept c
then the pressure from each set varies as τ, (c) if the
for all the sets be the same, then $\frac{p}{m\rho}$ is also the same, or t
ber of spheres per unit volume is the same.

Now suppose there is a mixture of any number of gase
region; when there is equilibrium there is one physical q
namely, temperature, which is the same for all; the

f this mixture depends, as we know, upon its temperature, energy of these moving spheres is entirely kinetic, and may ed, therefore to be a function of the mean *vis viva*. Let assume that in this medium of moving spheres we have a tation of a mass of gases, and that what is called the ture of the gaseous mass is nothing else than the τ or mean nergy of a single moving sphere. Then, with this assumption, e parts (α, β, γ) of inference (3) above come pond to the laws connected with the names of Boyle, Charles, and e respectively, and inference (2) corresponds with the law on concerning gaseous mixtures.*

ay also deduce the ordinary hydrostatical equations of om from the formulæ which we have obtained.

ince these equations give us

$$p = \frac{P}{\ }, \text{ and } p = m\int_{-\infty}^{\infty} dx \ ^{4}X,$$

$$pX, \text{ and } \frac{d}{\ } = mX,$$

larly

X, Y, and Z are the components impressed force of the s of the space variations of χ along the coordinate axes, therefore, the physical properties of a portion of an aggregate of gases correspond, in all respects, with the physical properties mum consisting of a set of elastic spheres, on of a certain size f such spheres with the sole assumption that the physical termed temperature, in the case of the gas, corresponds, esented by, the mean kinetic energy of a set of the spheres, each sphere representing the chemical atom

are however physical properties of gases which this theory explain. The most important of these is the ratio of the heat at constant volume and constant temperature respect The specific heat of a gas pressure when it is heated under nt pressure is greater than that of a gas heated with a con olume, as when it is confined in a rigid vessel, for the physical reason that in the former case a portion of the converted into mechanical work, namely, that performed by ansion under the constant pressure. The ratio of the specific gas under constant pressure to the specific heat with con olume has been determined for many gases with great ac- briefly from observation of the velocity of sound in such which velocity the value of the ratio to be arrived very im part

on the assumption of the gas being constituted of a number spheres in rapid but irregular motion among each other, physical property of temperature being represented or by the mean energy of each sphere the ratio of these heats must be exactly 1⅔.

v be the volume occupied by a unit of mass of the moving medium, and ρ the number of spheres to be in unit volume, and the density, it follows that

$$\rho = \rho v = 1$$

we know that p, the pressure referred to unit of surface, is given by equation

$$p = \frac{2}{3} \rho\tau,$$

is the mean energy $= \rho\tau v$. If now τ increase from τ to $\tau + \delta\tau$, remains constant, the increase of intrinsic energy must be unit, $\rho\delta\tau$. Also if there be a similar change in τ without ction of τ being constant, but supposing p to be constant, external mechanical work performed equal to $p\delta v$, where ncrease of volume. Also

$$p\delta v = \frac{2}{3} \rho\delta\tau,$$

nce the whole energy required to be supplied from without s is the

$$\rho\delta\tau + \frac{2}{3} p\delta v$$

ratio of the increase to be supplied from without, in order e mean energy of the moving sphere medium should be d by the same amount in the two cases respectively becomes

erefore the gaseous mass be adequately represented by the sphere medium, the ratio of the specific heats must be 1⅔. ury vapour is the only gas for which the ratio has so large as this. Several of the more permanent gases have the qual to 1·408, while in others it falls as low as 1·26. The or mercury vapour, as determined by Kundt and Warburg (*Poggendorff*, clvii. 353), is between 1·695 and 1·631, the mea the observations being somewhat under 1·6. If any valu 1·6 be insisted on it will be impossible to retain the th above enunciated. In point of fact we may say, in anti of what has yet to come, that there is no modification of the theory as hitherto treated which could give a higher value ratio in question than 1⅔.

It follows from what has been proved that either all know and vapours, except the vapour of mercury, and perhaps ca nn t be polyatomic, or else that the attempts to explain the ction of gases by the kinetic theory must be abandone must therefore proceed further to investigate the physic perties of a medium consisting of compound atoms or m built up of atoms in any definite arrangement, such molecul in a condition of irregular motion among themselves, suc have supposed in the cases of the spherical atoms hither sidered

It will be observed on reference to the cases of the spheres investigated, that, whether there be forces to fixed centres i on the medium or not, the chance of any sphere having the nate of its centre and its component velocities between x and $x+dx$, y and $y+dy$, z and $z+dz$, u and $u+du$, v and $v+dv$, w and $w+dw$ proportional to $e^{-hE} dx\,dy\,dz\,du\,dv\,dw$, where E is the total kinetic and potential of the sphere in the state of posit motion defined by x, y, z, u, v, w.

We may generalize this proposition, and prove that w sphere is replaced by a molecule of any shape and constitu as to be defined as to position and motion by r generalized ordinates $q_1 \ldots q_r$, with the corresponding momenta $p_1 \ldots p_r$, the el the molecule having r of these variables between the limit q_1 and $q_1 + dq_1$, p_1 and $p_1 + dp_1$, &c., or, what is the same thing, the nu such molecules at any time with variables thus limited, there be forces to fixed centres or not, and whether inte forces or intermolecular forces are or are not in action on th ecular aggregate, is proportional to

$$e^{-hE} dq_1 \ldots dp_r,$$

where h is a constant, the same for all molecules, and E total energy, kinetic and potential, of the molecule in the s as to position and motion, the potential energy being tha fixed centre forces on the molecule, together with that of i atomic forces in the given position.

The problem before us may be stated thus:—

A number of similar molecules possessing in the whole n of freedom, where n is very large, are in motion in a region bounded by a material envelope, under the action either to fixed centres (called external forces) or of forces between molecules and different parts of the same molecule, as we forces between the fixed boundary and the contained mole of them conservative, so that the total energy, kinetic and p of the aggregate remains always the same; it is required to chance of a grouped any one or more molecules possessin whole s degrees of freedom, defined by the coordinates q_1 momenta $p_1 \ldots p_s$, where s is small compared with n, ha variables between the limits q_1 and $q_1 + dq_1$, p_s and $p_s + dp$

We might start with the assumption made above in th the points under central forces, that this chance must b form

$$\psi(\phi_1, \phi_2, \&c.)\, dq_1 \ldots dp_s,$$

where ϕ_1, ϕ_2, &c., are obtained by the elimin t between the equations of motion of the s group under t centre and boundary forces and those between its componen because there is nothing in the conception of a molecul that of a system with a number of degrees of freedom, a internal forces; and in this case, considering the generali assumption as to the external forces, it would be impossibl erive the existence of any general equation, independent of between the variables, except that of the conservation of e that the chance in question becomes

$$\psi(E_s)\, dq_1 \ldots dp_s,$$

where E_s is now defined, and it remains to determine the f

If we considered a second group of one or more molec having s' degrees of freedom (where s may or may not be s', but, like s, is much smaller than n), and defined by the co and momenta $q_{s+1} \ldots q_{s+s'}$, $p_{s+1} \ldots p_{s+s'}$, then the two groups contain $s+s'$ degrees of freedom defined by the variables and since $s+s'$ is small compared with n, the chance of t having its variables between q_1 and $q_1 + dq_1 \ldots p_{s+s'}$ and $p_{s+s'}$ must be

$$\psi(E_{s+s'})\, dq_1 \ldots dp_{s+s'}$$

But this chance must be equal to the chance of the s gro fixed in the state $q_1, q_1 + dq_1 \ldots p_s, p_s + dp_s$, multiplied by th of the remaining s' group being in the state q_{s+1}, q_{s+1} $p_{s+1} \ldots p_{s+s'}$ $dp_{s+s'}$, where the s group are so fixed.

to find this latter chance we observe that it is the chance of group being in their required limits of position and motion, the internal forces between the r and s group become forces on the s group and fixed centres.

he total kinetic energy of the r group in their given state be d that of the $r+s$ group be T_{r+s}, the total kinetic energy of group must be $T_{r+s} - T_r$.

if the total potential energy of the $r+s$ group under the ce of all forces be χ_{r+s}, this is made up of-

χ_r, the potential energy of the r group to fixed centres, and of its internal forces;

χ_s, similarly taken for the s group; and

χ_{rs}, the potential energy of the r and s group forces.

hen the r group is fixed the potential energy of the s group ced to (2) and (3), or is $\chi_{r+s} - \chi_r$.

refore the chance of the s group having its variables within quired limits when the r group is fixed must be

$$\psi(E_{r+s} - E_r)\, dq_{r+1} \ldots dp_{r+s},$$

fore

$$\psi(E_r)\,\psi(E_{r+s} - E_r)\, dq_1 \ldots dp_{r+s} \quad \psi(E_{r+s})\, dq_1 \ldots dp_{r+s},$$

$$\psi(E_r)\,\psi(E_{r+s} - E_r) \quad \psi(E_{r+s}),$$

fore $\psi(x) = e^{-hx}$ suppose

he chances of the r group having its variables between the q_1 and $q_1 + dq_1 \ldots p_r$ and $p_r + dp_r$ must, in the state of per t or stable motion, be proportional to

$$e^{-hI_r}\, dq_1 \ldots dp_r,$$

was to be proved.

posing now that the aggregate of molecules under consideration consists of a number of sets of similar molecules, the number of ecules in one of these sets being N, where N is very large, pose that each of these N molecules possesses σ degrees of m defined by the coordinates $q_1 \ldots q_\sigma$ with the momenta , and that its mass is m. Three of the σ coordinates may ken as the rectangular coordinates of its centre of mass, in case the corresponding momenta will be mu, mv, mw, where nd w are the component velocities of translation of that centre ss. Then in this case, if $q_4 \ldots q_\sigma, p_4 \ldots p_\sigma$ be the remaining nates and momenta of the molecule, the chance of the molecule variables being within the limits x and $x + dx$, etc., p_σ and p_σ will be proportional to

$$e^{-h(\chi+T)}\, dx\, dy\, dz\, dq_4 \ldots dp_\sigma \qquad \text{(I)},$$

T, the kinetic energy of the molecule, is equal to

$$\frac{1}{2}(u^2 + v^2 + w^2) + \ldots,$$

f is a quadratic function of the p's, having as coefficients functions of the q's.

e integrate the expression (I) for all possible values of $p_4 \ldots p_\sigma$, we obtain an expression of the form

$$Be^{-h\frac{m}{2}(u^2+v^2+w^2)}\, du\, dv\, dw \qquad \text{(II)},$$

B is independent of u, v, and w, and $\frac{m}{2}(u^2+v^2+w^2)$ From m of (II) it follows, exactly as in the case of the elastic spheres, he chances of all directions of the velocity of translation of a ule are equal, that the mean velocity and mean square velocity nslation of each molecule are

$$\frac{2}{\sqrt{\pi}}\sqrt{\frac{1}{mh}} \text{ and } \sqrt{\frac{1}{mh}}$$

tively, and that the mean kinetic energy of translation is the same for a molecule of any set.

in, if T' be the mean total kinetic energy of the mole

$$T' = \frac{\iiint \ldots T e^{-h(\chi+T)}\, dx \ldots dp_\sigma}{\iiint \ldots e^{-h(\chi+T)}\, dx \ldots dp_\sigma}$$

we evaluate this expression, paying attention to the form of quadratic function of the p's mentioned above, we shall find I) the expression $\frac{\sigma}{2h}$.

ollows from this result that each additional degree of molecule increases the mean total kinetic energy of the mole y the quantity $\frac{1}{2h}$, which is the mean kinetic energy of trans- parallel to any one of the axes, and that the total kinetic is proportional to the number of such degrees of freedom.

again, we integrate the expression (I) for all values of the nta, we obtain an expression of the form

$$Ce^{-h\chi}\, dx\, dy\, dz\, dq_4 \ldots dq_\sigma \ldots\ldots\ldots\ldots \text{(IV)}.$$

χ is the potential energy of the molecule due to fixed centres and to interatomic forces in the position defined by x, y, z, The dimensions of the molecule are so small that we may forces from each fixed centre on different parts of the mol parallel and equal and functions of the distance of the mass from that fixed centre, so that, if the part of χ arisi these fixed centre forces be called χ_1, χ_1 will be a function and of these variables only, the remaining part of χ (arisi interatomic forces), which may be called χ_2, will be a fun the $\sigma - 3$ variables $q_4 \ldots q_\sigma$.

If in (IV) we write $\chi_1 + \chi_2$ for χ, and then integrate for a of $q_4 \ldots q_\sigma$, we obtain an expression of the form

$$De^{-h\chi_1}\, dx\, dy\, dz,$$

where D is independent of x, y, z, and therefore ρ the de the N molecular matter in the neighbourhood of the point x

$$\rho = De^{-h\chi_1}.$$

From the result all the propositions proved above with r to the aggregate of elastic spheres or monatomic molecules, correspondence of the physical properties of such an aggreg those of gases as indicated by the gaseous laws, may be also for this aggregate of polyatomic molecules. So that equal to $\frac{3}{2h}$, or the mean kinetic energy of agitation of an the aggregate of moving molecules. If v be the volume occ unit of mass, ρ the number of molecules in unit of volume the mass of each molecule, we have, exactly as in the case to,

$$mv = 1, \quad p = 1,$$

and

$$p = \frac{2}{3}\rho T.$$

We also get the ordinary hydrostatical equations

$$\frac{dp}{dx} = \rho X, \quad \frac{dp}{dy} = \rho Y, \quad \frac{dp}{dz} = \rho Z$$

from the expression for p combined with the equation

$$\rho = mDe^{-h\chi_1},$$

remembering that

$$\frac{d\chi_1}{dx} = -X,$$

whence the correspondence of the physical properties of this po polyatomic monatomic molecule with those of a gas, on the tion that the temperature represents the mean kinetic e agitation, is at once apparent.

It can be shown also that the aggregate of moving mo such as we conceive gases to be, possesses another very im physical property which, by its analogy to the second law of dynamics, affords additional evidence of the relation betw phenomena of heat and those of aggregation in one kind of m the property in question being that if in any aggregate of molecules the mean kinetic energy of any one of them be , and if δQ be an increment of energy imparted to the a from without, then $\int \frac{\delta Q}{T}$ a perfect differential.

If to this aggregate we apply a certain small quantity δQ or energy from without, and if δT be the increase of th kinetic energy of agitation, while the volume is unaltere the containing vessel prevents any of the energy δQ fro absorbed in doing external work, but it is conceivable t increase of T may cause such a change in the average fat molecule as to produce a variation $\delta\chi$ in the mean potentia of the molecule, $\delta\chi$ being proportional to δT.

Therefore $\int \frac{\delta T}{T}$

But

$$\int \frac{\delta\chi}{T}$$

therefore

$$\int \frac{\delta\chi}{T}$$

If the volume vary by $\delta\tau$, the pressure being constant, then additional external energy, to the energy absorbed, so that if external energy now applied be $\delta Q'$, and the increase of temperature δT be the same in both cases, we have

$$\delta' Q = p\left(\frac{\sigma}{3} + \frac{d\chi}{d\tau}\right)\delta\tau + \rho\delta\tau$$

$$\delta Q = p\left(\frac{\sigma}{3} + \frac{d\chi}{d\tau}\right)\delta\tau$$

But if p be constant, then as before

$$p\delta\tau = \frac{2}{3}\delta\tau,$$

refore the ratio of $\delta'Q$ to δQ, or of the two specific heats at
t pressure and constant volume respectively, becomes

$$\frac{+3\frac{d\chi}{d\tau}+2}{\quad}$$
$$\sigma \quad 3\frac{d\chi}{d\tau}$$

nice we in all respects except that it must be positive; also
s that s must be integral and not less than 3, if we denote
s we have for the ratio

with the necessary limitation of σ and s cannot be greater
or 1·6, and in the limiting case the gas must be mon-

refore any value above 1·6 of the ratio for mercury vapour
ted upon the theory must be abandoned so far as present
ations are concerned. It, however, the difference between
any higher value given by the observations be regarded as
erstable limit of experimental error the value for mercury
a gas which on chemical grounds is ranked as monatomic,
viewed in conformity with the theory of Boltzmann
spherical atoms were united by attraction to form a molecule
h a molecule would have five degrees of freedom and the
heat ratio would in this case be 1·4. Now 7 would then be
The value 1·4 is a plausible approximation to the observed
lts of the determination of a number of two-atom gases such
ogen, nitric oxide, oxygen and others, but all observations
ommitted in the ratio 1·408 or from 1·405 to 1·408 that
e seems reasonable to regard the difference ·008 as within
it of experimental error, unless indeed we had grounds
ecting a certain one of all the methods employed for
ermination of the ratio. But there are other difficulties
mmediately arise from the spectroscopic properties of
ases. The atoms emitted by such gases, so long as they are
heat density never present a continuous spectrum but a
n consisting of bright lines with intervening dark spaces.
e spectrum of hydrogen we thirty-two bright lines, that
ny upon a line that of nitrogen fifteen, and so on.
s light is recorded it is the case with intermittent disturbance
d light of definite refrangibility due to vibration of
eriod, we must regard the even continuous spectra as consisting
with, and arising from vibrations of determinate periods in
ecule of the heated gas. Now if a gas such as hydrogen or
be constituted as we are supposing of an indefinite number
similar molecules it must follow that each molecule must
ble, at any rate when not too closely packed together, of as
dependent vibrations as there are bright lines in the spectrum
hat is to say, in addition to the three degrees of freedom
from motion of translation in which each molecule
sses an indefinite number of additional degrees of freedom of possible
motion of its parts which are indicated by the number of periods
ne. The degrees of freedom corresponding to motion of
ion cannot well contribute anything to the specific heat
n owing to their assumed irregularity and independence of
, but it is otherwise with the internal or relative degrees of
of each molecule. For, unless the gas be very dense, we may
ceive a sufficient interval of time between one encounter
next of any molecule with another for many vibrations
ch according to its own law, to take place in the relative
of different parts of the molecule. At each encounter the
ecules would be forcibly shaken, and when the encounters
e frequency the vibrations would become irregular and
trum would become, to use a general diffused light of no
ticular clarity just as matter degenerates into ordinary noise
ses the distinct bright lines in the spectra of these gases.
ing the theory, therefore, into agreement with observed
ena, we require very many more degrees of freedom in each
than could possibly be assigned to it in accordance with
erved value of the ratio of the specific heats, namely
for example, consistently with difficulty the minimum number
such degrees, as we have just now seen, while its spectrum
equires at least nine. And the difficulty increases as we pass
ogen and others.

ught perhaps conceive with the view of possibly explaining
culty, that there were in all gases a number of composite
es with many degrees of freedom mixed up with the others
es with three or five such degrees, but in so small a proportion
these molecules that their presence produces no appreciable
on the specific heats; or, since we have no experimental de-
tion of the specific heats of gases at light-giving temperatures
we might, at least until such experimental determination
arrived at, conceive that our atoms may change their con
under increased temperature, and become themselves ca
vibration. There is nothing in the conception of an atom a
considering it which is really inconsistent with such an hyp

Certain observed phenomena accompanying dissociation a
bination give rise to other difficulties in the way of the ne
of the kinetic theory in addition to those arising from th
distribution of mean kinetic energy just now discussed. F
nitrogen and hydrogen for example, are mixed in proportion
ammonia it is observed (1) that at ordinary temperatures
not exhibit the slightest tendency to combine directly w
other, while, on the other hand, (2) ammonia at ordinary temp
does not exhibit the slightest tendency to decompose into
or hydrogen. But ammonia when subjected to certain v
temperature becomes partially decomposed that is, be
mixture of so many parts of ammonia and of so many oth
of nitrogen and hydrogen in the proportions to form ammon
if the temperature be high enough the decomposition may
plete. But, in accordance with the kinetic theory, the co
whatever they may be which at high temperature cause the a
to decompose, must sometimes occur to individual mole
ordinary temperature, because temperature, as we unders
merely indicates a certain quantity of kinetic energy, and t
in a gas, however cold, there will be always some molecu
tate for dissociation and this dissociation having taken p
by it never be compensated by recombination; therefore
tion should be going on in ammonia at all temperatures,
ult is contrary to the observed phenomena (2). It might
conceived, a way of meeting this last-mentioned difficu
the dissociation attendant upon high temperature—that is,
average large molecular velocity of translation requires th
should be a fairly rapid repetition of encounters among m
moving with dissociation velocity to ensure the production
sociation and that in the case of a gas at low temperature,
average velocity the chance of two molecules encounter
another at high velocities is small, and the chance of any
meeting with any rapid succession of such encounters is pr
inappreciable and therefore that the dissociation spoken of real
takes place.

As above stated, we conceive that in any gas at ordinary
and temperature the intermolecular forces are very smal
aggregate that is, in Clausius's language, have a very small
by which is understood, not that the forces themselve
acting, are small, but that, considering the whole aggr
molecules at any instant, there are very few pairs near e
each other to exert any appreciable force on each other.
could watch any individual molecule for any time, we sho
that during by far the greater portion of the time it was
free from any action by surrounding molecules. The
traversed by the type molecule between the instant when
out of the sphere of action of one molecule and the insta
it passes into the sphere of action of the next—that is, f
encounter to another is called its *free path*.

We may find the chance that a molecule starting from a
with velocity ω in a uniform gas shall have free path be
and $x+dx$ from that point.

If a be the chance for such a molecule of free path *at leas*
then a^2 is the chance of a free path at least 2. Hence th
of free path at least x must be of the form a^x.

Following the method employed by O. E. Meyer,[1] let
this in the form

where therefore

$$l = -\frac{1}{\log a};$$

then the chance of free path $x+dx$ is

$$\frac{x+dx}{l}.$$

The chance that such a molecule shall have its first en
between x and $x+dx$ is the difference of these two expr
that is,

$$\frac{dx}{l}$$

This is the chance of a free path between x and $x+dx$.

The mean free path for such a molecule must then be

$$\int_0^\infty e^{-\frac{x}{l}}\frac{x}{l}dx = \int_0^\infty e^{-\frac{x}{l}}\frac{x}{l}dx = l.$$

This is the meaning of the constant l in $e^{-\frac{x}{l}}$. But if w
by E the number of encounters which a molecule moving
space with velocity ω experiences on the average per unit o

[1] *Kinetische Theorie der Gase*, Breslau, 1877.

$$B = \frac{\omega}{l}; \text{ or } \frac{1}{l} \quad \frac{B}{\omega}.$$

the chance for such a molecule of free path between x and dx is

$$B e^{-Bx} \omega\, dx,$$

above definition of B.

hance of a molecule whose velocity is ω having free path ourse the same as the chance of its free path having the $\frac{x}{\omega}$. If $t = \frac{x}{\omega}$, the chance of duration between t and $t + dt$

$$B e^{-Bt} \omega dt; \text{ or } Be^{-Bt}\, dt$$

determines the value of B, if the molecule where

$$B = N\pi s^2 2 \left\{ 1 + \frac{1}{1} \frac{1}{1.3} \quad \frac{1}{1.3} \right.$$

$$\left(\quad \right)^{n-1} \frac{1}{1 \cdot n} \quad \frac{1}{2n} \quad \frac{1}{1} \quad \omega^2 I_0$$

$= \frac{}{\sqrt{\pi h}}$, and s is the sum of the

be observed that the series converge
nan nuity, the successive coefficients be

$$\frac{1}{3} - \frac{1}{30} + \frac{1}{210} - \frac{1}{151} \cdots$$

g found E for the number of encounter by a molecule having velocity ω, we t of encounters experienced by any mole e denote by C,

$$C = \frac{4}{\sqrt{\pi}} h^3 \int_0^{\infty} \quad \text{for}$$

hich Meyer deduces

$$C \qquad Vs$$

$$= 2\sqrt{2}\, N\pi s^2.$$

the mean value of the free path for all molecule velocity, is $L = \frac{\Omega}{C} = \frac{1}{\pi\sqrt{2} N s^2}$

the kinetic theory of gases presents to us the conception of lly perfect rest, as the result of motion maintained in detail manent and stable on the average. Whatever difficulty felt at first sight in the acceptance of this theory in the medium at rest is greatly enhanced when we pass to the blation of a disturbed medium like a mass of air through wave of sound is passing. In our ordinary investigations a disturbance the gas is treated as a continuous body, sub- small relative motions of its parts, accompanied by corre- g variations of internal pressure. When a disturbance or a ndensation or rarefaction is set up in any portion of this gas late the resulting effects by the well known equations of otion. But on this kinetic theory the medium is supposed st of a number of discrete masses—elastic spheres or the hich preserve the physical properties of the medium merely ecurrence of their mutual collisions, such collisions obeying in individual cases, but preserving a certain ave in the motion of the whole aggregate, and we need some investigation to assure ourselves of the applicability of the treatment of wave motion to such a medium.

we observe that the physical properties of our medium, so he relation between pressure, density, and temperature is ed, merely require that the temperature be measured by the tal kinetic energy of translation, and that the mean kinetic of translation parallel to any fixed line be equal to one third hean total energy of translation. If the molecules constituting portion of this medium were animated by a common velocity eration, the physical properties of this portion would be y determined by the velocities and kinetic energies relative ommon motion. When the distribution of such relative velo stable or permanent, the average relative kinetic energy in d direction is one-third of the average relative total kinetic such property constituting normal distribution.

ose that in any portion of a medium, consisting of equal spheres, this distribution has been disturbed that is, Σmu^2, and Σmw^2 are unequal. If V were the relative velo- any pair of spheres after such disturbance and before they and θ the angle between V and the common normal at the impact, then the normal and tangential relative velocities before impact are $V\cos\theta$ and $V\sin\theta$, and after impact they - $V\cos\theta$ and $V\sin\theta$ respectively. The relative velocity af pact, resolved in the direction of relative velocity before im therefore

$$V\cos^2\theta + V\sin^2\theta,$$

or $V\cos 2\theta$; and the chance of θ being between θ and $\theta + d$

$$\sin 2\theta\, d\theta.$$

Therefore the average square relative velocity resolved original direction becomes after impact

$$V^2 \int^{\pi} \cos^2 2\theta \sin 2\theta\, d\theta \text{ or } \frac{1}{}.$$

The relative velocity after impact in the plane of V normal perpendicular to the direction of V before impact is

$$V\sin\theta\cos\theta - V\sin\theta\cos\theta, \text{ or } V\sin 2\theta.$$

And if a fixed line be taken in the plane perpendicular to average value of the square of the relative velocity after resolved parallel to this line

$$\frac{1}{\pi} \int_0^{\pi} \int_0^{\pi} \quad \text{or} \quad \text{below}$$

Hence we conclude that, in whatever manner the distribu on turbulent motion any portion of the medium at any instant, if w all those pairs of spheres which within any given interval en velocities have a mean of the normal distribution after that m

D denote the average time between two collisions for an sphere, the chance that the sphere will continue for any free from collisions is $e^{-\frac{t}{D}}$; we have seen that

If, therefore, D be the number of spheres within any region total relative velocity is between w and $w + dw$, but so distri- that the mean square of their relative velocities along a line not $\frac{w}{3}$, then after a time t considerably greater than the time τ the number of the D spheres which have encoun- tered will be utterly inconsiderable and the distribution will become normal throughout the region.

Suppose, for instance, that a sound wave is passing along a tube filled with air, so that

$$C \qquad E \quad P \quad C \qquad L$$

$$(5)$$

the air in the tube is, at any instant, in a state of alternate pression and rarefaction, so that C, E, C, E above.

If the note sounded be say 500 vibrations per second, the of the wave CE is about $\frac{1}{10}$ feet and the time taken by the in traversing that distance is about $\frac{1}{1000}$th of a second.

The air in any section of the tube next E is alternately positive momentum and an equal amount of negative momentum reversal taking place twice every $\frac{1}{1000}$th of a second; also the am which produces the average momentum in either case is the distribution of energy among the u, v, and w directions, always producing an excess or defect in uu above or below vv and ww. By what has been proved above, this distribution of energy becomes inappreciable owing to mo collisions in a time considerably less than $\frac{1}{1000}$th of a sec fact, in about $\frac{1}{1000000}$th of a second when the value of atmospheric air is considered. It is therefore legitimate, in lating the velocity of sound in air at first on the elastic hypothesis, to regard the distribution as always normal section of the tube, the air in that section or in any elem portion of it possesses in any kind of velocity or ac tion, estimated as if we were dealing with a continuous mas

Diffusion of Gases

If any further light is to be thrown on the pl nature of a molecule from investigations, experimen analytical, concerning gases, it will most probably means of experiments on the diffusion of gases, or the internal friction or viscosity of gases, and the parison of these results with those obtained analy by the methods of the kinetic theory. Such inv tions have been undertaken experimentally by Cr Loschmidt, Maxwell, O. E. Meyer, and others. count of them will be found in O. E. Meyer's work referred to. The same problems have also been dis analytically by Maxwell,[1] and by Stefan, O. E. Meye Boltzmann in the treatises referred to below. We ceed to give a short account of Meyer's results.

[1] *Phil. Mag.*, July 1860, and Feb. and Mar. 1868.

erm "diffusion" has sometimes been applied to the
by which a gas passes through a porous diaphragm.
wever, is now generally denominated *transpiration*.
also been applied to the expansion of a gas into
as on the removal of a diaphragm separating the
n an exhausted receiver. This is now generally
ated *free expansion*. We shall understand, as is
al, by the term diffusion the process by which,
o or more gases are mixed throughout any space
ent proportions at different points, but so that if
ules were of the same size the whole would be in
um, the different through each othe
l to equalize the proportions at points in the

e, for instance, a tube ... and ... at two ... of
constant temperatu ... of that pressure of the com-
throughout the tube and ... to no forces, but the
gases ... and that of ... diffuse from one
tube to the other. Let the axis of the tube be taken for
... If N_1 be the number of molecules of ... and N_2
... molecules of ... per unit volume, we have ... a
constant pressure and temperature at ... point of the tube
$N_1 + N_2$ constant. But if ... between N_1 and N_2 at any
... velocity functions of ... It will be found that under
... there more molecules of gas ... per ... through every
... tube which may be in the plane of ... in one direction
... left to right ... than in the opposite direction. On the
... more molecules of gas ... per ... from right to left than
... to right. And this ... so ... till the mixture be once
... throughout the tube.

... direction of the rate at which the
... spherical ... can be ... as
... of molecules of gas ... which cross ... the tube from
... right over the ... to the ... from right
... the problem of diffusion. We ... obtained by
... as follows. ... the number of
... and dimensions to put in place of
... of Loschmidt's ... per ... through the ...

$$\frac{1}{3}\frac{dN_1}{dx}\bar{\omega}l_1 .$$

... the mean velocity ... ω, where l denotes
... free path for a molecule having velocity ω and $\bar{\omega}l$ the
... value of that function for all molecules of the gas
... we come to deal with two gases, the molecules of one not
... the same ... and dimensions with those of the other. We
... that, in the absence of any ... motion velocity of the two
... the plane of x, more, ... molecules of gas A would
... plane per unit of time from left to right than of gas B
... to left, because a ... constant pressure and tem-
... of the mixture in every part of the tube, the number of
... of the two gases ... must ... the same at every
... Hence, if N_1, N_2 = N, where N ... constant. Hence

$$\frac{1}{3}\frac{dN_1}{dx}\bar{\omega}l_1 = \frac{1}{3}\frac{dN_2}{dx}\bar{\omega}l_2 .$$

... processes of molecules of gases A ... from left to right
... of time is $\frac{1}{3}\frac{dN_a}{dx}\bar{\omega}l_a$, and ... of molecules of gas B ... from right to left ... of time is

$$\frac{1}{3}\frac{dN_b}{dx}\bar{\omega}l_b ,$$

... if we now ... denote by suffixes a and b quantities
... to the ... respectively. Here l_a and l_b are ... mean
... of molecules ... through the
... $\bar{\omega}l_a$ is not generally equal to ωl_a ... mean ... of
... crossing the plane from left to right ex-
... cess ... from right to left by $\frac{1}{3}\frac{dN}{dx}$
... times that the combined ... have a common
... $(\omega'_1 \ldots \omega l_a)$, and that ... common velocity
... the ... motion of the molecules. On that hypothesis
... rate of diffusion can be calculated as follows. The pro-
... of the stream of the combined gases which consists of mole-
... A is

$$N_a - \frac{1}{3}\frac{dN_a}{dx}\{\omega'_1 \ldots \omega l_a\} .$$

... the total surplus number of molecules of gas A passing
... unit area of the plane per unit of time is

$$\frac{1}{3}\frac{dN_a}{dx}\{N_a - \ldots \omega l_a) + \omega l_a\}$$

$$\frac{1}{3}\frac{dN_a}{dx}\{N_b\,\bar{\omega}l_a + N_a\,\overline{\omega l_b}\}$$

or

$$\frac{1}{3N}\frac{dN_a}{dx}\{N_b\,\bar{\omega}l_a + N_a\,\overline{\omega l_b}\}$$

The expression

$$\frac{1}{3N}\{N_b\,\bar{\omega}l_a + N_a\,\overline{\omega l_b}\}$$

is defined to be the "coefficient of diffusion" of gas A into gas B. It is evidently the same as that of gas B into gas A.

The Relation of the Coefficient of Diffusion to Density.—It can be shown that l_ω, the mean free path for a molecule having velocity ω, is for any single gas inversely proportional to the density, and for any mixture of gases inversely proportional to λ, the aggregate volume ... cupied by matter in unit space. Hence, in the expression $\frac{1}{3}\omega l\frac{dN}{dx}$, ωl is inversely proportional to the density, or to λ, as the case may be.

Now the rate of diffusion on this theory depends upon $\frac{1}{3}\frac{dN}{dx}\bar{\omega}l$. Hence, given the absolute increase of density of a gas per unit of length, that is, given $\frac{d\lambda}{dx}$, the rate of diffusion ought to vary inversely as the density of the combined gases. On the other hand, given the proportional increase of the density, or $\frac{1}{\lambda}\frac{d\lambda}{dx}$, the rate of diffusion ought to be independent of the density, because in that case $\frac{d\lambda}{dx}$ varies directly, and ωl inversely, as N. The analytical result that at given temperature, and given the absolute value of $\frac{dN}{dx}$, the rate of diffusion is inversely proportional to the density of the gases agrees with the experimental results obtained by Loschmidt for carbonic acid gas and air, carbonic acid gas and hydrogen, hydrogen and oxygen.[1]

Relation of the Coefficient of Diffusion to Temperature.—The coefficient of diffusion varies directly as the square root of the absolute temperature, for

$$\omega l = \frac{\omega'}{B},$$

$$B = 2Ns^2\sqrt{\pi}\left\{e^{-h\omega^2} + \frac{2h\omega^2+1}{\omega\sqrt{h}}\int_0^{\omega\sqrt{h}} d\mu\, e^{-\mu^2}\right\};^2$$

$\omega\sqrt{h} = y$,

$$B = 2Ns^2\sqrt{\pi}\left\{e^{-y^2} + \frac{2y^2+1}{y}\int_0^{y} e^{-\mu^2}d\mu\right\}.$$

Hence

$$\frac{1}{B} = \frac{\sqrt{h}}{\sqrt{\pi}Ns^2}\psi(y),$$

where ψ denotes a certain function, and

$$\left(\frac{\omega}{B}\right) = h^{\frac{3}{2}}\int_0 d\omega\, e^{-h\omega^2}\frac{\omega^4}{B}$$

$$= h\int_0^{\infty} dy\, e^{-y^2}\frac{y^4}{h^2}\frac{1}{B} = \frac{1}{\sqrt{h}}\int_0^{\infty} dy\, e^{-y^2}\, y^2\psi y = \frac{1}{\sqrt{h}}.$$

The analytical result also agrees fairly with Loschmidt's experiment above referred to.

Friction or Viscosity of Gases.

Suppose two layers of gas separated by an imaginary plane, similar in all respects except that the molecules on one have a small common momentum in a certain direction parallel to the plane. We may take the imaginary plane for that of y, and the average direction of motion of the molecules on one side of the plane, *e.g.*, the left-hand side for the axis of y, the molecules on the right-hand side of the plane having no average momentum. Then the molecules crossing from the left to the right side carry with them an average momentum in the direction y, and so tend to impress the right-hand stratum of gas with that momentum. On the other hand, the molecules of the right-hand stratum crossing the plane into the left-hand one have, relatively to the molecules in the latter, an average momentum in the opposite direction, and therefore tend to diminish the average momentum of the left-hand stratum

[1] *Sitzungsberichte*, 1870, Bd. lxi. S. 380. [2] See Meyer's *Kin. Theorie*, p. 29

if we attempt to cause one stratum of gas to pass
nother in parallel planes, we experience a resistance
the interchange of molecules between the portions
separated by the plane. This is in some respects
ous to sliding friction between solid bodies, and is
y German writers the "friction" (*Reibung*), by Max
l others the "viscosity," of the gas. Meyer[1] inves-
his effect of friction in a manner somewhat similar
employed in case of diffusion, and obtains for the
ent of viscosity $\frac{1}{3} mNvol$.

on of the Coefficient of Viscosity to D

The viscosity of a gas is independent of t
g to O. E. Meyer, $\frac{mN}{3} vol$. Now, for an
seen, inversely proportional to the den
ersely proportional to the density. On t
ly proportional to the density. Hence t
nt of the density. The agrees with th
well from the kinetic theory in 1860, an
uments by Maxwell[2] and O. E. Meyer.
Meyer and Springmühl[3] on the *Visco*
times in which two different gases mak
flow through a tube maintain the same
ther. As in the case of the coefficient
y proportional to the square root of the de
the coefficient of diffusion and that of
ame function ω, it should be po sible
to determine the rate of diffusion. Ex pe
ave been conducted by Stefan[4] with res
ulated values for the coefficient of diffu
with those determined by Loschmidt, also
ve given the above results for the coefficient of diffusion
osity from O. E. Meyer's work, he uses a method to meet
ry general acceptance. It has been shown however by
nn,[7] that the method is incomplete. Meyer's results are
obtained on the assumption that the molecules of a gas
ing diffusion or internal friction, which have no resultant velo-
y, are moving with that velocity in all di
calculate the number of molecules
ough a given plane during a short
ers at any given distance from the p
molecules, issuing from each encounter with velocity
ndifferently in all directions, we get on Meyer's result
sumption is true only of a gas at rest that is, having no
of translation so that our result as obtained would express
of diffusion, the rate at which two gases *begin* to diffuse
any instant both at rest that is with no translational velo
ixed in unequal proportions in different portions of sp
actual case of diffusion, either of the two diffusing gases
a small velocity of translation. If we take this velo
ount in calculating the number of molecules of the
through a plane, according to Meyer's method, we
t it introduces two new terms, one of which, when
becomes steady, is equal and opposite to the result obtai
er. This is proved by Boltzmann in the case of viscosity
tise above referred to. The same proof is easily applie
of diffusion.

Stefan's Method.—Stefan[8] regards the two diffusing gases
small velocities of translation, or stream velocities, in
opposite directions, so that the molecules of one gas
, have an average momentum $m_1 u_1$ in direction from
, and those of the other gas, of mass m_2, an average
$m_2 u_2$, from right to left. By virtue of encounters between
sets of molecules, each gas is always imparting to
portion of its own average momentum, and receiving
e other a corresponding momentum in the opposite di
The momentum so transferred or interchanged per
alls the *resistance* which one gas offers to the other—diffu
investigation Stefan assumes that all classes of molecules
gas, whatever their molecular velocity may be, have
erage velocity in the direction of diffusion—that is, the
velocity—so that the motion of the molecules of a diffu
ld be exactly represented by considering the molecules
est—that is, with only its molecular velocity—at the

temperature and pressure, and then giving to each molec
additional common velocity u in the direction of diffusion.
mann, however, shows that, in order correctly to represent the
of the diffusing gas, we must impart to molecules having
molecular ve independent of direction different
velocities in the direction of diffusion. And it will be fou
the resistance of the gases is sensibly modified by this prope

The complete solution of the problem—that is, the det
tion of u as a function of x, on the hypothesis that the m
are elastic spheres—is difficult

If we assume molecules to be centres of forces varying inve

the nth power of the distances, or that the force at distance

We
are
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form
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[illegible]

ON MOLECULAR DIMEN

Many attempts have been made to arrive at ve
an estimate or expectation more or le
numerical value of the diameter of a
absolute force between molecules.

In accordance with the view of the
in this article, we are here concerned
tion only in so far as they are found
the
mon
diffusion and viscosity of gases, to
estimate of molecular dimen

It is first necessary to decide what is meant
dimension of a molecule. If a molecule is an elastic
it has dimensions with the exception of which
familiar. It is not of course seriously contended
physicists that the molecules of a gas are actual
elastic spheres, or exert no force on each other at a
tance greater than that of actual contact, and t
infinite force. But it is necessary to conceive the fo
finite, although they may approach or rapidly with
tance at the collisions of molecules in the ac
differ little from what they would be if the molecul
ideal elastic spheres. Nevertheless, they must h
ence; and, that being the case, it is difficult, if
ible, to frame a definition of the boundary of
ule, except as a certain surface at which the force
ween the molecule in question and other mo
tain a certain value.

If for instance, we were to regard a molecule as centre

[illegible]

yet unpublished paper on Dyn

[1] An account of these will be
on Professor Tait's *Recent Progress*
following memoirs: *Phil. Mag.*
P. C. Hodges; *Phil. Mag.*, March
by the same author. See also, I
Royal Institution, 2d Feb. 1883.

[illegible]

Progress of [illegible] Art. xii., a
79, "On the Size of Molecu
on the Mean Free Path of M
delivered by Sir W. Thom

pp. 311-325 of the work above referred to.
eedings of the Royal Society, 8th February 1866
endorff's Annalen, 1871, cxlii. 14.
. Ann., 1873, cxlviii. 1 and 526.
ungsber. d. k.-k. Akad., 1872, lxv. 323
a full account of these and other experiments on diffusion and
e O. E. Meyer, *Kinetische Theorie d. Gase*, under the heads "Reibu
ffusion."
r Gas-Reibung," in the *Sitzungsber. d. k.-k. Akad.*, 1881.
oir "On the Dynamical Theory of Diffusion" (*Sitzungsber. d.* *Akad.*,

an attractive force $\frac{\mu}{r^4}$ and a repulsive force $\frac{\mu'}{r^n}$, we might

molecule to be a sphere of radius a, such that $\frac{\mu}{a^4} = \frac{\mu'}{a^n}$.

manner to consider a molecule as a centre of force, repelling
e to the law of the inverse n^{th} power of the distance, we
d the magnitude of sphere of radius
the least distance to which two
equal to the mutual
each other in a direct encoun-
the hypothesis concerning the
back when the
city
gift obtained

th

is
of the
$\sqrt{2}$ the
of the

ecule we
equal to $\sqrt{2}\,\pi$ where
e relation
on be deter
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It follo
ent of
quired before
n we can de
the ment in the formula
have numerical va
in the absolute numer
the unit of the
volume, upon
ent of diffusion
by the atomicity that
known quantities, t
molecule of the
ver by a comparison
the greater
and tends, do
as a method for
ypothesis of repul
he inverse fifth pow
ntity the rate of diffu
ie a above de
n constant ν is
equal to $\frac{1}{\sqrt{2}\,\pi}$ where
triple the numerical factor
must be one of
the numerical value of
ratio the correct value of
tal methods we term of $\sqrt{2}\,\pi$
$\frac{1}{\sqrt{2}\,\pi}$. If by experi-
the reciprocal value of
a more numerical
$\sqrt{2}$ or $\sqrt{2}\,\pi$
the value of $\sqrt{2}\,\pi$
all the molecules in
calculated. If we attempt to
accuracy in this method, we
analysed could contain now
one unknown quantity, the radius of the
migration. If the difficulty
is obtained in different
include the correction on diffu-
and molecular
tion worthy with
mention $\sqrt{2}$ can
accordance to the
we can calculate
every connected
number only, can
cule force. Coupled
be analytical result with the results of experiments on
through such a tube as above described, we find them
on being harmonized by attributing any numerical value to
could have good reason for concluding that the law of force
to a certain extent at least the true law, and that the
value of σ that which harmonizes the theoretical with

mental result. And the determination of σ, the absolute
correspond to or indeed σ, the determination of the size of
cule
all the kinetic theory hypothesis have been fully developed,
great reliance can be placed on the result of such com-
that the experimental results themselves
depended upon. However valuable these experiments may
purpose they are not valuable for the purpose of
molecular dimensions until our mathematical analysis
sufficiently developed to enable us to interpret the experimental
numerical perhaps impossible to deduce from the experiments
we are in
specific that the coefficients
with increasing temperature, and
contain
from proportional to the square root
absolute temper-
It, indeed, it can be shown that that
dy term, and
be also shown that the density of one
diffusing
through which steady diffusion is
tends to
retical progression that the analysis
has to the
of
real relation
as if they were elastic spheres
following
sphere; but a
ule or molecule
ers. Mercury is regarded by most
is monatomic
assume that its molecules are com-
pheres; on that assumption we may calculate the *specific*
velocity of mercury vapour on Faraday's hypothesis to be

where λ is the ratio which the aggregate volume of all the

spherical molecules in unit volume bears to unit volume. If K, the specific inductive capacity of mercury vapour, can be determined experimentally, the equation $K = \frac{1 + 2\lambda}{1 - \lambda}$ affords a means for estimating the value of λ,—that is, the aggregate volume of the molecules.

Another method, originally proposed by Van der Waals, is based on the small deviations from Boyle's law observed in a gas. Suppose a vessel of volume V containing a number N_1 of small spheres, each of mass m, moving with a certain average velocity. Let p_1 be the pressure. Let a second class of small spheres, in number N_2, each of the same mass m as the former and having the same average kinetic energy, be introduced into the vessel. If the second class of spheres could freely penetrate the first, and were not impenetrable, so that there should be no restriction to the sphere of the first class and a sphere of the second being in the same place at the same time, then the pressure on the wall of the vessel would be increased in the exact proportion $\frac{N_1 + N_2}{N_1}$, and Boyle's law would be exactly fulfilled. But if the spheres cannot penetrate each other, the volume occupied by the second class of spheres is not V but $V - \frac{4}{3} N_2 \pi r^3$, if r be the radius of a sphere of the latter class. Consequently, the pressure due to the second class of spheres is rather greater than it should be, and there is a deviation from Boyle's law. Van der Waals treats the pressure as proportional to the number of encounters, and therefore as inversely proportional to the mean free path, which is evidently diminished by any increase in the magnitude of the spheres, and diminished more than in proportion by any increase in the number.

(H. W. W. S.)

CHEMICAL ASPECT.

The word *Molecule* is used by chemists to express the smallest quantity of a pure substance, that quantity of it which its formula ought to represent. What this quantity is, in any particular case, must be ascertained by studying the chemical reactions by which the substance is produced and the chemical changes which it undergoes. We may give one or two illustrations as to how how this can be done, as well as to indicate the limits within which these methods can be applied.

The formula usually assigned to acetic acid is $C_2H_4O_2$. This agrees with almost all the chemical actions in which it takes part. Thus, one quarter of the hydrogen is replaceable by other metals, as in $C_2H_3KO_2$, &c.; and in chlorine, two, or three quarters of the hydrogen can be replaced by chlorine. There must, therefore, be four (or a multiple of four) atoms of hydrogen in the molecule. Similarly, half of the oxygen can be replaced by sulphur, and one quarter of the oxygen along with one quarter of the hydrogen can be replaced by chlorine. There must, therefore, be two (or a multiple of two) atoms of oxygen in the molecule. Again, the formation of marsh gas and carbonato of soda when acetate of soda is heated with caustic soda, and the formation of aceto-nitrile from cyanide of potassium and iodide of methyl, show that the carbon in acetic acid is divisible by two, or that the molecule contains two (or a multiple of two) atoms of carbon. $C_2H_4O_2$ is the simplest formula which fulfils these conditions, but the existence of an acid acetate of potash and an acid acetate of ammonia, the formulæ of which are usually written $C_2H_3KO_2.C_2H_4O_2$ and $C_2H_3(NH_4)O_2.C_2H_4O_2$, as if these were compound derived from two molecules of acetic acid, would lead us to $C_4H_8O_4$, as this shows that the hydrogen is divisible by eight. In the same way, we can easily convince ourselves that $C_6H_{10}O_5$, *or some multiple of it*, is the formula of starch; that C_8H_5NO, *or some multiple of it*, is the formula of indigo blue, and so on. But it is not easy to determine by purely chemical methods whether these formulæ themselves, or multiples of them, really represent the molecule. A simple formula may suffice for the many of the reactions of a substance, and may even represent a great many of its derivatives, and yet reactions and derivatives may be discovered which require a multiple of that simple formula. This has already been indicated in reference to acetic acid, and a very s

tion is supplied by mellitic acid. For a long
e formula $C_1H_2O_1$ was used for this acid, and by
of it all the then known derivatives were repre-
But later investigations by Baeyer proved that
rmula must be multiplied by three, the new deriva-
tained by him not being capable of representation
y formula simpler than $C_{12}H_6O_{12}$. Very many ex
of the same kind might be adduced, but those given
rve to show the nature of the difficulty of settling
rmula and with it the molecular weight of a sub
It need scarcely be said that the multiple formula
nts everything which the simple formula repre ents
mething more, and that chemists as a rule take the
t formula which will answer the purpo . The
al methods of determining the formula and mole
eight apply equally to all pure sub tance , but they
give us absolute values, only numbers to which
lecular weights are proportional. And for purely
l purposes these are all that we require. Thus
a chemist speaks of acting on a molecule of ne-
cid with two molecules of pentachloride of pho
he means that he mixes them in the proportion
parts of the former to 2 1775 of the latter
e sake of precision we sometimes speak of a mole
water (or other substance) in grammes, or even of
me-molecule, a *gram molecule*, &c. Thus in the case
ntioned a gramme molecule of succinic acid means
ammes of succinic acid, &c.
while for practical purpose these proportional
rs are quite sufficient, we cannot leave out of view
lation to the actual constitution of matter. There
l reason to believe that matter consists of discrete
es, and that every pure substance is made up of
portions of matter, all alike, so that one of them, if
ld examine it, would give us a complete idea of
emical composition, constitution, and character of
bstance. These small portions, of which the smallest
ty of the substance which we can examine contains
millions, we may call *molecules*. From the character
we have supposed this molecule to possess, viz., that
y represents all the chemical properties of the sub
- it will be seen that these *real, absolute* molecules
be proportional to the molecular weight ascertained
mical means; so that, while for practical laboratory
nufacturing purposes we use the gramme, the pound,
ton as our unit, and speak of its grammes, pounds,
s, as the case may be, of water, as a molecule (or
e molecule, ton molecule, &c.), in dealing with the
constitution of matter we should use as our unit
ass of a single atom of hydrogen, and our gramme
le would then be a definite, very large, but not yet
tely ascertained, number of real molecules.
has been already shown above that, on the kinetic
of gas, a gas consists of a number of particles
g about in straight lines in all directions, and that
omogeneous gas which follows Boyle and Charles's
these particles are all alike. The masses of the
es of different gases are therefore to one another in
me proportion as the densities of the gases, temperature
nd pressure being the same. Thus in gases, the in
dently moving particles of the kinetic theory are the
les of which the chemist is in search, and it becomes
tant that we should compare our chemically found
lar weights with the densities. Theoretically accu
esults could be obtained only in the case of a perfect
out small deviations from Boyle's and Charles's laws
t interfere with the application of this method.
ical methods, as we have already seen, lead us to a
lar number, *or a multiple of it*, so that our choice is
le limited to two or three numbers widely differing
from one another. We find that if we do not exceed
limits of chemical stability a gas approaches the state
perfect gas as the temperature increases, or as the
sure diminishes. Now if one of the numbers re
probable by chemical evidence *nearly* coincides with
given by comparison of gas densities, under cond
where the substance sensibly deviates from Boyle
Charles's laws, we find that by diminishing the pres
increasing the temperature within the limits of ch
stability, and thus bringing the substance nearer the
of a perfect gas, the correspondence between these
numbers becomes closer. This has already been p
out and illustrated in the article CHEMISTRY, vol. v. p
We can now compare the results in the case of
of the chemical and of the physical determinat
molecular weight, by giving some examples, placin
by side the formula and molecular weight adopt
chemist and the mass in grammes of the gas occ
the volume of 22·33 760 *p* (27·4 + *t*) 273 litres.
volume is that which one gramme of an ideal gas
the molecular weight 1, and perfectly following
and Charles's law would occupy at pressure *p* milli
of mercury and temperature *t* C. If, then, *w* be the
cular weight of any gas, *w* grammes of it should
this volume, and the deviation from this would n
light deviation from Boyle and Charles's laws.
annexed table *w* is the molecular weight and *m* th
contained in 22·33 760 *p* (27·4 + *t*) 273 litres
the temperature is not specially stated the determin
were made under the normal atmospheric conditions.

	H =	*w*	*m*
Nitrous oxide		44	44·04
Ammonia			
Carbonic oxide			
Marsh gas			
Olefiant gas			
Hydrogen			
Argon			
Sulphur			
Bromide of thorium			
Osmic oxide			
Perchloride of phosphorus			
Sulphide of arsenic			

A comparison of the values of *w* and *m* leads to the following conclusions:

(1) In the case of a very great number of substances which exist in a few reactions are given in the table two determinations agree, the slight differences observed being evidently due to deviation of the gases from the laws of a perfect gas. (2) In a considerable number of cases, physical evidence has been adduced that the molecule of the gas is a multiple of the simplest number satisfying the chemical condition. This cannot be looked upon as a coincidence between the methods, because, if a particular formula be the chemical condition, any multiple of it will satisfy the same, and indeed, in many of the cases we are considering it is impossible from chemical considerations to say that the higher molecular weight actually adopted, although such chemical considerations might in all cases have warranted its adoption without physical support. Thus, we are not without chemical evid

of the formula $H_6Cl_2O_3$, or even Al_2Br_6 and Fe_2Cl_6, gh chemists would probably have contented themwith H, Cl, O, $AlBr_3$, and $FeCl_3$ had it not been for idence of gas and vapour density, and certainly with latter no one would have thought of P_4, As_4, or S_6.[1] here are a number of substances in the case of there is an apparent disagreement between the of the two ways of determining molecular weight. substances are said to have an anomalous gas or density. The expression anomalous vapour density time applied to the case of such substances a orms and arbitrary, but not very accurately. It be better to say that these substances have an *tal* vapour density, because their complex molecular e, while not clearly indicated by their chemical ter, are not at variance with any established law shall therefore reserve the term "anomalous vapour " for those substances the molecular weight of as given by their vapour density is not reconcilable any formula which is chemically admissible. In e of some substances, such as the oxid of chlorine, been shown that the discrepancy was due to erroervation, impure specimens having been used in periments, but there still remain many substances, in the sense above indicated, anomalous vapour . The substances have therefore been examined pecial care, with the result of completely vindicating ne the theory, and of disclosing a very interesting theoretically important kind of chemical change. We ake, as instances of such anomalous vapour densities, bstances in the last division of the table, and show e anomaly here in the case has been explained.

ammoniac has the composition represented by the a NH_4Cl. The formula agrees with all the chemical of the substance and of all the substances in any lated to it, but it does not agree with the results of density determinations. When sal-ammoniac is it is converted into a mixture of gases, and the vapour is reconverted into solid sal-ammoniac when it is This looks exactly like the process of sublimation, was universally supposed that the vapour given n sal-ammoniac is heated was really sal-ammoniac. But its vapour density corresponds not to the for NH_4Cl and the molecular weight 53·5, but to the this. Now this formula does not admit of dissoc nd the explanation at once suggests itself that pour examined was not really the vapour of sal iac, but of hydrochloric acid and ammoniac gas

potheti- of the decomposition of sal-ammoniac would of course completely explain the apparent y, each molecule NH_4Cl dividing into two mole NH_3 and HCl, the gas from a given weight of sal would of course contain twice as many molecules occupy twice the space which it would do if no such position had occurred. On this supposition the would remain uncombined as long as the ature was above the decomposing point of sal- and when the temperature fell below this point they would unite and reproduce sal-ammoniac. It was sary, however, to prove that this decomposition occu

As has been shown above (p. 618), the rate of dif of a gas depends upon its density. In this case th gases into which the substance may be supposed to up at the moment of volatilization differ considera density; we ought, therefore, to be able to effect p separation by means of diffusion, and it has been that such partial separation actually does occur. if we have hydrogen gas on one side of a porou phragm and volatilized sal-ammoniac on the other we find after a time that, mixed with the hydrog the one side, we have what we may for shortness ca ammoniac vapour that is, a vapour which when forms solid sal-ammoniac with an excess of amm which, being less dense than hydrochloric acid ga diffused faster, while on the other side, also mixed hydrogen which has diffused through the diaphrag have sal-ammoniac vapour with excess of hydrochlori the denser and more slowly diffusing gas. This of proves that the decomposition has occurred, but i not prove that the vapour of sal-ammoniac consists e of hydrochloric acid and ammonia *mixed* with one an That this in fact is not the case has been shown numerous experiment. The two gases were sepa rated to a temperature higher than that at which s moniac volatilizes, and were then allowed to mix in a kept at the same temperature as the two gases. I vessel a delicate thermometer was placed, and it was that the mixing of the two gases was accompanied small but very decided evolution of heat. This that some chemical combination takes place, and th mixed gases must contain some vapour of NH_4Cl. over, careful determinations of the vapour density ammoniac prove that it is a little more than the of the densities of ammonia and hydrochloric ac compared with air at the same temperature and ure, 1·01 instead of 0·925 at 350° C.); and this in of density on mixing the hot gases is easily explain supposing that a small proportion is in the condit NH_4Cl, while the most of the gas consists of se NH and HCl molecules.

In a similar way it has been shown that the vap oil of vitriol is a mixture of two vapours, that of H_2O, and that of sulphuric anhydride, SO_3; and sulphide of ammonium when volatilized breaks up two volumes of ammonia and one of sulphuretted drogen, $(NH_4)_2S = 2NH_3 + H_2S$. We find, therefore in the former case, as in that of sal-ammoniac, $v = \frac{3}{2}v$, and in the latter, $v = 3v$.

The peculiar kind of decomposition is now known by th "dissociation" (Second Year, pp. 175, 176.) In the cases w mentioned the substances undergo nearly complete dissocia the temperature at which they volatilize, and recombinatio place when they are cooled and again assume the solid, o the case of oil of vitriol, the liquid state. These substan therefore not suited for the illustration of the whole co dissociation. This has been carefully studied in the case o compounds in which the dissociation is far from complete, boiling point of the substance, with the result that, if AB compound dissociates into the separate molecules A and represent the amount of dissociation as the ratio of th ber of pairs of separate A and B molecules to the total nu pairs of A and B, both separate and combined. This ratio R is 0 when there is no dissociation, and 1 when dissociation is complete, $R = 1$.

(1) R increases as the temperature rises. (2) dR/dt (whe temperature) has a maximum when $R = \frac{1}{2}$. (3) The presence o either A or B diminishes the value of R. For instance, nearly completely dissociated into PCl_3 and Cl_2 at 300° C.; large excess of PCl_3 is mixed with the vapour it is found to scarcely any Cl_2, so that dissociation is greatly diminished presence of excess of PCl_3. These experimental results are of explanation on the kinetic theory of gas, if we adopt Pfau hypothesis. This is, that for each case of dissociation the

[1] Perhaps it is worth while to note that the molecular weight of sulphur in the form of vapour was first determined by Gay-Lussac and Thénard by taking the density of the vapour relative to that of air, and multiplying the ratio of the densities by 28·88, the molecular weight of air, as determined by Dumas. Their result was 96·3, which is very near the truth.

value for the internal kinetic energy[1] of a molecule of *AB*. ecule of *AB*, by encounters with other molecules or with of the vessel containing the gas, acquires a greater amount al kinetic energy than this limit, it at once breaks up into , so that in the ...cous mixture there are no molecules of ng more internal kinetic energy than the limit. Further, olecules, one of *A* and one of *B*, meet one another with elocity and with such an amount of internal kinetic energy ether the internal kinetic energy is less than the limit, they te to form a molecule of *AB*. Thus the molecules with ternal kinetic energy will be separate molecules of *A* and with small internal kinetic energy will mostly be united as his hypothesis has been to a considerable extent worked out lied by Pfaundler and by Naumann and the deduction gree fairly well with the results of experiment, but in some e theory has not been fully developed, and in one at do altogether to accord with observed fact. Some of the s have been mentioned above. We know enough of the f dissociation to see that it belongs to the class of *reversed actions*, in which a chemical change is reversible, and equili kept up, with constant external conditions, by the two chemical changes taking place to an equal extent in a given We can see that all such cases are explicable by the statistical but we cannot apply this method mathematically until we ore of the intimate nature of the molecule—not of the w they act upon one another. In the direction of the ... have looked specially at the case in which *A*, *B* and *AB* gaseous, because it was the question of molecular vapour s which led us to treat of the subject. Dr Crafts also shows one or two of the substances are dissolved or liquid ow see with what restrictions the method of vapour density able to the determination of molecular weight, and we can and more fully the example given in the text-book, p. 469. It is there shown that acetic acid vapour does not to the laws of Boyle and Charles until the temperature is about 250°, at the ordinary barometric pressure. At and at temperatures the vapour density corresponds to the formula $C_2H_4O_2$.

At lower temperatures the density corresponds to a higher ar weight. Now Playfair and Wanklyn determined the density at much lower temperatures than the ordinary boil- t of acetic acid, by greatly diminishing the pressure of the acetic acid vapour. This they accomplished by mixing it w large quantity of hydrogen, so that the pressure due to acetic vapour formed only a small fraction of the total pressure. vapour density of acetic acid at the low temperatures at which worked was found to correspond very nearly with the fo $C_4H_8O_4$, and, by comparing this result with what has been (p. 620) of the chemical evidence as to the molecular weight of acid, we may reasonably conclude that the molecule of aceti at low temperatures is $C_4H_8O_4$, and that as the temperature is it undergoes dissociation each molecule dividing into t $C_2H_4O_2$. This is then a case where *A* and *B* are equal, and divide into *A* + *A*. Another instance of the same kind is pro to be found in peroxide of ... (p. 315), NO_2 divides into NO + NO ... vapour h ...ng to the lo ...temperature ... S_2. Thro ... the density ... (p. 49 We have ... determinatio ... but the as ... is dim ... ...on of sub ... which ... dilution of h ... how ... moving part ... but th ... ...sequently ... already ... ...on of the re ... masses of the particles by liquid ... it is probable that th ... to be very near each other and to have shape and motion, as well as mass, and the temperature, same their rate of motion.

In solids we have to suppose extra-volume particles, and perhaps ... to be part of the structure of at all. Solids are no doubt composed of atoms, and those ... are evidently arranged ... formed ... When the solid is ... it breaks ... molecular ... are the ... now being ready to ... under favo... circumstances. But while the ... do not perhaps ... properly called molecular ... physical sen... chemical purposes we may call them so, for they are the s... portions of the substance which but represent atoms, as we have seen that a chemical formula should be represented by the formula ... (W. C.

LESKIN is a stout heavy cotton fabric of leathery ence woven as a satin twill on a strong warp. It ed generally either as a bleached white or as a slaty olour, but occasionally it is printed in imitation of patterns. Being an exceedingly durable and comfo exture, it was formerly much more worn by working specially outdoor labourers, than is now the case. It used for gun-cases, carriage covers, and several pur- n which a fabric capable of resisting rough usage is le.

LESWORTH, Sir William (1810–1855), the eighth t, was born in London, 23d May 1810, and succeeded extensive family estates in Devon and Cornwall in On the passing of the Reform Act of 1832 he was re to parliament, though only twenty-two years old, for tern division of the county of Cornwall, to support the y of Lord Grey. For some time he took little part lebates of the House of Commons, but in April 1835 nded, in conjunction with Mr. Roebuck, the *London*, as an organ of the politicians known to the world hilosophic Radicals." After the publication of two s he purchased the *Westminster Review*, and for some he united magazines were edited by him and J. S. From 1837 to 1841 Sir William Molesworth sat for rough of Leeds, and during those years acquired con- le influence in the House of Commons by his speeches his tact in presiding over the select committee on portation. From 1841 to 1845 he remained in private cupying his leisure time in editing the works in Latin nglish of Thomas Hobbes of Malmesbury, a recreation cost him no less than £6000. In the latter year he was returned to the borough of Southwark, and re that seat until his death. On his return to parliame devoted special attention to ... condition of the col and delivered many speeches in favour of a reduct colonial expenditure and on the better administ His arguments on these questions charged the opini the members of the House of Commons ... and the sentu of the daily press, aided by the printed ... of his speeche to the gradual acceptance of his views by the electo large. It was not, however, until January 1855 ... afterward he was allowed full opportunity to work out the di... problems connected with the government of Great Br... Office was conferred upon him in December 1852 by Aberdeen, but it was the honour of directing the ... improvements and reforms of his own country, an chief work by which his name will be brought into promi... at this time was the construction of the new Westm... Bridge. At last in July 1855, he was called to p... over the Colonial Office, but unfortunately its dutie... no sooner entered upon than he was cut ... death (22d October 1855) to the universal regret ... countrymen, for he had lived down the animosities ... youth, and had attracted to himself the sympath... all thoughtful men. The influence which his view... acquired and the position ... may be judged from the fa... in 1852 the delegates of the Transvaal Government ... forward, as the chief argument for the withdrawal ... English from the Transvaal, the subsequence of his pre... the abandonment of the Orange River Territory in ...

...ubject of the Molesworth Ministry ... in Sir ... Molesworth, *Memoirs*, vol. i., the title of the ... to which ...

[1] It may be noted that the existence of ... indicates the ... possession of a molecular structure, but that a ... pattern like ... of atoms may easily be supposed to present ... without the assumption of really independent molecules.

[1] By internal kinetic energy is meant the kinetic energy of motion of parts of the molecule relatively to one another, in contradis... to the kinetic energy of motion of the molecule as a whole.

e found in the *Bibl. Cavaliericensis*, vols. i. and iii. The name of illiam Molesworth is frequently mentioned in the biographies l, Cobden, Carlyle, Grote, and Panizzi.

OLFETTA, a city and seaport of Italy, in the province ari, 16 miles by rail north north west of Bari. From ea it presents a fine appearance with its white stone s and the remains of its turreted walls; and there are al buildings of considerable pretensions. The castle m the 11th century the prison of Otho, duke of wick. The cathedral is dedicated to St Conrad. ttracts well frequented markets, a small foreign trade 0 tons in 1881), and such industries as cotton and net ry, soap boiling, and rope spinning. The population 26,016 in 1871.

letta (Melficta or Matfetum) was given by Charles V. to the of Termoli in 1529, and during his brief spell was overrun by by the French under Lautrec. In 1531 Cesare Gonzaga took le of duke of Guastalla and prince of Molfetta; but in 1540 was sold to the Spanish family, and in 1798 incorporated with yal domain. The Hospitaller bishopric, directly of the papal see.

OLIÈRE (1622–1673), to give Jean Baptiste Poquelin age name which he chose, for some undiscovered reason, ame, was born in Paris, probably in January 1622. baptismal certificate which is usually, and almost with ute certainty, accepted as his is dated 15th January but it is not possible to infer that he was born on ay of his christening. The exact place of his birth s disputed, but it seems tolerably certain that he saw ght in a house of the Rue St Honoré. His father ean Poquelin, an upholsterer, who, in 1631, succeeded vn uncle as "valet tapissier de chambre du roi." The y of Poquelin came from Beauvais, where for some ries they had been prosperous tradesmen. The d of their Scotch descent seems to have been finally oved by the researches of M. E. Reverend du Mesnil. mother of Molière was Marie Cressé; and on his r's side he was connected with the family of Mazuel, rians attached to the court of France. In 1632 ere lost his mother; his father married again in 1633. ather possessed certain shops in the covered Halle de ire, Saint Germain des Près, and the biographers have ned that Molière might have received his first bent ds the stage from the spectacles offered to the holy people at the fair. Of his early education little is n, but it is certain that his mother possessed a Bible Plutarch's *Lives*, books which an intelligent child l not fail to study. In spite of a persistent tradition, is no reason to believe that the later education of re was neglected. "Il fit ses humanitez au College rmont," says the brief life of the comedian published s friend and fellow-actor, La Grange, in the edition s works printed in 1682. La Grange adds that e "eut l'advantage de suivre M. le Prince de Conti toute ses classes." As Conti was seven years ger than Molière, it is not easy to understand how e came to be the school contemporary of the prince. re modern critics studies the Jesuit fathers encouraged pupils to take part in *ballets*, and in later life ere was a distinguished master of this sort of entertainment. According to Grimarest, the first writer who ished a life of Molière in any detail (1705), he not acquired "les humanités, but finished his "philosophie" in five years. He left the College de Clermont in , the year when Gassendi, a great contemner of Aristotle, arrived in Paris. The *Logic* and *Ethics* of Aristotle, his *Physics* and *Metaphysics*, were the chief philosophical text books at the College de Clermont. But when came the pupil of Gassendi (in company with Cyrano ergerac, Chapelle, and Hesnault), Molière was taught preciate the atomic philosophy as taught by Lucretius. seems no doubt that Molière began—and almost or quite finished, a translation of the *De Natura* According to a manuscript note of Trallage, publis M. Paul Lacroix, the manuscript was sold by M widow to a bookseller. His philosophic studies left mark on the genius of Molière. In the *Jugement de sur les deux Parties des Nouveaux Dialogues des* (1684), the verdict is "que Molière ne parleroit p Philosophie." To "talk philosophy" was a favouri cise of his during his life, and his ideas are indicat sufficient clearness in several of his plays. There no connexion between them and the opinions of " le Critique" in a dialogue of that name, published land in 1709. From his study of philosophy, gained his knowledge of the ways of contemporary p of Pancrace the Aristotelian, of Marphorius the stoic, of Tris-otum, "qui s'attache pour l'ordre au tetrachorde", of Philaminte, who loves Platonism, of who relishes "les petits corps," and Armande, wh "les tourbillons." Grimarest has an amusing a of a controversy in which Molière, defending De chose a lay-brother of a begging order for umpire Chapelle appealed to the same expert in favour of Ga His college education over, Molière studied law, an is even evidence—that of tradition in Grimare of Le Boulanger de Chalussay, the libellous auth play called *Elomire Hypochondre*—to prove that actually called to the bar. More trustworthy is th ing remark in La Grange's short biography (168 *entre des écoles de droit*, il choisit la profession d dien." Before joining a troop of half-amateur com however, Molière had some experience in his father ness. In 1637 his father had obtained for him th to succeed to his own office as "valet tapissier de c du roi." The document is mentioned in the inven Molière's effects, taken after his death. When th travelled the valet tapissier accompanied him to the furniture of the royal quarters. There is ve reason to believe (Loiseleur, *Points Obscurs*, p. 9 Molière accompanied Louis XIII. as his valet tap Provence in 1642. It is even not impossible that was the young valet de chambre who concealed Cin just before his arrest at Narbonne, 13th June 164 this is part of the romance rather than of the his Molière. Our next glimpse of the comedian we document of 6th January 1643. Molière ackno the receipt of money due to him from his deceased m estate, and gives up his claim to succeed his father as de chambre du roi." On 28th December of the sa we learn, again from documentary evidence, tha Baptiste Poquelin, with Joseph Béjard, Madeleine Geneviève Béjard, and others, have hired a tenni and fitted it up as a stage for dramatic performance company called themselves L'Illustre Théâtre, *illust* then almost a slang word, very freely employed writers of the period.

We now reach a very important point in the history of Molière, which it is necessary to discuss length in defence of the much maligned charact great writer and a good man. Molière's connecti the family of Béjard brought him much unha The father of this family, Joseph Béjard the elde new tapissier, a man with eleven children at least. His wife was Marie Hervé. The most noted of his childre panions of Molière, were Joseph, Madeleine, Geneviè Armande. Of these, Madeleine was a woman o talent as an actress, and Molière's friend, or perha trees, through all the years of his wanderings. N 14th February 1662 (for we must here leave the logical order of events), Molière married Armand Élisabeth Grésinde Béjard. His enemies at tha

number of his biographers in our own day, have ted to prove that Armande Béjard was not the sister, e daughter of Madeleine, and even that Molière's ay have been his own daughter by Madeleine The arguments of M. Arsène Houssaye in sup this abominable theory are based on reckless and t confusions, and do not deserve criticism. But tem of M. Loiseleur is more serious, and he goes her than the idea that Madeleine was the mother ande. This, certainly, was the opinion of tradition, ion based on the slanders of Montfleury, a rival of e's, on the authority of the spiteful and anonymous of *La Fameuse Comédienne* (1688), and on the libellous play, *Elomire Hypochondre*. In 1821 on received a shock, for Beffara then discovered e's "acte de mariage," in which Armande, the bride, en of as the sister of Madeleine Bejard, by the same and mother. The old scandal, or part of it, was by M. Fournier and M. Bazin, but received another 1863. M. Soulié then discovered a legal document March 1613, in which the widow of Joseph Bejard ced, in the name of herself and her children, his ance, chiefly a collection of unpaid bills. Now in cument all the children are described as minors, and them is "*une petite non encore baptisée*." The little ill not christened in March 1643, is universally ized as the Armande Béjard afterward married by e. We reach this point, then, that when Armande infant she was acknowledged as the sister, not a the er, of Madeleine Bejard. M. Loiseleur refuses, how o accept this evidence. Madeleine, say he, had become the mother, in 1638, of a daughter by Raymond de Moirmoron, comte de Modene, and erlain of Gaston duc d'Orleans, brother of Lou In 1642 Modene, who had been exiled for political s, "was certain to return, for Richelieu had just nd Louis XIII. was likely to follow him." Now ine was again this is M. Loiseleur's hypothesis to become a mother, and if Modene returned, and this fact, he would not continue the *liaison*, still uld he marry her,—which, by the way, he could not his wife was still alive. Madeleine, therefore, d her mother to acknowledge the little girl as her ild. In the first place, all this is pure unsupported esis. In the second place, it has always been denied ejard's wife could have been a mother in 1643, owing advanced age, probably fifty three. But M. Loise imself says that Marie Hervé was young enough to he story "sufficiently probable." If it was probable, more was it possible. M. Loiseleur supports his tion by pointing out that two of the other children, ed as legally minors, were over twenty five, and that ge was understated to make the account of Armande more probable. Nothing is less likely than that e would have consulted this document to ascertain uth about the parentage of Armande, yet M. Loise whole theory rests on that extreme improbability st also be observed that the date of the birth of Béjard is unknown, and he *may* have been, and ing to M. Jal (*Dictionnaire Critique*, p. 178) *must* een, a minor when he was so described in the deed f 10th March 1643, while Madeleine had only passed enty-fifth birthday, her legal majority, by two months iew of Joseph's age is supported by Bonnet (*Molière en*, p. 77). M. Loiseleur's only other proof is that Hervé gave Armande a respectable dowry, and that, do not know whence the money came, it must have from Madeleine. The tradition in Grimarest, which Madeleine behave *en femme furieuse*, when she heard marriage, is based on a juster appreciation of the character of women. It will be admitted, probably the reasons for supposing that Molière espoused the da of a woman who had been his mistress (if she had be mistress) are flimsy and inadequate. The affair dowry is insisted on by M. Livet (*La Fameuse Comé* reprint of 1877, p. 113). But M. Livet explains the by the hypothesis that Armande was the daugh Madeleine and the comte de Modene, which exacti tradicts the theory of M. Loiseleur, and is itself dicted by date at least as understood by M. Loi Such are the conjectures by which the foul calumn Molière's enemies supported the lays of m French critic

To return to the order of events, Molière pass year 1643 playi with, and helping to manag Théâtre Illu The company acted in various courts, with very little co- Molière was ar arrested by the trade man who supplied candles, an company had to borrow money from one Aubrey to their leader from the Grand Châtelet (15th August The process of turning a tennis court into a theat somewhat expensive, even though no seats were pr in the pit The troupe was for a short time under protection he duc d'Orléans, but his favours we lucrative. The duc de Guise, according to some printed in 1646, made Molière a present of his wardrobe But costume was not enough to dra public to the tennis court theatre of the Croix and empty houses at last obliged the Théâtre Illu leave Paris at the end of 1646

"Nul animal n'osait rentrer dans notre salle," s author of the contemporary play on Molière, *Élomire chondre*. But at that time one of the travelling com found means to exist in the provinces, and Molière summoned to play among the rural towns. The care strolling players is all sorts and conditions of mankind. The *Roman* scarcely gives a picture of the adventu nature, the di of transport, the queer cavalcade of horses, mule lumbering carts that drew the wardrobe and prop the sudden metamorph the to ours, who half-have just been rattling, into a large, the square local square, the disturbed nights in overcrowded country all the love and war of art in the march P tells us what the arrangeme at the theatre w Molière's early time. Ta were little com and costume re made by stro

nough the heavy curtain often knocked o hat of the comedian or even a dance took to the of a warrior or a god. Th ghts were candles st tin sconces at the back an de, but luxury soon went so far that a chandelier of ten candles was su from the roof. As interested the candles were let do a rope and pulley, and any one within easy reach them with his finger. A fi e and fanfaron, fiddlers, supplied the music. The highest prices w for seats in the *Salle* (central admission fivepence the privilege of standing on the pit was twopence hal was the charge. The doors were opened at one the curtain rose at four.

The normal division of the Théâtre Illustre provinces was Du Parc, the most noted actor Molière, the Béjards and Du Parc, called Gro Ré extremely difficult to follow exactly the fortunes the company. They played at Pézenas, for some the date of this performance, when Molière presente Montesquieu) failed in tragedy and was pelted, is va given as 1644-45 (Taillaige), 1647 (Desfeuilles), 1 (Lacroix). Perhaps the theatre prospered bette where than in Paris, where the streets were barrica

early days of the war of the Fronde. We find
re at Nantes in 1648, at Fontenay-le-Compte, and
spring of 1649 at Agen, Toulouse, and probably at
ulême and Limoges. In January 1650 they played
rbonne, and between 1650 and 1653 Lyons was the
quarters of the troupe. In January 1653, or perhaps
Molière gave *L'Étourdi* at Lyons, the first of
ed p contrasted with the slight farces with
he generally diverted a country audience. It would
too long to have the precise date of this piece, but
range (1682) says that "in 1653 Molière went to
, where he gave his first comedy, L'Etourdi," while
Registre La Grange enters the year as 1655. At
De Brie and his wife, the famous Mlle. de Brie,
d the troupe, and Du Parc married marquis de Gorla,
known as Mlle. du Parc. The libellous author of
Vie de Corneille reports that Molière's heart was
nt the cock of the heartiful Du Parc and De Brie, and
addition has a persistent life. Molière's own opinion
s ladies and men of his company may be read be
the lines of his *Impromptu de Versailles*. In 1653
de Conti, after many political adventures, was
g at La Grange, near Pézenas, in Languedoc, and
brought him into relations with his old school
Molière. Conti had for first gentleman of his bed
ber the abbé Daniel de Cosnac, whose memoirs now
light for a moment on the fortunes of the wander
troupe. Cosnac engaged the company "of Molière and
Béjart," but another company, that of Cormier, nearly
epted the favour of the prince. Thanks to the resolu
f Cosnac, Molière was given one chance of appearing
private theatre of La Grange. The excellence of
ting the splendour of the time, and the mutual
t Cosnac and of Sarrazin, Conti's secretary, gained
ay for Molière, and a pension was assigned to his
ny (Cosnac, *Mémoires*, t. I^er, Paris, 1852). We
e proposed to pay Molière a thousand crowns of his
money to recompense the honours he had supplanted
ntrast, it is obvious that his profession had become
ently lucrative. In 1654 during the session of the
s of Languedoc Molière and his company played at
ollier. Here Molière danced in a ballet (*Le Ballet
comparaisons*) in which a number of men of rank took
ccording to the fashion of the time. Molière's own
were those of the Poet and the Pedant. The poet
little piece is to introduce opposite characters
e and arguing together. Silence dances with six
n. Truth with four courtiers, Money with a poet
fourth. Whether the ballet, or any part of it, is
here, is still disputed (*La Jeunesse de Molière, avec
Ballets, Documents &c.*, P. L. Jacob, Paris, 1858). In
however it is certain that the troupe was at Lyons,
they met and hospitably entertained a prelate
Cruche d'Alby, who informs the town that
" Molière at Pézenas, w
were convened, and where local
barber's chair in which the poet
hastened. The long list of Molière's
t autograph receipt, dated at Pézenas, 4th Feb
1656, for 6000 livres, granted by the estates of
guedoc. This sum was not divided for the earliest repre
tion, at Pézenas or Montpellier, of Molière's second finished comedy,
Dépit Amoureux. Conti now withdrew to Paris, and
to "make his court the fourth way. Almost his
t of penitence was to dissolve Molière's troupe (1657),
consequently found that the liberality of the estates
ruptly dried over. Conti's relations
Molière must have definitively closed long before 1666,
the now pious prince wrote a treatise against the
stage, and especially charged his old schoolfellow with keeping a new school, a school of atheism (*Traité de la Comédie*, p. 21, Paris, 1666). Molière was now (1657) independent of princes and their favour. He went on a new circuit to Nismes, Orange, and Avignon, where he met another old class-mate, Chapelle, and also encountered the friend of his later life, the painter Mignard. After a later stay at Lyons, ending with a piece given for the benefit of the poor on 27th February 1658, Molière passed to Grenoble, returned to Lyons, and is next found in Rouen, where, we should have said, the Théâtre Illustre had played in 1613 (F. Bouquet, *La Troupe de Molière à Rouen*, p. 90, Paris, 1880). At Rouen Molière must have made or renewed the acquaintance of Pierre and Thomas Corneille. His company had played pieces by Corneille at Lyons and elsewhere. The real business of the comedian in Rouen was to prepare his return to Paris. "After several secret journeys thither he was fortunate enough to secure the patronage of Monsieur, the king's only brother, who granted him his protection, and permitted the company to take his name, presenting them as his servants to the king and the queen-mother" (Preface to La Grange's edition of 1682). The troupe appeared for the first time before Louis XIV. in a theatre arranged in the old Louvre (24th October 1658).

Molière was now thirty-six years of age. He had gained all the experience that fifteen years of practice could give. He had seen men and cities, and noted all the humours of rural and civic France. He was at the head of a company which, as La Grange, his friend and comrade, says, "sincerely loved him. He had the unlucrative patronage of a great prince to back him, and the jealousy of all playwrights, and of the old theatres of the Hôtel de Bourgogne and the Marais, to contend against. In this struggle we can follow him by and of the *Registre* of La Grange (a brief diary of receipts and payments), and by the help of notices in the rhymed chronicles of Loret.

The first appearance of Molière before the king was all but a failure. *Nicomède*, by the elder Corneille, was the piece, and we may believe that the actors of the Hôtel de Bourgogne, who were present, found much to criticize. When the play was over, Molière came forward and asked the king's permission to act "one of the little pieces with which he had been used to regale the provinces." The *Docteur Amoureux*, one of several slight comedies admitting of much "gag," was then performed, and "diverted as much as it surprised the audience." The king commanded that the troupe should establish itself in Paris (Preface, ed. 1682). The theatre assigned to the company was a *salle* in the Petit Bourbon, in a line with the present Rue du Louvre. Some Italian players already occupied the house on Tuesdays, Fridays, and Sundays; the company of Molière played on the other days. The first piece played in the new house (3d Nov. 1658) was *L'Étourdi*. La Grange says the comedy had a great success, producing twenty pistoles for each actor. The success is admitted even by the paternal author of *Élomire Hypochondre* (Paris, 1670)

"Le jour l'Etourdi, qui fut une merveille."

The success, however, is attributed to the farcical element in the play and the acting—the cuckoo cry of Molière's detractors. The original of *L'Étourdi* is the Italian comedy (1629) *L'Inavvertito*, by Nicolò Barbieri detto Beltrame's. Molière pushed rather far his right to "take his own where'er he found it." Had he written nothing more original, the contemporary critic of the *Festin de Pierre* might have said, not untruly, that he only excelled in stealing pieces from the Italians. The piece is conventional: the stock characters of the prodigal son, the impudent valet, the old father occupy the stage. But the dialogue

azing rapidity, and the vivacity of M. Coquelin in
lle still makes *L'Étourdi* a favourite on the stage,
it cannot be read with very much pleasure. The
ece, new in Paris, though not in the provinces, was
pit Amoureux (first acted at Béziers, 1656). The
s not less successful than *L'Étourdi*. It has two
ne an Italian *imbroglio*; the other, which alone
he stage, is the original work of Molière, though, of
the idea of *amantium irae* is as old as literature.
ng so good," says Mr. Saintsbury, "had yet been
the French stage, as the quarrels and reconciliations
quartette of master, mistress, valet, and soubrette
he hostile Le Boulanger de Chalussay (*Élomire*
ondre) admits that the audience was much of the

> Et de tous les côtés chacun criait tout haut,
> "C'est la faire et jouer les pièces comme il faut."

ne praise was given, perhaps even more deservedly, to
ieuses Ridicules (18th November 1659). Doubts have
ised as to whether this famous piece, the first true
atire of contemporary foibles on the French stage,
ew play. La Grange calls it *pièce nouvelle* in his
, but, as he enters it as the third *pièce nouvelle*,
y only mean that, like *L'Étourdi*, it was new to
The short life of 1682, produced under L. Guérin's
d probably written by Marcel the actor-say the
es was "made" in 1659. There is another contro
s to whether the ladies of the Hôtel Rambouillet,
ly their *bourgeoises* and ridiculous mutual worshipped
nage, in later years at least, professed to recognize an
on the over-refinement and affectation of the original
most ways, honourable *précieuses* of the Hôtel Ram
. But, Chapelle and Bachaumont had discovered
ial *précieuses*, hyper-aesthetic literary ladies, at Mont-
before Molière's return to Paris; and Tristan,
Roman Bourgeois (1666), found Paris full of middle
précieuses, who had survived, or, like their modern
parts, had thriven on ridicule. Another
l Molière copy from the earlier *Précieuses* of the
e Pure? This charge of plagiarism was brought by
e, in the preface to his *Véritables Précieuses*. De
work was a novel (1656), from which the Italian
had put together an acting piece in their manner,
a thing of "gag," and improvized speeches. The
h is interesting only because it proves how early
found enemies who, like Thomas Corneille in 1659,
l him of being skilled only in farce, or, like Somaize,
l him with literary larceny. These were the stock
ns of Molière's opponents as long as he lived. The
of the *Précieuses Ridicules* was immense, on one
occasion the king was a spectator, leaning against
eat chair of the dying Cardinal Mazarin. The play
ver cease to please while literary affectation exists,
has a comic force of deathless energy. Yet a man
may spare some sympathy for the poor heroine,
o not wish, in courtship, to "begin with matrimony,"
efer first to have some less formidable acquaintance
eir wooers. Molière's next piece was less important,
ore purely farcical, *Sganarelle; ou le Cocu Imaginaire* (8th May 1660). The public taste preferred a work
light nature, and *Sganarelle* was played every year
as Molière lived. The play was pirated by a man
etended to have retained all the words in his memory.
ounterfeit copy was published by Ribou, a double
to Molière, as, once printed, any company might act
y. With his habitual good-nature, Molière not only
l Ribou to publish later works of his, but actually
oney to that knave (Soulié, *Recherches*, p. 287).
11th October 1660 the Théâtre du Petit Bourbon
emolished by the superintendent of works, without notice given to the company. The king gave Molière
Salle du Palais Royal, but the machinery of the old th
was maliciously destroyed. Meanwhile the older comp
of the Marais and the Hôtel de Bourgogne attempt
lure away Molière's troupe, but, as La Grange de
(*Registre*, p. 26), "all the actors loved their chief
united to extraordinary gentus an honourable cha
and charming manner, which compelled them all to p
that they would never leave him, but always share h
tune..." While the new theatre was being put in
the company played in the houses of the great and
at the Louvre. In (orig
built by Richelieu) Molière began to play on 20th Ja
1661. Molière now gratified his rival by a failure.
Dépit de Amoureux, a heavy tragi-comedy, which had
lain among his papers, was first represented on 11th Feb
1661. Either Molière was a poor actor out of his co
or his manner was not sufficiently "tragic," and, a
say, "démodée," for the taste of the day. He appe
were determined that he could not act in tragi-comedy
he, in turn, burlesqued their pretention and exagge
manner in a later piece. In the *Précieuses* he
lished already rallied "les grands comédiens" of the
Bourgogne. "Les autres," he makes Magdelon say
his own troupe, "sont de grands acteurs qui récitent c
l'on parle, et ne savent pas faire rouler le vers." A
was likely to imitate the *grands comédiens*, and their tr
who avenged themselves on that unfortunate jeune p
Don Garcie de Navarre. The object of the new
drama is one of many examples which bear how Mo
mind was enraged with the serious or romantic pe
jealousy, a passion which he had soon cause to know
intimately. Meantime the everyday life of the thea
on, and the doorkeeper of the Théâtre St Germain
wounded by some revellers who tried to force their
into the house (La Grange, *Registre*). A year lat
Italian actor was stabbed in front of Molière's house,
and sought to take shelter (Campardon, *Nouv*
p. 290). To the endangered actors were peculiarly su
Molière himself was frequently threatened by the mar
and others whose claims he ridiculed on the stage, and
seem even reason to believe that there is some tr
history of the angry marquis who rubbed the
against his buttons, thereby cutting her
story comes late (1758) into his biography, supp
by a passage in the contemporary play, *Zélinde*
1663, Father Eustache Le Noble, Molière's
hate in the profits of his company, one for himself
one for his wife, at his marriage. That fatal step was
contemplated (La Grange). On 15th June he ha
out for the first time *L'École des Maris*. The scene
of the piece is laid at Athens, and Molière
promptly [illegible] plot borrowed from the *Adelphi* of Te
One of the *motifs* of the play [illegible] borrowed from
as old at least as Boccaccio [illegible] still more recently
by Charles de Bernard. It is [illegible] Molière's
that the acute and baffled paternal woos
like several other butts in Molière's comedy, [illegible]
certain extent with our sympathy and pity as well as
laughter. The next new piece was *Les Fâcheux* (a
ballet the Comedy of Boredom), played before the
Fouquet's house at Vaux le Vicomte (August 1661).
The co-editors, without knowing it, were [illegible]
"attack" on the succession, for Fouquet
the ebullience of his unabatable ambition (
says in motto), and the King was [illegible]
and full of Fouquet, his rival in the affections
Vallière. The author of the prologue to *Les Fâ*
Pellisson, a friend of Fouquet's, was arrested [illegible]
the superintendent of finance. Pellisson's prologu

were retained in later editions. In the dedication king Molière says that Louis suggested one scene f the Sportsman), and in another place he mentions he piece was written, rehearsed, and played in a ht. The fundamental idea of the play, the inter- s by hores, is suggested by a satire of Régnier's, at by a satire of Horace. Perhaps it may have been knowledged s ns of the king which mac declare that Molière habitually worked up hints ames given him by persons of quality (*Nouvelles* s, 1663).

February 1662 Molière married Armande Béjard. ate is given thus in the *Registre* of La Grange, y 14, Les Vi-onnaires, L'Ecol de M

Part Visite chez M d'Equeuilly"

the marem he ha painted a blue circle, his way of n a happy event, with the words, "mariage de M. ière au sortir de la Visite." M Lorsclem give the one pr ace as 29th February, in another a 20th ry. But La Grange elsewhere mentions the date rove Tuesday, which was it seems, 14th February. ere M Lor-clem make the date of the marriage a lay "in January." The truth is that the marriage t i dated 23d January 1662 (Soulie, *Documents*, p Where it s so difficult to establish the date of the ge, a simple fact, it must be infinitely harder to dis- he truth as to the conduct of Madame Molière. The nable a-sertions of the anonymous libel, *Les Intrigues ère et celles de sa Femme ou la Fameuse Comédienne*, have found their way into tradition, and are accepted But M. Lavet and M Bazin have that the alleged lover of Madame Molière y absent from France, or from the court, at the hen they are reported, in the libel, to have conquered rt. between Chapelle and Molière, h the comedian is made to tell the story of his , is plainly a mere fiction, and is answered in est by another dialogue between Molière and Rohault, ch Molière only complains of a jealousy which he to be unfounded It is noticed too, that the con ary assailant of Molière counted him among jealous among deceived, husbands. The Incest-accusation t by the actor Montfleury that Molière had married daughter, Louis XIV answered by becoming the er of Molière's child. The king, indeed, was a end of the actor, and, when Molière was accused of on the production of *Don Juan* (1665), Louis gave ion. We need not try to make Madame Molière a French ladies of the theatre say, but the actions e charges against her are unsubstantiated. It is ly thought that Molière drew her portrait in *Les Contes d'Eliomire*, acte iii sc ix., "elle est capri- ieuse comme toute les Belles."

n 1663 onwards Molière suffered the increasing of his royal actors. La Grange mentions the visit rlon and Montfleury to the queen mother, and troupe to obtain equal favour, "la troupe de Molière ordinaire beaucoup de jalousie" (12th August 1662). th Dépit amoureux was played for the first time the ble *L'Ecole des Femmes*, which provoked a literary d caused a shower of "paper bullets of the brain." nocence of Agnès was called indecency, the sermon olphe was a deliberate attack on Christian mystères. ve not the place to discuss the religious ideas of ; but both in *L'Ecole des Femmes* and in *Don Juan* s display a bold contempt for the creed of "boiling es" and of a physical hell. A brief list of the nd pamphlet provoked by *L'Ecole des Femmes* is all offer in this place.

ber 26, 1662 *École des Femmes.*

February 9, 1663.—*Nouvelles Nouvelles*, by De Visé. Molière accused of pilfering from Straparola.

June 1, 1663. Molière's own piece, *Critique de l'École Femmes*. In this play Molière retorts on the critics, and espec on his favourite butt, the critical marquise.

August 1663. *Zélinde*, a play by De Visé, is printed. The is in the shop of a seller of lace, where persons of quality meet attack the reputation of "Elomire," that is, Molière. He from the Italian, the Spanish, from Furetière's *Francion*, "il lit les vieux bouquins," he insults the *noblesse*, he insults Christia and so forth.

November 17, 1663.—*Portrait du Peintre* is printed,—an a on Molière by Boursault This piece is a detailed criticism cental personages of *L'Ecole des Femmes*. It is pronounced vulgar, farcical, obscene, and (what chiefly vexed Molière, who the danger of the accusation) impious. Perhaps the only biog real matter we gain from Boursault's play is the interesting that Molière was a front-player. On 4th November 1663 M replied with *L'Impromptu de Versailles*, a witty and mer attack on his critics, in which Boursault was mentioned by n The actors of the Hôtel de Bourgogne were parodied on the s and their art was ridiculed.

The next scenes in this comedy of comedians were:—

November 30 The *Panégyrique de l'Ecole des Femmes*, by Rol

December 7. *La Vengeance de l'Impromptu; ou la Vengeance des quets*, by De Vis

January 19, 1664. *L'Impromptu de l'Hôtel de Condé*. It reply by a friend of Montfleury

March 14, 1664. *La Guerre Comique; ou Défense de l'Éco Femmes*.

1664. *Lettre sur les Nouveaux Théâtre*, published in *Dive Galerie* by the author of *Zélinde*.

In all these quarrels the influence of Corneille opposed to Molière, while his cause was espoused Boileau, a fruitful ally, when "les comédiens et les aut depuis le cadet [Corneille ?] jusqu'à Thysope, sont di ment armés contre lui" (*Impromptu de Versailles*, scène

Molière's next piece was *Le Mariage Forcé* (15th ruary 1664), a farce with a ballet. The comic chara of the reluctant bridegroom excites contemptuous as well as laughter. From the end of April till 22d the troupe was at Versailles, acting among the picture plea-ures of that great festival of the king's. The *Prin d'Elide* was acted for the first time, and the three acts of *Tartuffe* were given Molière's natural hatre hypocrisy had not been diminished by the charges of phemy which were showered on him after the *Ecole Femmes*. *Tartuffe* made enemies everywhere. Janse and Jesuits, like the two marquises in *L'Impromptu Versailles*, each thought the others were aimed at. years passed before Molière got permission to pla whole piece in public. In the interval it was acted b Madame, Condé, the legate, and was frequently rea Molière in private houses. The *Gazette* of 17th May (a paper hostile to Molière) says that the king thought piece inimical to religion. Louis was not at that on good terms with the *dévots*, whom his amours scan ized but, not impossibly, the queen mother (then suffe from her fatal malady) disliked the play. A most vi attack on Molière, "that demon clad in human flesh written by one Pierre Roullé (*Le Roy Glorieux au M* Paris, 1664). This fierce pamphlet was suppressed, the king's own copy, in red morocco with the royal a remains to testify to the bigotry of the author, who curé of Saint Barthélemy. According to Roullé, Mo deserved to be cast through earthly to eternal fires. play was prohibited, as we have seen, but in August the king adopted Molière's troupe as his servants, and them the title of "troupe du roy." This, however, did cause Molière to relax his efforts to obtain permissio *Tartuffe* (or *Tartufe*, or *Tartuffe*, as it was variously spel and his perseverance was at length successful. Tha thoughts were busy with contemporary hypocrisy is pr by certain scenes in one of his greatest pieces, the *F de Pierre*, or *Don Juan* (15th February 1665). The le of *Don Juan* was familiar already on the Spanish, Ita

nch stages. Molière made it a new thing: terrible
antic in its portrait of *un grand seigneur méchant*
modern in its suggested substitution of *la humanité*
gion, comic, even among his comedies, by the mirth-
acter of Sganarelle. The piece filled the theatre,
stopped, probably by authority, after Easter. It
printed by Molière, and even in 1682 the publi
of the full text was not permitted. Happily the
De la Regnie, the chief of the police, escaped
tions, and gave us the full scene of Don Juan and
ggar. The piece provoked a virulent criticism
tions sur le Festin de Pierre, 1665). It allowed
olière has some farcical talent, and is not an killed
giarist, but he "attacks the interests of Heaven,"
a school of infidelity," "insults the king," "con-
irtue," "offends the queen mother," and so forth
olies were published, one of which is by some critics
d to show traces of the hand of Molière. The king
s has been shown, was to adopt Molière's company
servants, and to pension them. *L'Amour Médecin*,
comedy, appeared 22d September 1665. In th
Molière, for the second time, attacked physicians.
ember there was a quarrel with Racine about his
Alexandre, which he treacherously transferred to the
le Bourgogne. June 4, 1666, saw the first repre
n of that famous play, *Le Misanthrope* (or *L'Atra
Amoureux*, as the original second title ran). This,
erhaps the masterpiece of Molière, was n
with the critics, with the court, and with posterity
ith the public. The rival comedians called it "a
le of comedy," and so it was. The eternal passions
timents of human nature, modified by the refinement
utmost refinement of civilization, were the matter of
e. The school for scandal kept by Célimène, with
y judgments on all characters save the artist a
nvas. The perpetual strife between the sensible
n of a kindly man of the world (Philinte) and the
dignatio of a noble nature soured (Alceste) supe
e intellectual action. The humours of the joyous ly
Célimène and of her court, especially of that death-
or poet Oronte, supply the lighter comedy. Boileau,
, Goethe have combined to give this piece the
rank even among the comedies of Molière. As to
eys" to the characters, and the guesses about the
l from whom Alceste was drawn, they are as value
other contemporary tattle.

iefer summary must be given of the remaining years
ife of Molière. The attractions of *Le Misanthrope*
einforced (6th August) by those of the *Médecin
Lui*, an amusing farce founded on an old *fabliau*.
ember the court and the comedians went to Saint
n, where, among other diversions, the pieces called
te, *La Pastorale Comique* (of which Molière is said
e destroyed the MS.), and the charming little piece
lien, were performed. A cold and fatigue seem to
njured the health of Molière, and we now hear of
sumptive tendency which was cruelly ridiculed in
e Hypochondre. Molière was doubtless obliged to
much of the distracted or pedantic physicians of an
en medicine was the battlefield of tradition, super
and nascent chemical science. On 17th April
obinet, the rhyming gazetteer, says that the life of
e was thought to be in danger. On the 10th of
nowever, he played in *Le Sicilien* before the town.
earlier months of 1667 Louis XIV. was with the
n Flanders. There were embassies sent from the
to the camp, and on 5th August it was apparent
olière had overcome the royal scruples. *Tartuffe*
ayed, but Lamoignon stopped it after the first night.
nge and La Torillière hastened to the camp, and
got the king's promise that he would reconsider the matt
on his return. Molière's next piece (13th January 166
was *Amphitryon*, a free a very free adaptation fro
Plautus, who then seems to have engaged his attentio
for not long afterwards he again borrowed from the ancie
writer in *L'Avare*. There is a controversy as to wheth
Amphitryon was meant to ridicule M. de Montespan, t
husband of the new mistress of Louis XIV. Michelet h
a kind of romance based on the probably groundless hyp
theses. The king still saw the piece occasionally, after
had purged himself and for-worn sack under Madame
Maintenon, and probably neither he nor that devout lad
detected any personal references in the coarse and wit
comedy. Naturally, Molière was accused of plagiarizing, th
time from Rotrou, who had also imitated Plautus. Th
next play was the immortal *George Dandin* (10th July), fir
played at a festival at Versailles. Probably the piece w
a rapid palimpsest on the ground of one of his old farce
but the addition of these typical members of a coun
family, the De Sotenvilles, raises the work from farce
satiric comedy. The story is borrowed from Boccacci
but is of unknown age, and always new. Adolphus Ego
in *The Small Hours at Ulvaston* hence a kind of mode
George Dandin. Though the sad fortunes of the peas
with social ambition do not fail to make us pity him on
what, it is being too refined to regard *George Dandin*
a comedy with a concealed tragic intention. Molière
must have been at work on *L'Avare* before *George Dand*
appeared, for the new comedy after Plautus was first act
on 9th September. There is a tradition that the pie
almost failed; but, if unpopular in the first year of its p
duction, it certainly gained favour before the death of
author. *M. de Pourceaugnac* (17th September 1669) w
first acted at Chambord, for the amusement of the kin
It is a rattling farce. The physicians, as usual, bore t
brunt of Molière's raillery, one of which is still applicab
Earlier in 1669 (5th February) *Tartuffe* was played
last, with extraordinary success. *Le Bourgeois Gentilhom*
a comedy ballet, was acted first at Saint Germain (1
February 1670). The king might have been expected
dance in the ballet, but from Racine *Britannicus* (1
December 1669) the skeptical monarch learned th
Nero was blamed for exhibitions of this kind, and he d
not wish to out-Nero Nero. A trilogy this time took t
place of medicine as a butt, but the satire has becom
obsolete, except, perhaps, in Turkey, where astrology
still a power. The *Bourgeois Gentilhomme*, too famil
to require analysis, was first played on 23d October 17
The lively *Fourberies de Scapin* saw the footlights
footlight there were on 24th May 1671, and on 7
May we read in La Grange of "les Répétition de Spye
ont commancé." La Grange says the theatre was new
decorated and fitted with machines. A "concert
twelve violins" was also provided, the company be
resolute to have everything handsome about them. N
singers were introduced, who did not refuse to sing
masked on the stage. Quinault composed the words
the music, which was by Lully. Molière and Pierre Corne
collaborated in the dialogue of the magnificent ope
the name of which *Psyché* La Grange eventually learn
how to spell. The *Comtesse d'Escarbagnas* (2d Febru
1672) was another piece for the amusement of the cou
and made part of an entertainment called *Le Ballet
Ballet*. In this play, a study of provincial manne
Molière attacked the financiers of the time in the per
of M. Harpin. The comedy has little importance compa
with *Les Femmes Savantes* (11th February), a severe
comedy, in which are satirized the vanity and affectation
sciolists, pedants, and the women who admire them. T
satire is never out of date, and finds its modern form

le où l'on s'ennuie, by M. Pailleron. On the 17th
y Madeleine Béjard died, and was buried at St
She did not go long before her old friend or lover,
His *Mariage Forcé*, founded, perhaps, on a
anecdote of De Gramont, was played on 8th
On 7th August La Grange notes that Molière was
d and there was no comedy. Molière's son died
th October. On 22d November the preparations
Malade Imaginaire were begun. On 10th Feb
673 the piece was acted for the first time. What
on 17th February we translate from the *Registre*
ance

ame day, about ten o'clock at night, after the comedy,
de Molière died in his house Rue de Richelieu He
e part of the rôle of Malade, after the much been coloured
tion which caused a violent comedy In the violence of
n he burst a vessel in his body and did not live more
an hour or three quarters after the bursting of the vessel
s buried at St Joseph parish of St Eustache There
e was placed about a foot above the ground

s material proofs described in a letter, and
by an eye witness, discovered by M Benjamin

y 21st February about nine in the evening, were buried
ith le Poquelin Molière, *tous ses vivants chantres*, and a
ful There were no prayers nor except the ecclesiastic
t bore the body in a wooden box covered with a pall,
ren in blue and candles in their holders and there
ere with burning torches of wax The funeral was
ast to Saint Eustache church and God buried at the foot of the
ere was present a crowd, and some twelve hundred livres
ributed among the poor The archbishop however ordered
ere should be interred without any ceremony, and had
ndered the doors of the church to do any service for him
le a number of curés were commanded to be present for
ect

an attempt was made to exhume the body of
in 1792 the wrong tomb appears to have been
Unknown is the grave of Molière.

re, according to Mlle Poisson, who had seen him
extreme youth, was "neither too stout nor too thin,
er than short He had a noble carriage, a good leg,
slowly, and had a very serious expression. His
thick, his mouth large with thick lips, his com-
brown, his eyebrows black and strongly marked,
his way of moving the arms that gave him his comic
on on the stage "His eyes seemed to search the
men's heart," says the author of *Zélinde*. The
es printed by M. Soulié prove that Molière was
ch dress, splendid furniture, and old book The
of his conversation attested the names of his
who were all the wits of the age, and the greater
ames the greater their love of Molière A man
iend and enemies agreed in recognizing him a
ce-star in comedy His ideas of tragic declamation
advance of his time, for he set his face against the
t habit of ranting. His private character was
ble for gentleness, probity, generosity, and delicacy,
attested not only by anecdotes but by the evidence
s art Here (probably Ge Menander is lost) the
of all comic writers within the limits of social and
distinguished from romantic comedy, like that of
ere, and of political comedy, like that of Aristo
He has the humour which is but a sense of the
ne of life, and now takes the form of the most
wit and the keenest observation, now of melan
nd pity, and wonder at the fortunes of mortal
n the literature of France his is the greatest name,
the literature of the modern drama the greatest
t of Shakespeare. Beside his contemplative genius
essed an inerring knowledge of the theatre, the
ge of a great actor and a great manager, and
s plays can never cease to hold the stage, and to
charm, if possible, even more in the performance than in the reading.

There is no biography of Molière on a level with the latest researches into his life. The best is probably that of M. Taschereau, prefixed to an edition of his works (*Œuvres Complètes*, Paris, 1863). To this may be added Jules Loiseleur's *Les Points Obscurs de la Vie de Molière*, Paris, 1877. We have seen that M. Loiseleur is not always accurate, but he is laborious. For other books it is enough to recommend the excellent *Bibliographie Moliéresque* of M. Paul Lacroix (1875), which is an all but faultless guide. The best edition of Molière's works for the purposes of the student is that published in *Les Grands Écrivains de la France* (Hachette, Paris, 1873-1882). The edition is still incomplete. It contains reprints of many contemporary tracts, and, with the *Registre* of La Grange, and the *Bibliographie Moliéresque* of M. Lacroix, is the chief source of the facts stated in this notice, in cases where the rarity of documents has prevented the writer from studying them in the original text. Another valuable authority is the *Recherches sur Molière* (Paris, 1863) of Ed Soulié (1863). Lotheisen's *Molière, sein Leben und seine Werke* (Frankfurt, 1880), is a respectable German work. *Le Moliériste* (Tresse, Paris, edited by M. Georges [illegible]), a monthly journal, containing notes on Molière and his contributors. The essays, biographies, plays, [illegible] extremely numerous. The best guide to them is the *Bibliographie* of M. Lacroix. The English [illegible] as a rule absolutely untrustworthy. (A. L.)

MOLINA, Luis (1535–1600), a Spanish Jesuit, whom his *Provincial* have rendered immortal, was born at Cuenca in 1535. Having at the age of eighteen become a member of the Company of Jesus, he studied theology at Coimbra, and afterwards became professor in the university of Evora, Portugal. From this post he was called, at the end of twenty years, to the chair of theology in Madrid, where he died on 12th October 1600. Besides other works he wrote *Liberi arbitrii cum gratiæ donis, divina præscientia, providentia, prædestinatione et reprobatione, concordia* (4to, Lisbon, 1588); a commentary on the first part of the *Summa* of Thomas Aquinas (2 vols. fol., Cuenca, 1593); and a treatise *De Justitia et Jure* (6 vols., 1593–1609). It is to the first of these that his fame is principally due. It was an attempt to reconcile in words at least, the Augustinian doctrines of predestination and grace with the Semipelagianism which, as shown by the recent condemnation of BAJUS (*q.v.*), had become prevalent in the Roman Catholic Church. Assuming that man is free to perform or not to perform any act whatever, Molina maintains that this circumstance renders the grace of God neither unnecessary nor impossible:—not impossible, for God never fails to bestow grace upon those who ask it with sincerity; and not unnecessary, for grace, although not an efficient, is still a sufficient cause of salvation. Nor, in Molina's view, does his doctrine of free will exclude predestination. The omniscient God, by means of His "[illegible] media" (the phrase is Molina's invention, though the [illegible] also to be found in his older contemporary Fonseca), or power of knowing future contingent events shall employ our own free-will and treat Him preferred grace, and upon this foreknowledge He can found His predestinating decrees. These doctrines, although in harmony with the prevailing feeling of the Roman Catholic Church of the period, and further recommended by their marked opposition to the teachings of Luther and Calvin, excited violent controversy in some quarters, especially on the part of the Dominicans, and at last rendered it necessary for the pope (Clement VIII.) to interfere. At first (1594) he simply enjoined silence on both parties so far as Spain was concerned; but ultimately, in 1598, he appointed the "Congregatio de Auxiliis Gratiæ" for the settlement of the dispute, which became more and more a party one. After holding very numerous sessions the "congregation" was able to decide nothing, and in 1607 its meetings were suspended by Paul V., who announced his intention of himself pronouncing judgment in due time. He contented himself, however, in 1611

rohibiting all further discussion of the question "de
s," and studious efforts were made to control the
ation even of commentaries on Aquinas. The
st subsequently passed into the Jansenist controversy,
is as a champion of Jansenism that Pascal in th
cial Letters attacks Molina and the *scientia media*
ANSENISM).

LINE, a city of the United States, in Rock Island
, Illinois, is situated in a picturesque district on the
nk of the Mississippi, opposite the upper end of Rock
. First settled in 1832, the town was organized as
in 1872. It is noted for its water-power, developed
aintained by the Government, and for the number and
ance of it. manufacturing establishment. By means
am nearly a mile in length, from the main shore
island, an almost uniform head of 7 feet of water i
d, which is used in driving the machinery of the
nment arsenal on the island, and in supplying power
ral factories. Beds of bituminous coal are mined in
ghbourhood, and three lines of railway pass through
y, affording with the river ample means of communi
The most prominent manufactures are agricultural
ents and machinery generally, waggons, organs,
and stoves. Moline has nine churches, a complete
of graded free schools, including a high school, and
library. The population increased from 1066 in
o 7805 in 1880, and with the suburbs the number
estimated at 12,000.

LINOS, MIGUEL DE (1627 *c.* 1690), a Spanish
whose name is intimately associated with that type
gion known in Italy and Spain during the latter
the 17th century as Quietism, was born of poor
in the diocese of Saragossa, on 21st December 1627.
g entered the priesthood, he settled about his fortieth
a Rome, where he speedily rose to high reputation as a
confessor, and gained many distinguished friends,
whom were several cardinals, including Odescalchi
wards Innocent XI., 1676). In 1675 he published at
a small duodecimo volume entitled *Guida spirituale
involge l'anima e la conduce per l'interno cammino all
o della perfetta contemplazione e del ricco tesoro della
nteriore*, which was soon afterwards followed by the
trattato della cottidiana communione, usually bound
h it in later editions. The work, which breathes a
of simple and earnest piety, is designed to show how
peace may be found by what may be called con-
tive or passive prayer, by obedience, by frequent
nion, and by inward mortification; it was widely
ted, and greatly increased the popularity of its
, whom Innocent XI. after his elevation provided
ooms in the Vatican, and is said to have also taken
spiritual director. Its doctrine of the passivity of
ghest contemplation and purest prayer does not
to have raised the slightest dissension until after
olication, in 1681, of the *Concordia tra la fatica e
te nell' oratione*, by the Jesuit preacher, Paolo Segneri,
gh scrupulously refraining from any mention of
me of Molinos, and indeed displaying considerable
ation as a controversialist, Segneri by this tract and
other with which he followed it up brought upon
f much unpopularity; and so great did the excitement
e that a committee was at last appointed by the
ition to investigate his own views as well as to
ne the writings of Molinos and of his friend Petrucci
r of *La contemplazione mistica acquistata*). The
(1682) was entirely favourable to the doctrines of the
Spirituale, the writings of Segneri being censured
adalous and heretical; but in 1685, in consequence
resentations made to the pope by Louis XIV., under
suit influence of Père La Chaise, both Petrucci and
Molinos were laid under arrest, and the papers of the
including a voluminous correspondence, seized. P
was soon afterwards liberated, and relieved from
persecution by the gift of a cardinal's hat; but, after M
had languished in confinement for two years, sudden
persons, many of them of high rank, were also appre
by order of the Inquisition for what were then for t
time called "Quietist opinions." In 1687 the pope
fied his approval of the condemnation pronounced
Inquisition on sixty-eight doctrines imputed to M
The "heretic" forthwith "abjured" these, and thus
the flames indeed, but did not regain his liberty.
later years nothing is known according to the most
able account he lan[illegible] ment until
December 1696.

[illegible] Leipsic, 1687; by A. H. [illegible]
[illegible] and plain

of Gottfried Arnold. [illegible]

1882

MOLISE, now Campo
ing twenty mile[illegible] the [illegible]t of the Adriatic
bounded by the Abruzzi C[illegible] and Aquila, To
Lavoro (Caserta, Benevento [illegible] Capitanata (Fo
Most of it lies on the north-eastern [illegible] the Apen
and is watered by the Biferno, the Fortore, and the T
but it also includes [illegible] country on the other side
contains the head-streams of the Volturno. Abou
sixths of the surface may be described as mountain
hilly, the loftiest range being the Matese on the
towards Benevento, with its highest point in
Miletto, 6750 feet. The population, which increase
316,007 in 1861 to 365,131 in 1881, is mainly dep
[illegible]d and as[illegible] pursuits, neither manuf
nor trade being highly developed. According to the
of 1871, [illegible] with more than 5000 i
ants [illegible] 2,890 Isernia, 8123; Isernia,
Agnone 7117, [illegible] denzio, 6217, and Larino, 5357;
ing to the [illegible] 1881, 21 of the 133 communes,
population exceeding 4000.

The Molise territory was in ancient times part of the co
the Sabine and Samnite. Under the Lombards it was
in the duchy of Benevento; but the district of Sepino,
and Terra were early all to form a dominion for the Lombard
come to be called King Grimoald. About two centuries later this
the county-ship of Boiano, and the name was soon after cha
count-ship of Molise, probably because the local dynasty lived
di Molise, or Molise. Attached under Frederick II to the
Lavoro, and at a later date incorporated with Capitanata, the
did not again become an independent province till 1811.
it surrendered fifteen communes to Benevento, and received
from Terra di Lavoro.

MOLLUSCA

Mollusca form one of the great "phyla," or sub-
inedoms of the Animal Pedigree or Kingdom.
ry History of the Group. The shell bearing forms
g to this group which were known to Linnæus were
y him (in 1748) in the third order of his class
under the name "Testacea," whilst the Echino
Hydroid, and Annelid, with the naked Molluscs,
his second order, termed "Zoophyta." Ten years
replaced the name "Zoophyta" by "Mollusca,"
as thus in the first instance applied, not to the
t at present so termed, but to a group consisting
f other organisms. Gradually, however, the term
became restricted to include those Mollusca formerly
mong the "Testacea," as well as the naked Mollusca.
mportant to observe that the term *μαλάκια*, of which
is merely a Latinized form, was used by Aristotle
te a group consisting of the Cuttle-fishes only.

definite erection of the Mollusca into the position
f the great primary group of the animal kingdom
George Cuvier (1788-1800), who largely occupied
with the dissection of representative of this type (1).
pendent anatomical investigation of the Mollusca
n carried on by the remarkable Neapolitan naturalist
li (1791), whose researches (2) were not published
ter his death (1817), and were followed by the
l work of another Neapolitan zoologist, the illus-
elle Chiaje (3).

"embranchement" or sub-kingdom Mollusca, as de-
Cuvier, included the following classes of shell-fish:
uttles or poulpes, under the name CEPHALOPODA; 2,
l, whelks, and slugs, both terrestrial and marine,
he name GASTEROPODA; 3, the sea-butterflies or
snails, under the name PTEROPODA; 4, the clams,
, and oysters, under the name ACEPHALA; 5, the
ells, under the name BRACHIOPODA; 6, the sea-
or ascidians, under the name NUDA; and 7, the
s and sea-acorns, under the name CIRRHOPODA.
main limitations of the sub-kingdom or phylum
a, as laid down by Cuvier, and the chief divisions
ognized within its limits by him, hold good to the
day. At the same time, three of the classes con-
by him as Mollusca have been one by one removed
t association in consequence of improved know-
nd one additional class, incorporated since his day
e Mollusca with general approval, has, after more
rty years, been again detached and assigned an
dent position owing to newly acquired knowledge
ost of Cuvier's classes to be removed from the Mol-
that of the Cirrhopoda. Their affinities with the
rustacea were recognized by Cuvier and his contem-
, but it was one of the brilliant discoveries of that
ble and too-little honoured naturalist, J. Vaughan
on of Cork, which decided their position as Crus-
The metamorphoses of the Cirrhopoda were described
ed by him in 1830 in a very complete manner,
legitimate conclusion as to their affinities was for-
by him (4). Thus it is to Thompson (1830), and
Burmeister (1834), as erroneously stated by Keferstein,
hat the merit of this discovery belongs. The next
be removed from Cuvier's Mollusca was that of the
etter known as Tunicata. In 1866 the Russian
ogist Kowalewsky startled the zoological world with
account of the developmental changes of Ascidia,
he Tunicata (5), and it became evident that the

affinities of that class were with the Vertebrata, whilst their
structural agreements with Mollusca were only superficial.
The last class which has been removed from the Cuvierian
Mollusca is that of the Lamp-shells or Brachiopoda. The
history of its dissociation is connected with that of the
class, viz., the Polyzoa or Bryozoa, which has been both
added to and again removed from the Mollusca between
Cuvier's date and the present day. The name of J.
Vaughan Thompson is again that which is primarily con-
nected with the history of a Molluscan class. In 1830
he pointed out that among the numerous kinds of "polypes"
at that time associated by naturalists with the Hydroida
there were many which had a peculiar and more elaborate
type of organization, and for these he proposed the name
Polyzoa (6). Subsequently (7) they were termed Bryozoa
by Ehrenberg (1831).

Henri Milne Edwards in 1844 demonstrated (8) the affi-
nities of the Polyzoa with the Molluscan class Brachiopoda,
and proposed to associate the three classes Brachiopoda,
Polyzoa, and Tunicata in a large group "Molluscoidea"
coordinate with the remaining classes of Cuvier's Mollusca,
which formed a group retaining the name Mollusca. By
subsequent writers the Polyzoa have in some cases been kept
apart from the Mollusca and classed with the "Vermes";
whilst by others (including the present writer) they have,
together with the Brachiopoda, been regarded as true Mol-
lusca. The recent investigation by Mr. Caldwell (1887)
of the developmental history of Phoronis (9), together
with other increase of knowledge, has now, however, estab-
lished the conclusion that the agreement of structure
supposed to obtain between Polyzoa and true Mollusca is
delusive; and accordingly they, together with the Brachio-
poda, have to be removed from the Molluscan phylum.
Further details in regard to this, the last revolution in Mol-
luscan classification, will be found in the article POLYZOA.

As thus finally purified by successive advances of em-
bryological research, the Mollusca are reduced to the
Cuvierian classes of Cephalopoda, Pteropoda, Gastropoda,
and Acephala. Certain modifications in the disposition of
these classes are naturally enough rendered necessary by
the vast accumulation of knowledge as to the anatomy and
embryology of the forms comprised in them during fifty
years. Foremost amongst those who have within this
period laboured in this group are the French zoologists
Henri Milne Edwards (20) and Lacaze Duthiers (21), to
the latter of whom we owe the most accurate dissections
and beautiful illustrations of a number of different types.
To Kölliker (22), Gegenbaur (23), and more recently Spengel
(24), amongst German anatomists, we are indebted for
epoch-making researches of the same kind. In England
Owen's anatomy of the Pearly Nautilus (10), Huxley's dis-
cussion of the general morphology of the Mollusca (11),
and Lankester's embryological investigations (12), have
aided in advancing our knowledge of the group. Two
remarkable works of a systematic character dealing with
the Mollusca deserve mention here—the *Manual of the
Mollusca* by the late Dr. S. P. Woodward, a model of clear
systematic exposition, and the exhaustive treatise on the
Malacozoa or Weichthiere by the late Professor Keferstein
of Göttingen, published as part of Bronn's *Classen und
Ordnungen des Thier-Reichs*. The latter work is the most
completely illustrated and most exhaustive survey of exist-
ing knowledge of a large division of the animal kingdom
which has ever been produced, and, whilst forming a monu-
ment to its lamented author, places the student of Mol-
luscan morphology in a peculiarly favourable position.

figures refer to the bibliography at the end of the article,

es of the Mollusca.—The classes of the Mollusca
ve recognize are as follows:

Phylum MOLLUSCA.

BRANCH A.—**Glossophora.**	BRANCH B.—**Lipocephala** (= Acephala, *Cuvier*).
—GASTROPODA.	Class 1.—LAMELLIBRANCHIA (Syn. Conchifera)
—*Isopleura.*	*Examples*—Oyster, Mussel, Clam, Cockle
mples Chiton, Neo enia.	
Anisopleura.	
mples Limpet, Whelk, nail, Slug.	
—SCAPHOPODA.	
mple—Tooth-shell.	
—CEPHALOPODA.	
Pteropoda.	
mples—Hyalæa, Pneu- nodermon.	
—*Siphonopoda.*	
mples—Nautilus, Cut es, Poulp.	

ral Characters of the Mollusca.—The forms com
in the above groups, whilst exhibiting an extreme
of variety in shape, as may be seen on comparing
ster, a Cuttle-fish, and a Sea-slug such as Doris,
adapted, some to life on dry land, others to the
of the sea, others to running streams, whilst capable,
swimming, others of burrowing, crawling, or jumpe
ne, on the other hand, fixed and immobile, some
t the most formidable of carnivores, others feed
vegetable mud, or on the minutest of micro-scopic
ms—yet all agree in possessing in common a very
rable number of structural details which are not
d in common by any other animal.

structural features which the Mollusca do possess
mon with other animals belonging to other great
of the animal kingdom are those characteristic of
lomata, one of the two great grades (the other and
being that of the Coelentera) into which the higher
s, or Enterozoa as distinguished from the Protozoa,
ided (**13**). The Enterozoa all commence their individ
istence as a single cell or plastid, which multiplies
y transverse division. Unlike the cells of the Proto
se embryonic cells of the Enterozoa do not remain each
neighbour and capable of independent life, but pro
arrange themselves in two layers, taking the form
. The cavity of the two cell layered sac or Diblas
us formed is the primitive gut or ARCHENTERON.
Coelentera, whatever subsequent changes of shape
tle sac may undergo as it grows up to be Polyp or
sh, the original archenteron remains as the one
pervading all regions of the body. In the Coelomat
h-enteron becomes in the course of development
into two totally distinct cavities shut off from one
r an axial cavity, the MET-ENTERON, which retain
uction of a digestive gut; and a peri-axial cavity,
LOM or body-cavity, which is essentially the blood
and receives the nutritive products of digestion and
aste products of tissue-change by osmosis. The
a agree in being Coelomate with the phyla Verte
Platyhelmia (Flat-worms), Echinoderma, Appendicu
nsects, Ringed-worms, &c.), and others. In fact,
l the Enterozoa except the Sponges, Corals, Polyps,
edusæ.

common with all other Coelomata, the Mollusca
one period of life possessed of a PROSTOMIUM
ion in front of the mouth, which is the essential
of the "head," and is connected with the property
ard locomotion in a definite direction and the steady
e of the body (as opposed to rotation of the body
long axis). As a result, the Coelomata, and with
he Mollusca, present (in the first instance) the general
condition of body known as BILATERAL SYMMETRY;
dorsal is differentiated from the ventral surface, whi
right and a left side similar to, or rather the complem
of, one another are permanently established. In com
with all other Coelomata, the Mollusca have the mouth
first part of the alimentary canal which leads into
met-enteron formed by a special invagination of the
layer of the primitive body-wall, not to be confounded
that which often, but not always, accompanies the
cedent formation of the arch-enteron; this invagina
n termed the STOMODÆUM. Similarly, an anal apertu
formed in connexion with a special invagination w
meets the hinder part of the met-enteron, and is te
the PROCTODÆUM.

In common with many (if not all) Coelomata, the
lusca are provided with at least one pair of tube-like org
which open each by one end into the cœlom or body-ca
and by the other end to the exterior, usually in the ne
bourhood of the anus. These are the NEPHRIDIA.

Like all other Coelomata, the Mollusca are also prov
with special groups of cells forming usually paired or me
growths upon the walls of the cœlomic cavity, the
being specially possessed of reproductive power, and
ferentiated as egg-cells and sperm-cells. These are
GONADS. As in other Coelomata, the cell of the ge
may escape to the exterior in one of two ways: e
through the nephridia, or, on the other hand, by sp
apertures.

As in all other Coelomata, the cells which bui
respectively the primary outer layer of the body
lining layer of the met-enteron, and the lining layer
cœlom, are multiplied and differentiated in a variet
ways in the course of growth from the early embry
condition. Tissues are formed by the adhesion of a
ber of similarly modified cells in definite tracts. As
Coelomata, there is a considerable variety of tissues,
acterized by, and differentiated in relation to, parti
physiological activities of the organism. Not only
Coelomata but also many Coelentera show, in additi
the EPITHELIA (the name given to tissue which form
free surfaces, whether it be that of the outer body wa
the gut, or of a blood-space), also deeper lying tis
of which the first to appear is MUSCULAR tissue, an
second NERVOUS tissue.

The epithelia are active in throwing off their constit
cells (blood corpuscles from the wall of the cœlom),
producing secretions (glands of body wall and of gu
in forming horny or calcareous plates, spines, and
, known as CUTICULAR DEPOSITS (shells and bo
of the body wall, teeth of the tongue, gizzard, &c.).

In the Mollusca, as in all other Coelomata, in corres
ence with the primary bilateral symmetry and in rel
to the special mechanical conditions of the proston
the nervous tissue which is in Coelentera, and even in
worms, diffused over the whole body in networks,
to concentrate in paired lateral tracts, having a s
enlargement in the pre-oral region. The earlier plex
arrangement is retained in the nervous tissue of the
of the alimentary canal of many Coelomata, whilst
centration to form large nerve masses (GANGLIA), to
numerous afferent and efferent fibres are attached, a
the nervous tissue of the body wall.

In all Coelomata, including Mollusca, muscular tis
developed in two chief layers, one subjacent to the de
outer epithelium (SOMATIC MUSCULATURE), and a secon
rounding the alimentary canal (SPLANCHNIC MUSCULAT
Thus, primarily, in Coelomata the body has the charac
two muscular sacs or tubes, placed one within the
and separated from one another by the cœlomic s
The somatic musculature is the more copious and de

very generally an outer circular layer (*i.e.*, a layer in which the muscular fibres run in a direction transverse to the long axis of the body) and a deeper longitudinal layer; to these oblique and radiating fibres may be added. The splanchnic musculature, though more delicate, exhibits a circular layer nearer the enteric epithelium, and a longitudinal layer nearer the colomic surface.

In Coelomata and in many Coelentera there are found distributed between the tracts of muscular tissue, bounding them and giving strength and consistency also to the walls of the body, of the alimentary canal, of the colom, and of the various organs and tissue masses (such as nerve centres, gonad, &c.) connected with these, tracts of tissue the function of which is skeletal. The SKELETAL TISSUE of Mollusca, in common with that of other Coelomata, exhibits a wide range of minute structure, and is of differing density in various parts, it may be fibrous, membranous, or cartilaginous. The Mollusca, in common with the other Coelomata, exhibit a remarkable kind of association between the various forms of skeletal tissue and the epithelium which lines the coelomic cavity. The colomic cavity contains a liquid which is albuminous in chemical composition (BLOOD-LYMPH or HÆMOLYMPH), and into this liquid cells are shed from the colomic epithelium. They float therein and are known as BLOOD CORPUSCLES or LYMPH CORPUSCLES. The coelomic space with its contained hæmolymph is not usually in Coelomata, and is not in Mollusca, a simple even walled cavity, but is broken up into numerous passages and recesses by the outgrowth, both of the alimentary canal and of its own walls. By the adhesion of its opposite walls, and by an irregularity in the process of increase of its area during growth, the colom becomes to a very large extent a spongy system of intercommunicating LACUNÆ or irregular spaces, filled with the coelomic fluid. At the same time, the coelomic space has a tendency to push its way in the form of narrow canals and recesses between the layers of skeletal tissue, and thus to permeate together with the skeletal tissue in the form of a spongy, or it may be a tubular, network all the apparently solid portions of the animal body. This association of the nutritive and skeletal function is accompanied by a complete identity of the tissues concerned in these functions. Not only is there complete gradation from one variety of skeletal tissue to another (*e.g.*, from membranous to fibrous, and from fibrous to cartilaginous) even in respect of the form of the cells and their intercellular substance, but the coelomic epithelium, and consequently the hæmolymph with its floating corpuscles derived from that epithelium, is brought into the same continuity. The skeletal and blood containing and producing tissues in fact form one widely varying but continuous whole, which may be called the SKELETOGENIC SYSTEM OF TISSUES.

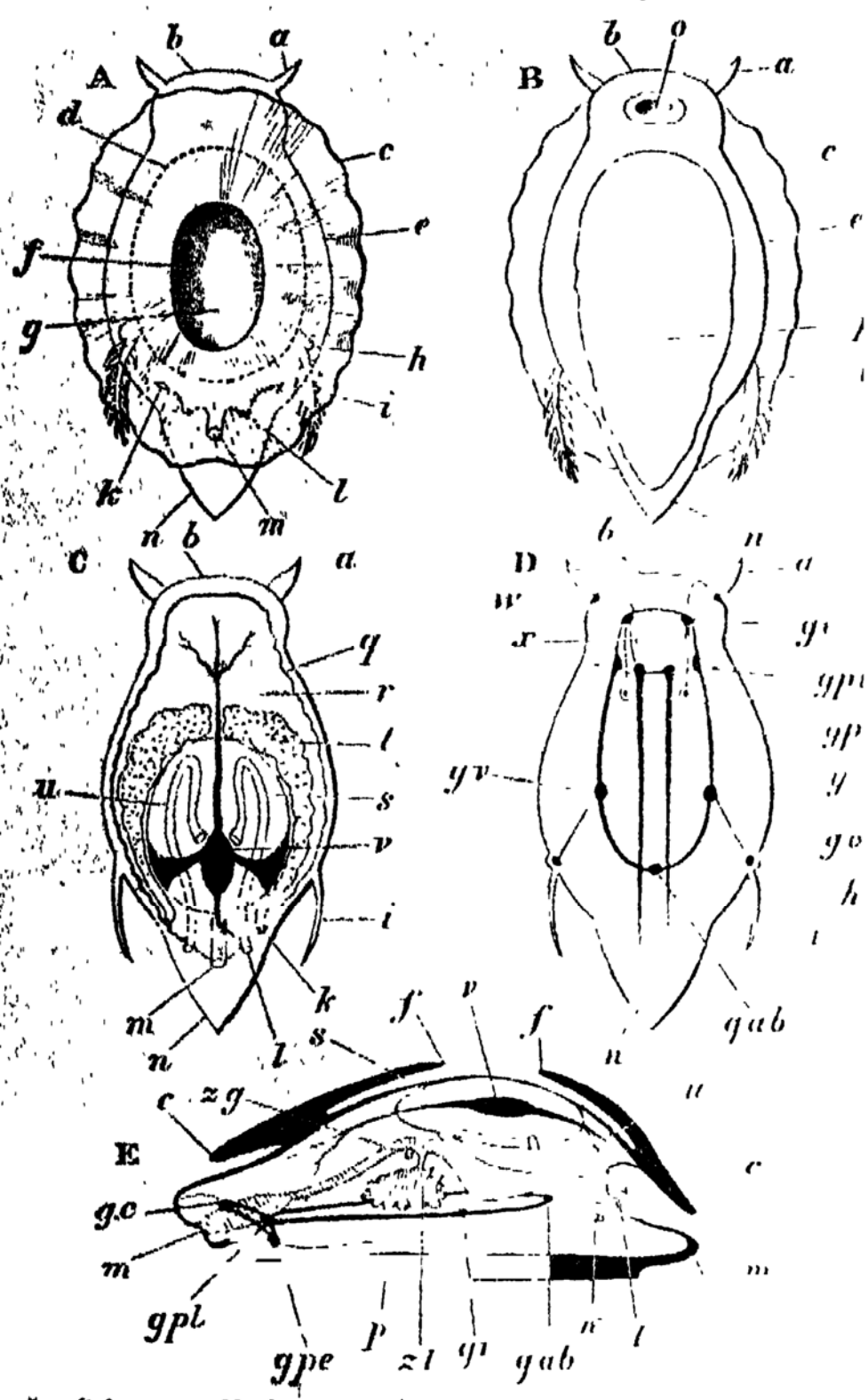
In many Coelomata not only do the skeletal tissues allow the coelomic space with its fluid and corpuscles to penetrate between their layers, but a special mode of extension of that space is found, which consists in the hollowing out of the solid substance of elongated cells having the form of fibres, which thus become tubular, and, admitting the nutritive fluid, serve as channels for its distribution. These are "capillary vessels," and it has yet to be shown that such are formed in the Mollusca. Larger vessels, however, concerned in guiding the movement of the coelomic fluid in special directions are very usually developed in the Mollusca, as in other Coelomata, by the growth of skeletal tissue around what are at first ill-defined extensions of the coelomic space. In this way a portion of the coelomic space becomes converted into vessels, whilst a large part remains with irregular walls extending in every direction between the skeletal tissues and freely communicating with the system of vessels. As in many other Coelomata, muscular tissue grows around the largest vessel formed from the primitive cœlom, which thus becomes a contractile organ for propelling the blood-lymph fluid. This "HEART" has in Mollusca, as in most other Cœlomata in which it is developed, a dorsal position. A communication of the blood-lymph space with the exterior by means of a pore situated in the foot or elsewhere has been very generally asserted to be characteristic of Mollusca. It has been maintained that water is introduced by such a pore into the blood, or admitted into a special series of water-vessels. It has also been asserted that the blood-fluid is expelled by the Mollusca from these same pores. Recent investigation (14) has, however, made it probable that the pores are the pores of secreting-glands and do not lead into the vascular system. There is, it therefore appears, no admission or expulsion of water through such pores in connexion with the blood, although in some other Coelomata it is established that water is taken in to the cœlomic space through a pore (Echinoderms), whilst in some others there is no doubt that the cœlomic hæmolymph is occasionally discharged in quantity through pores of definite size and character (Earthworm, &c.).

We have thus seen that the Mollusca possess, in common with the other Coelomata—1, a body composed of a vast *number of cells* or plastids, arranged so as to form a sac-like *body wall*, and within that a second sac, the *met-entero*, the wall of which is separated from the first by a *cœlom*, blood-lymph space; 2, a *stomodæum* and a *proctodæum*; 3, a *prostomium*, together with a differentiated *dorsal* and *ventral* surface, and consequently *right* and *left sides*, and bilateral symmetry; 4, a pair of *nephridia*; 5, *gonads* developed on the wall of the cœlom; 6, *dermic* epithelium (producing horny and calcareous deposits on its surface), *enteric* epithelium, and *cœlomic* epithelium; 7, lateral paired masses of *nerve tissue*, especially large in the prostomial region (nerve centres or *ganglia*); 8, *muscular tissue*, forming a *somatic* tunic and a *splanchnic* tunic; 9, *skeletogenic tissues*, consisting of membranous, fibrous, and cartilaginous *supporting tissues*, and of *blood-vessels* and the walls of *blood spaces*, the *cœlomic epithelium*, and the liquid tissue known as *hæmolymph* (commonly blood).

Schematic Mollusc. Starting from this basis of structural features common to them and the rest of the Coelomata, we may now point out what are the peculiar developments of structure which characterize the Mollusca and lead to the inference that they are members of one peculiar branch or phylum of the animal pedigree. In attempting thus to set forth the dominating structural attributes of a great group of organisms it is not possible to make use of ordinary definitions. Of Mollusca, as of other great phyla, it is not possible categorically to enunciate a series of structural peculiarities which will be found to be true in reference to every member of the group. We have to remember that the process of adaptation in the course of long ages of development has removed in some cases one, in others another, of the original features characteristic of the ancestor from which the whole group may be supposed to have taken origin, and that it is possible (and actually realized in fact) that some organisms may have lost all the *primary* characteristics of Molluscan organization, and yet be beyond all doubt definitely stamped as Mollusca by the retention of some *secondary* characteristic which is so peculiar as to prove their relationship with other Mollusca. An example in point is found in the curious fish-like form Phyllirhoe (fig. 58), which has none of the primary characteristics of a Mollusc, and yet is indisputably proved to belong to the Molluscan phylum by possessing the peculiar and elaborate lingual apparatus present in one branch of the phylum, the Glossophora.

In order to exhibit concisely the peculiarities of organization which characterize the Mollusca, we find it most

nvenient to construct a schematic Mollusc, which shall ssess in an unexaggerated form the various structural rangements which are more or less specialized, exaggger- ed, or even suppressed, in particular members of the group.



g. 1.—Schem tic Mollusc. A D at ep t t V heart, pericardium gonads and nephridi r t p system, the reader is requested to note th t from *g p* lies beneath and does not in any way t passes from *g.ab* to *g pl*. E Diagram in which th is cut in the median antero-posterior plan s —the shell sac is seen in section but th Letters in all the figures as follow of the mantle skirt or limbus (shaded origin of the free mantle skirt from the of the foot seen through the mantle (o parent, allowing the position of the and (the v be seen through its substance), *f*, cl the osphradium gill (Spengel's lit gill plume). *k*, aperture of the gonad nephridia, *m*, anus, *n*, posterior region than the mass of viscera (dorsal hump) wh surface of the foot; *q*, cut edge of the l cœlomic space (blood lymph spa body v). out to some extent retained as blood chann l cavity, *t*, gonad (ovary or spermary) pa cle of the heart receiving the ri and th left sending off anteriorly a large vessel, po teriorly a small one, *u*, the cerebr eye, paired, *r* dotted ring to show the position occupied by the œsophagus in relation to the nerve ganglia and cords; *y*, the otocyst paired, *z*, the digestive gland (so-called "liver") of the left side, *z'*, duct of the corresponding gland of the right side; *g.c*, cerebral ganglion united by the cerebral commissure to its fellow; *g.pl*, pleural ganglion united by the cerebro-pleural connective to the cerebral ganglion, and by the pleuro-pedal connective to the pedal ganglion; *g.pe*, the pedal ganglion united to its fellow by the pedal commissure—the two sending off posteriorly the long ladder-like nerves; *g.v*, the visceral ganglion (of the left side) united by the visceral loop or commissure to the similar ganglion on the right side, and by the viscero-pleural connective to the pleural ganglion; *g.ab*, abdominal ganglion developed on the course of the visceral loop; *g.ol*, olfactory ganglion developed near the osphradium on a nerve taking its origin from the visceral ganglion.

pe, in the sense which has been attributed to that wo d, or as the embodiment of an idea present to a creating mi d, or, even as an epitome of developmental laws. Were kn w- dge sufficient, we should wish to make this schem ic Mollusc the representation of the actual Molluscan an from which the various living forms have sprung. T nitely claim for our schematic form any such signi in the present state of knowledge would be pren but it may be taken as more or less coinciding with we are justified, under present conditions, in pictur ourselves as the original Mollusc or archi Mollusc correctly Archimalakion). After describing this sch form, we shall proceed to show how far it is reali ju tified in each class and order of Mollusca succes si

The schematic Mollusc (figs. 1, A to E) is oblo shape, bilaterally symmetrical, with strongly differ dorsal and ventral surface, and has a well-marked consisting of the prostomium (*s*) and the region diately behind the mouth. Upon the head we p pair of short CEPHALIC TENTACLES (*o*). The *mo* placed in the median line anteriorly, and is overhu the prostomium (B, *o*); the *anus* is placed in the m line posteriorly, well raised on the dorsal surface (The apertures of a pair of NEPHRIDIA are seen neighbourhood of the anus, right and left (A, *l*) the nephridial aperture, and in front of them, rig left, are the pair of apertures (*k*) appropriate to the of the GENERATIVE GLANDS (generative gland).

The most permanent and distinctive Mollusc-can is the foot (Podium). This is formed by an ex development of the somatic musculature along the v surface, distinctly coming at the region of the head, which is suddenly projects as a powerful muscular (B, *p*, E, *p*). It may be compared, probably g ally identical with the muscular ventral surface Planarians and with the sucker of Trematoda, but i extensively developed than are those corresponding tures. The muscular tissue of the foot and of al parts of the body of all Molluscs is cellular and mu as distinguished from the composite muscular fibr sisting of cell-fusions instead of separable cells) occurs in Arthropoda and in Vertebrata, and whic the further distinction of being composed of alter band of substance of differing refractive power "striated"). The appearance of cross-striation s the muscular cells of some Molluscs (odontoph Haliotis, Patella, &c.) requires further investigation is by no means altogether the same thing as the ing characteristic of striated muscular tissue.

Contrasting with the ventral foot is the thin- dorsal region of the body, which may be termed th podial region. The thin-walled region is formed b viscera covered in by the comparatively delicate an muscular body wall (figs. 1, E). A the ventral clearly separate from the posterior head, so is this region, and is conveniently spoken of as the VI SCERAL DOME or "hump" (*zg*). Protecting the viscera is a SHELL (concha), consisting of a horny basis i mixed with carbonate of lime, and secreted by the epithelium of this region of the body (*ca*). The in our schematic Mollusc is single, cap-shaped, and metrical. It does not lie entirely naked upon the of the visceral dome, but is embedded all round it to a large extent in the body wall. In fact, the ment of the visceral dome forms an open flatten in which the shell lies. This is the PRIMARY SAC, or FOLLICLE (A and B, *f*). The wall of the bod pects all round the visceral dome in the form of a skirt, so as to overhang and conceal to some exte head and the sides of the foot. This skirt, really a

[1] As to the minute structure of the shell in various cla Carpenter's article "Shell" in the *Cyclop. of Anat. and Physi* limits of our space do not permit us to deal with this or othe logical tones.

of the dorsal body wall, is called the MANTLE-FLAP
s pallialis), or more shortly the MANTLE or PALLIUM
he space between the overhanging mantle-flap and the
nd neck of the animal which it overhangs is called
E PALLIAL SPACE or CHAMBER. Posteriorly in this
re placed the anus and the pair of nephridial aper
see fig. 1, E).

development of the mantle-skirt and its sub-pallial
ppears to have a causal relation, in the way of pro
to a pair of processes of the body wall which
one on the right and one on the left, from the sides
body, nearer the anus than the mouth, and are
ed by the mantle-flap to some extent (A, B, *t*).
rocesses have an axis in which are two blood-vessels,
beset with two rows of flattened filaments, like the
f a comb in double series. These are the CTENIDIA
combs. Usually, as will be seen in the sequel, they
e part of gills, but since in many Mollusca (Lamelli
s) their function is not mainly respiratory, and since
ot completely formed gills are developed as a special
n some Mollusca to the exclusion of these pro
it is well not to speak of them simply as "gills" or
hiæ," but to give them a non-physiological name
that here proposed. Near the base of the stem of
enidium is a patch of the epithelium of the body
cularly modified and supplied with a special nerve
nglion. This is Spengel's olfactory organ, which
e respiratory fluid, and is persistent in its position
rve-supply throughout the group Mollusca. We
to call it the OSPHRADIUM

ing now to the internal organs, our schematic
is found to possess an ALIMENTARY CANAL, which
from mouth to anus, in the middle line, leaving
n it and the muscular body-wall a more or less
, in parts a spacious, CŒLOM. The *stomodæum* is
nd muscular, the *proctodæum* short, the bulk of
entary canal is therefore developed from the met-
or remnant of the archenteron after the cœlom
n pinched off from it. A paired outgrowth of the
eron forms the glandular diverticulum known as
estive gland or (commonly) liver (E, *a*, *l*).

ally to the alimentary tract the cœlom is spacious.
ce (C', E, *s*) is termed the PERICARDIUM, since it is
ed by a vessel running fore and aft in the median
hich has contractile muscular walls and serves as a
o propel the cœlomic blood-fluid. The pericardial
lthough apparently derived from the original cœlom,
n communication with the other spaces and blood-
derived from the cœlom; it never (or perhaps in a
v instances) contains in the adult the Mollusean blood
olymph, and is always in free communication with
terior through the tubes called *nephridia* (renal

The HEART receives symmetrically on each side,
d left, a dilated vessel bringing aerated blood from
adia. These dilated vessels are termed the *auricles*
e a', whilst the median portion itself, at the point
these vessels join it, is termed the *ventricle of the*
(*v*). The vessel passing fore and aft from the
e gives off a few trunks which open into spaces
œlom, the so-called lacunæ: these are excavated in
ection between the viscera and the various bundles
ous and muscular tissue, and may assume more or
character of tube-like vessels with definite walls.
and left opening into the pericardial cœlom is a
tube, the farther extremity of which opens to the
by the side of the anus. These two tubes (C', *n*)
symmetrically disposed NEPHRIDIA (renal organs).
GONADS (ovaries or spermaries) are placed in the
sal region of the cœlom (C', *t*), and have their own
es in the immediate neighbourhood of those of the

nephridia. The apertures are paired right and left,
are the ducts into which they lead; but at present
no ground for determining whether the gonad its
primarily in Molluscs a paired organ or a median
nor have we any well-founded conception as to the
of the ducts, when present, and their original relat

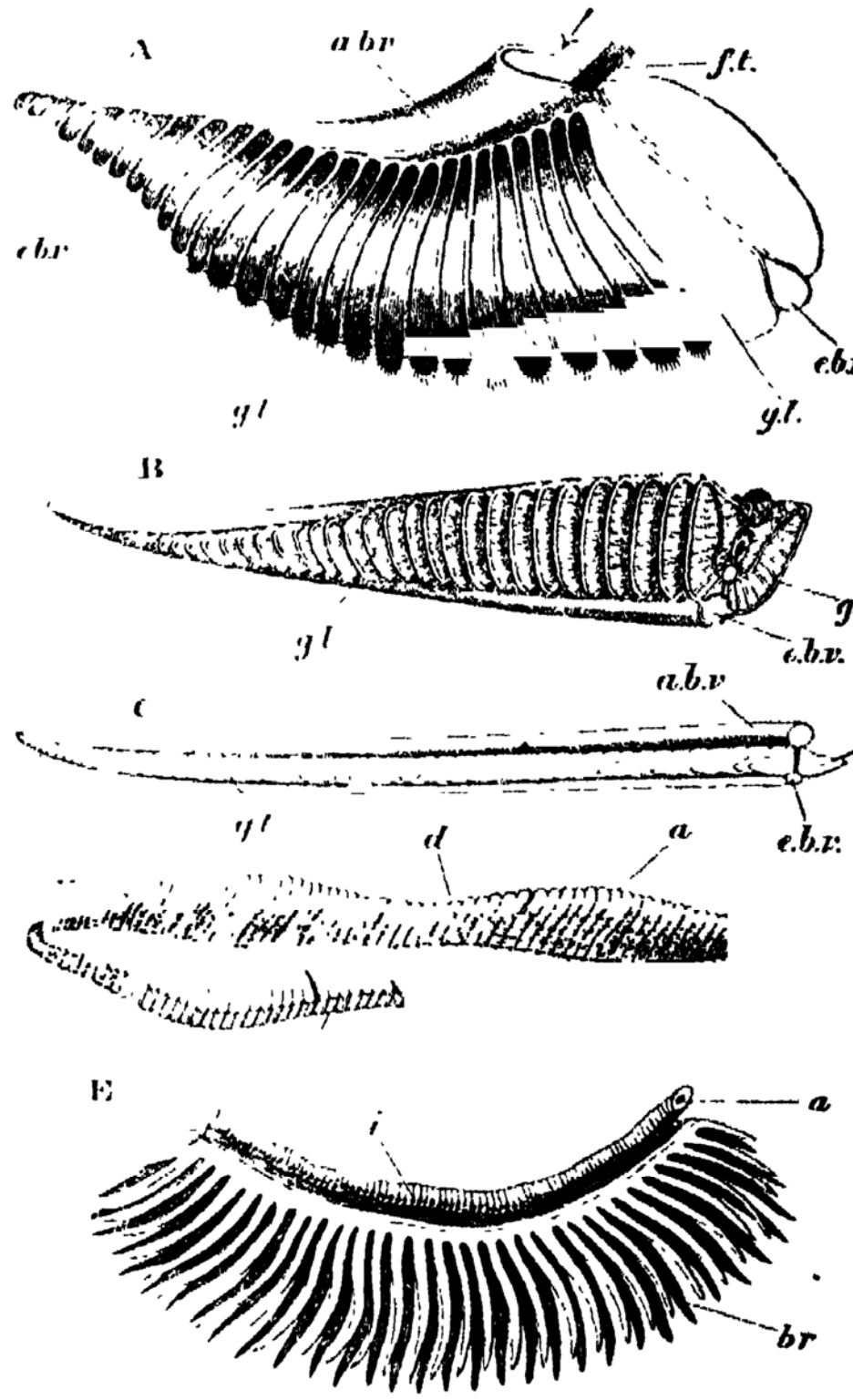


FIG. Ctenidia of various Molluscs (original). A. Of Chiton; *f.*
tis-ne, *a br*, afferent blood-vessel; *e.b.v*, efferent blood-vessel;
ally paired lamellæ. B. Of Sepia; letters as in A. C. Of Fissurell
as in A. D. Of Nucula, *d*, position of axis with blood-vessels;
b and *c* outer row of lamellæ. E. Of Paludina, *i*, intestine runnin
with the axis of the ctenidium and ending in the anus *a*; *br*, rows o
processes corresponding to the two series of lamellæ of the upper fl

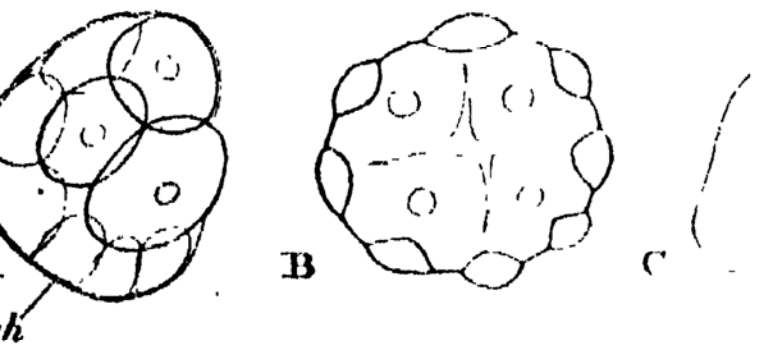
to the gonads. The genital ducts of some organis
modified nephridia, but the nature of those of M
of Arthropoda, of Echinoderma, of Nematoidea,
one Vertebrata has yet to be elucidated.

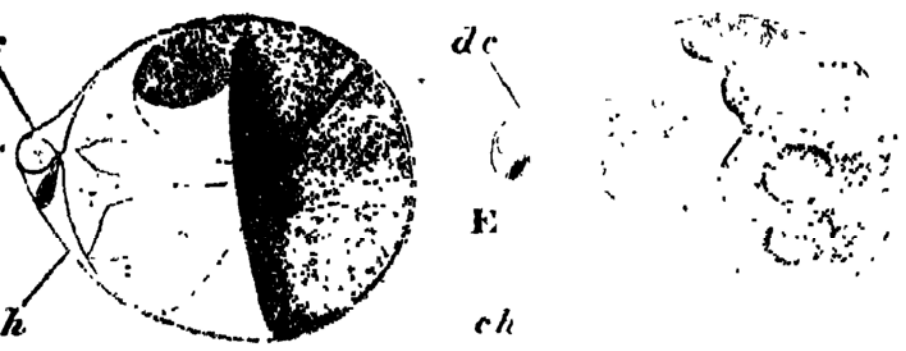
The disposition of the nerve-centres is highly ch
istic. There are four long cords composed of both
fibres and nerve-cells which are disposed in pairs, tw
and left of the pedal area or foot, two more dorsa
tending to a deeper position than that occupied
pedal cords, so as to lie freely within the cœlomi
unattached to the body-wall. These are respectiv
PEDAL NERVE-CORDS and the VISCERAL NERVE-CORD
latter meet and join one another posteriorly. A rig
left (D, *g.e*), and a median abdominal (*g.ab*) gangl
placed on these cords, and from them are given
osphradial nerves which have special ganglia (*g.olf*).
region of the prostomium the pedal nerve-cords are e
behind the mouth, forming the *pedal ganglia* (*g.p*
are united by nerve-fibres to one another. From th
they are continued forward into the prostomium,
they enlarge to form the right and left *cerebral gangl*
which are united to one another by nerve-fibres in

uth, just as the pedal ganglia are behind it. The
d left pedal ganglia are joined by transverse cords
ight and left visceral cords respectively, the point
n being marked on either side by a swelling (*g.pl*)
as the pleural ganglion. The visceral nerve-cord
be traced up on each side beyond the pleural
a to the cerebral ganglion. Thus we have a
complete double nerve-ring formed around the oso-
by the two pairs of nerve-cords which are in this
drawn, as it were, towards each other and away
eir lateral position both behind and before the
ead invagination. Whilst the swollen part- of the
acts are termed *ganglia*, the connecting cords
venientlv distinguished either as *connectives* or as
ures. Commissures connect two ganglia of the
ir We have a cerebral commissure, a pedal com
and a visceral commissure. Connectives connect
of dissimilar pairs, and we speak accordingly of
ebro-pedal connective, the cerebro pleural con-
the pleuro-pedal connective, and the vi-cero
connective.

NTERIC NERVOUS SYSTEM forming a plexus on the
the alimentary canal exists, but does not exhibit
nd ganglia visible to the naked eye except in the
ibranchiate Cephalopods.

schematic Mollusc is provided with certain ORGANS
IAL SENSE. Tactile organs occur on the head in the
short CEPHALIC TENTACLES (*o*). Deeply placed are





Development of the Pond Snail, *Lymnæus* (*to*
c, directive corpuscles (pro-segmental outcast
on; *or*, oral end of the blastopore; *x*, and
mation of the Diblastula by the invagination
smaller cells (optical section). B. View of t
face of invagination; the smaller cells are seen at the periphery by
they will multiply and extend themselves over the four larger cells.
y-formed Diblastula, surface view to show the elongated f
f invagination or blastopore; its middle portion cl
th the region of the foot; the extremity, *o*, coincides with the
nodæum, the opposite extremity, *x*, with the anus. D Optical
bryo a little older than A. E. Surface view of the same embr

Lankester,
elope
of the blastopore
) into the
ermen from

of closed vesicles containing each a calcareous con-
and acting as auditory organs, these are known as
STS (D, *y*). They are situated behind the mouth
foremost portion of the foot. At the base of each
e tentacle is a pigmented eye-spot the CEPHALIC
, *w*). The OSPHRADIUM (*h*), or peculiar patch of
y epithelium at the base of the ctenidium, has
been mentioned.

he scheme thus exhibited of the possible organization
ancestral Mollusc we shall now add a sketch of
de in which this form of body and series of internal
are developed from the egg.

egg-cell of Mollusca is either free from food material
mple protoplasmic corpuscle—or charged with food

material to a greater or less extent. Those cases w
appear to be most typical - that is to say, which adhere

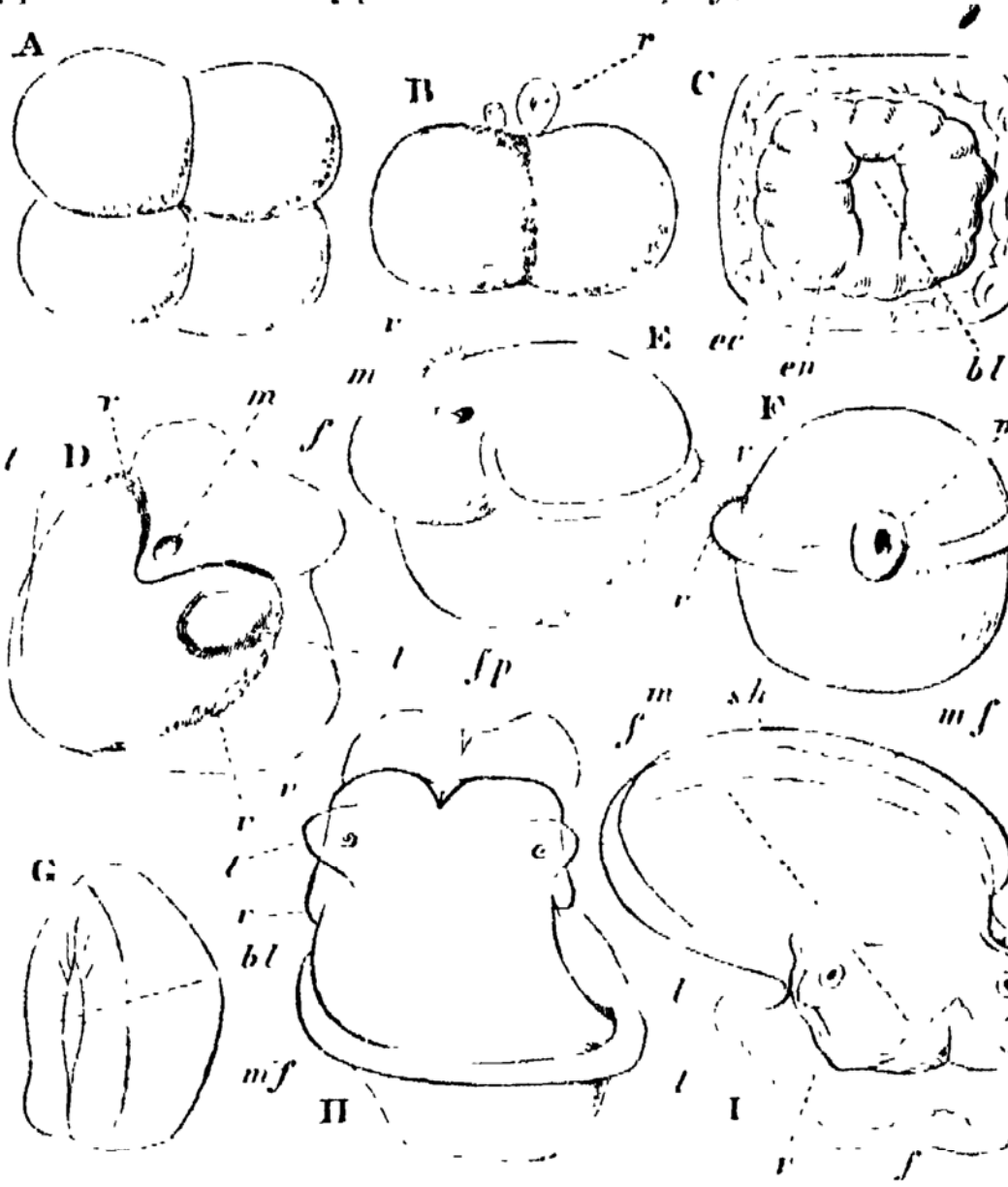
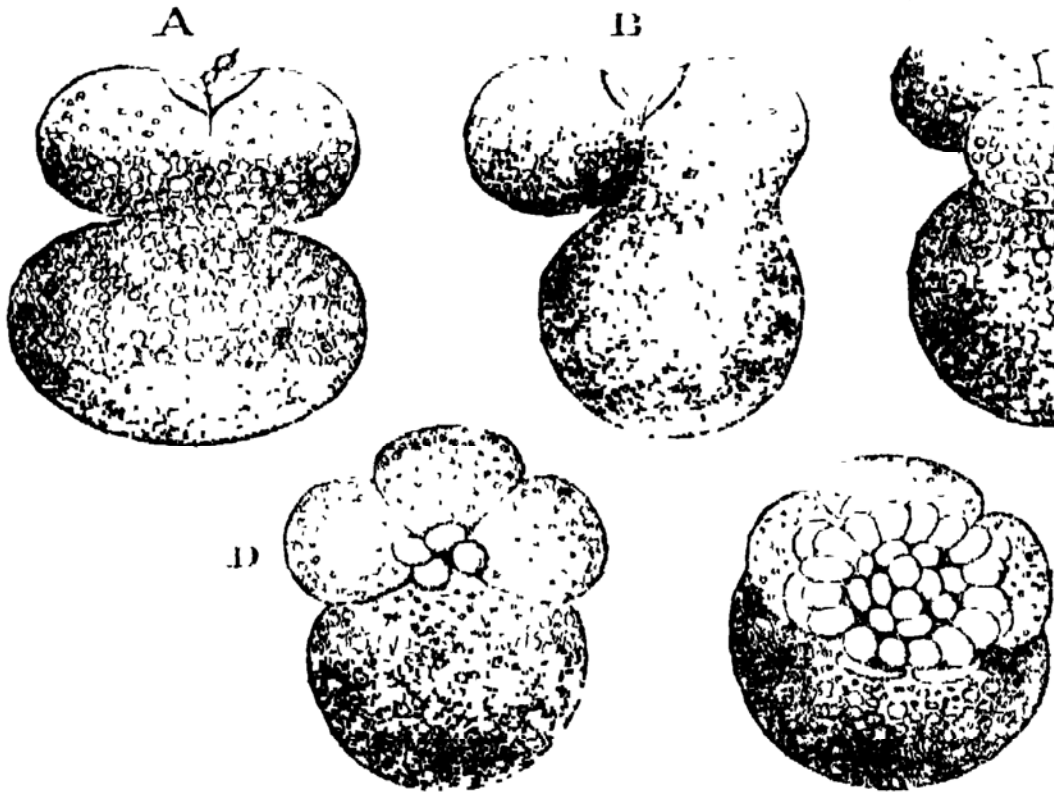


FIG. 4. Development of the Pond Snail, *Lymnæus* (*stagnalis*, after Lank
15). *r*, directive corpuscles; *bl*, blastopore; *en*, endoderm or entero
layer; *ec*, ectoderm or dermo-cardiac layer; *v*, velum; *m*, mouth; *f*, fo
facies; *fp*, pore in the foot (belonging to the pedal gland); *mf*, the pa
flap or lumbo-pallium; *l*, the bell; *sh*, the subpallial face of the sh
to become the lung. A. Ovum with four cells formed from the cleavage
ova, *ec*, cells. B. Same as A, but the cells of the ectoderm are smaller
showing the two cell-layers and the blastopore. D, E, F. Progressive
stages of Diblastula, that in E and F as seen from the dorsal aspect. G. Dorsal view of a Diblastula, to
the surface of invagination of the end-endoderm or hypoblast, *bl*. H, I. Two
stages later than D. (Compare H and I, 7 and 8, 9 and 10.)

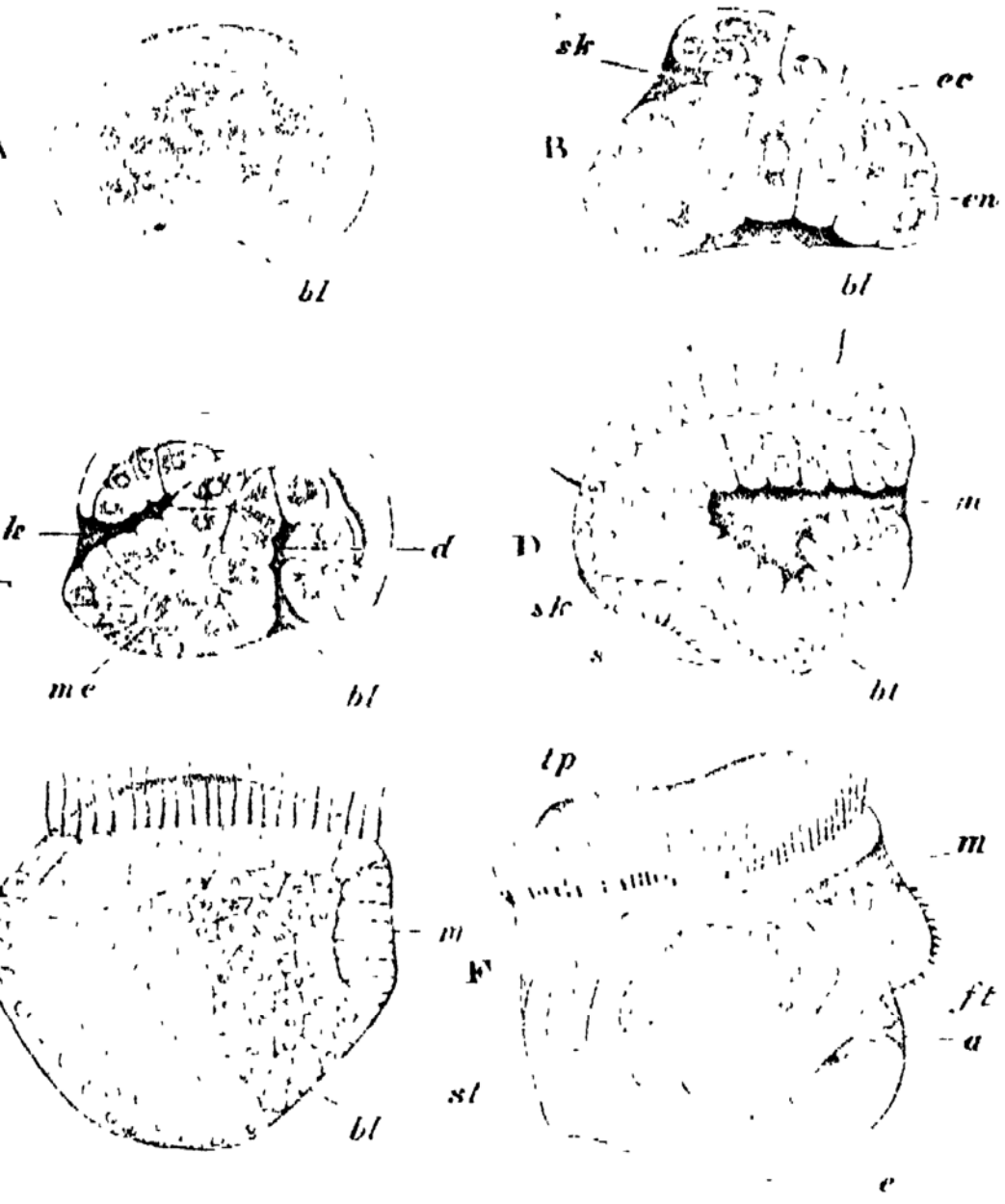
procedure which was probably common at one time t
then existing Molluscs, and which has been departed f



sphere are the
shaped
el or ten cells
ich affect the
med to disappe
e phere. C. T
ll mass has divi
of whi
D. Each of the for
a small pellucid cell. E. The cap of
by repeated formation o
of those first formed. E
cells, as in fig. 5, A, B.

only in later and special lines of descent show app

ly the following history. By division of the egg-cell
3, A, B; fig. 4, A, B; and fig. 5) a mulberry-mass of
blastic cells is formed (Morula), which dilates, forming
e-cell layered sac (Blastula). By invagination one



Development of the Oyster, *Ostrea edulis* (modified from Horst, Fig. 16).
astula stage (optical section). B. Optical section of a somewhat
all of the ectoderm. *bl*, blastopore. C. Optical section of a somewhat
stage, in which a ciliated area (*lp*) has become differentiated, and
shell gland (*sk*) has begun to appear. *st*, stomodæum. D. Similar
arch-enteron (*e*) is widening out. *m*, mouth. E. Optical section of a little
stage. The invagination cavity or blastopore is now more
rked *a*, and will become the anus. *ft*, the ciliated area from which the velum
muscular and skeleto-trophic mesoblast cells are budded off. F. Similar
w of a later stage. The blastopore (*a*) has closed, the anus will subse-
ently perforate the ectoderm at this point. *m*, the mouth, which
ow opens by an infolding of ectoderm and endoderm cells, and will finally
ld to constitute the stomodæum. *sk*, the shell gland, now
ducing shell. *st*, stomodæum. *bl*, blastocœl or primary body-cavity,
section is shown by the dotted outline in the upper part of the figure.

The embryo is now a Trochosphere. F, surface view of a somewhat
ter stage than D. *m*, mouth, *ft*, foot, *a*, anus, *st*, stomodæum, *bl*,
ea of the preoral ciliated area. The extent of the velum is indicated
with of the mantle fold (*e*) indicated by a line between the letters.

In this development as in that of Paludina (fig. 3) the blastopore persists
topore persist either as mouth or as anus, but the typical
le of invagination or part of the invaginated process becomes
ming the mouth. The mouth and the anus are termed secondary
ings, the mouth with the stomodæum and the short anal proctodæum
ther. The interpretation of the apparently contrary facts of
(development shown in the figures has been fully discussed in the
ctor's Text-book of Embryology (1901). Part of the text is
ken from that of Horst, and figures 3, 4, 5, 6, 7, and 8 are from drawings

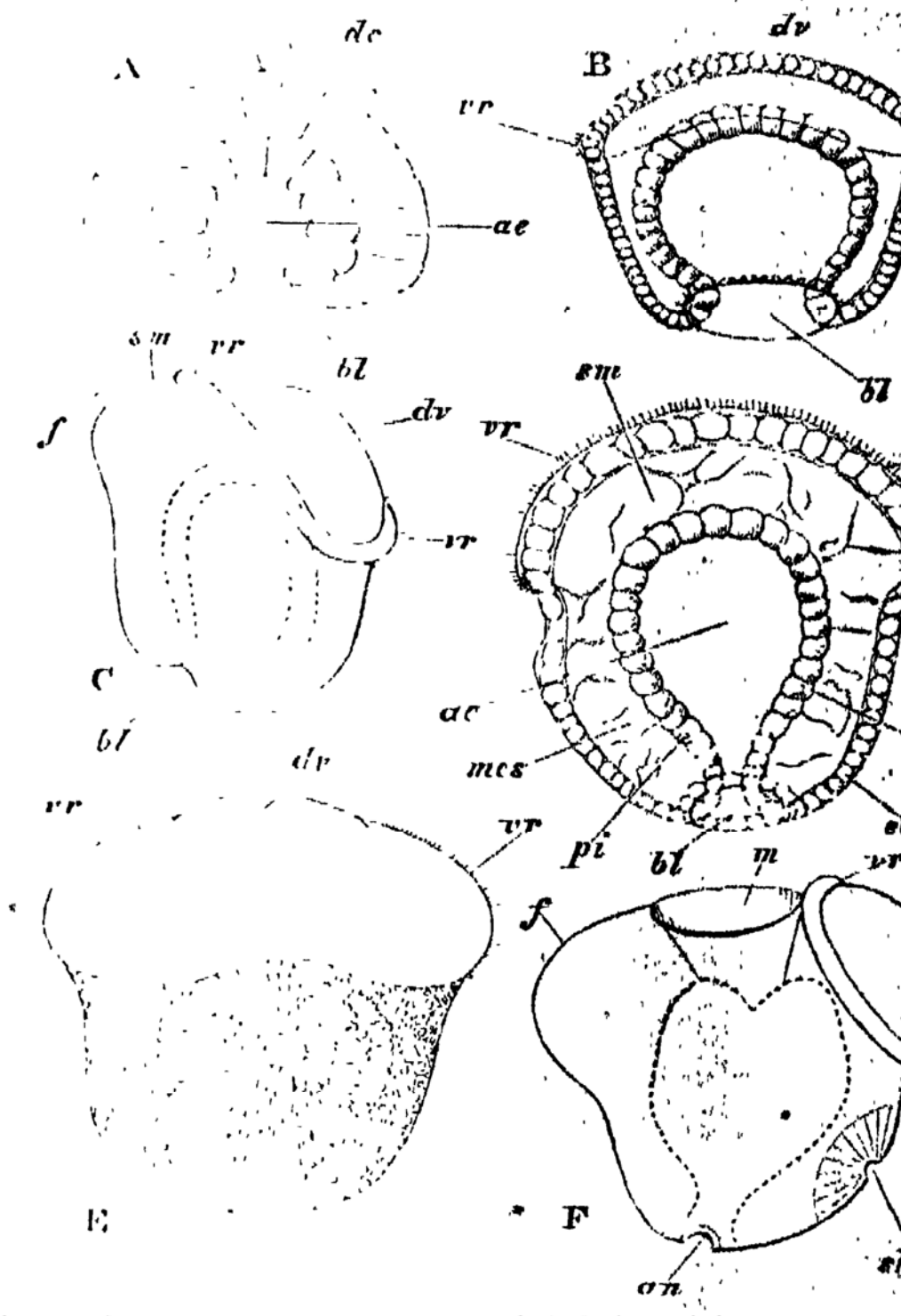
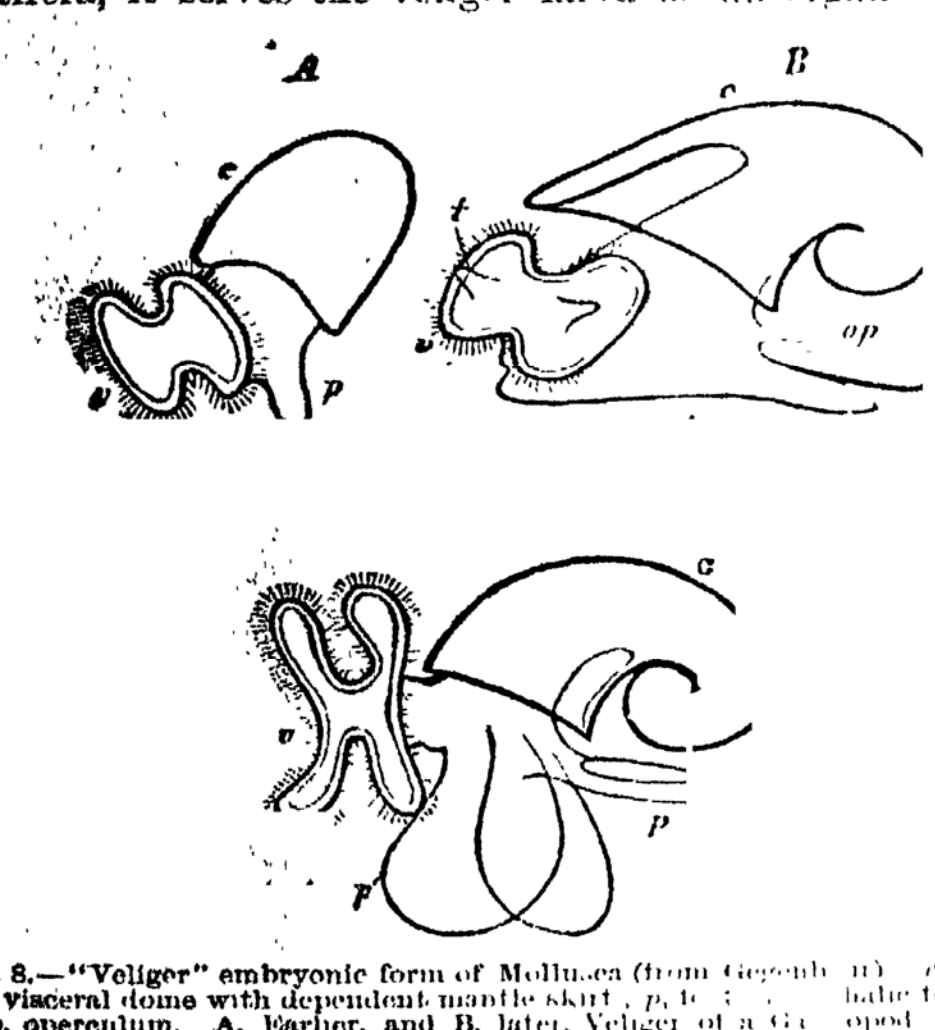


Fig. . Development of the River Snail, *Paludina vivipara* (after Le
17). *dc*, descendant cell (outcast cell), *ae*, arch-enteron or cav
by the endoderm cell layer or endoderm; *bl*, blastopore; *vr*, velum o
of ciliated cells; *ve*, velum as a cephalic dome, *sm*, site of the as
tricciliated area; *mes*, mesoblast cells, *me*, rudiments of the skeleto-trophic tiss
the point of invagination, the future rectum, *shgl*, the primitive
shell gland, *m*, mouth, *an*, anus. A, Diblastula phase (optical
B, the blastula has become a Trochosphere by the development
ciliated area (optical section). C, Side view of the Trochosph
formation of the foot. D, Further advanced Troch
The Trochosphere passing to the Veliger stag
formation of the primitive shell sac. F, Side vie
(*vr*), velum (*vr*), mouth, and anus.
the blastopore is not elongated. If p
The mouth and stomodæum form independently of the bl

ity of pecial descriptions in the text. Interna
the nippin off of a pair of lateral outgrowths (fo
part of the indeterminable "mesoblast") from the enter
layer the foundations of the cœlomic cavity are lai
some Cœlomata these outgrowths are hollow and of
size. In Mollusca they are not hollow and large, w
probably the archaic condition, but they consist at
a few cells only, adherent to one another; these cell
diverge, applying themselves to the body-wall and
gut wall so as to form the lining layer of the cœ
cavity. Muscular tissue develops from deep-lying cel
the rudiments of the paired nerve-tracts from thick
of the dermic cell layer or ectoderm.

The external form meanwhile passes through highl
acteristic changes, which are on the whole fairly co
throughout the Mollusca. A circlet of cilia forms wh
embryo is still nearly spherical (fig. 4, F; fig. 6, E;

in an equatorial position. As growth proceeds, one nisphere remains relatively small, the other elongates and arges. Both mouth and anus are placed in the larger a; the smaller area is the prostomium simply; the cili- d band is therefore in front of the mouth. The larval m thus produced is known as the Trochosphere. It ctly agrees with the larval form of many Chætopod rms and other Cœlomata. Most remarkable is its eement with the adult form of the Wheel animalcules Rotifera, which retain the præ-oral ciliated band as their ef organ of locomotion and prehension throughout life far the young Molluse has not reached a definitely lluscan stage of development, being only in a condition mmon to it and other Cœlomata. It now passes to the igor phase, a definitely Molluscan form, in which the proportion between the area in front of the ciliated let and that behind it is very greatly increased, so t the former is now simply an emarginated region of head fringed with cilia (fig. 8; fig. 6, F; fig. 7, F, d fig. 60, A). It is termed the "velum," and is frequently drawn out into lobes and processes. As in the tifera, it serves the veliger larva as an organ of loco



8.—"Veliger" embryonic form of Mollusca (from Gegenbaur). *c*, ve visceral dome with dependent mantle skirt; *p*, fo operculum. A, Earlier, and B, later, Veliger of a Gas r of a Pteropod showing lobe-like processes of the vel ured outgrowths of the foot.

tion. In a very few Molluses, but notably in the Com- n Pond-Snail, the emarginated bilobed velum is re ned in full proportions in adult life (fig. 70), having t its marginal fringe of specially long cilia and its omotor function. The body of the Veliger is char erized by the development of the visceral hump on surface, and by that of the foot on the other. Growth greater in the vertical dorso-ventral axis than in the gitudinal oro-anal axis; consequently the foot is relely small and projects as a blunt process between mouth d anus, which are not widely distant from one another, ilst the antipedal area projects in the form of a great mp or dome. In the centre of this antipedal area there appeared (often at a very early period) a gland-like pression or follicle of the integument (fig. 6, C, *sk*; fig. 7, F, *shgl*; fig. 60, B; fig. 68, *shs*; fig. 72***, *ss*). This is primitive shell-sac discovered by Lankester (18) in 1871, d shown by him to precede the development of the permant shell in a variety of Molluscan types. The cavity of s small sac becomes filled by a horny substance, and then very usually disappears, whilst a delicate shell, commencing from this spot as a centre, forms and spreads upon surface of the visceral dome.

The embryonic shell-sac or shell-gland represents transient form, in the individual development of Mollusca, that condition of the shell-forming area we have sketched above in the schematic Mollusc very few instances (in Chiton, and probably in Lima we shall see below, the *primitive shell-sac* is retained enlarged as the permanent shell-forming area. It is planted in other Molluscs by a *secondary shell-forming area*, namely, that afforded by the free surface of visceral hump, the shell-forming activity of which ex even to the surface of the depending mantle-skirt. Accordingly, in most Mollusca the *primitive shell* is represented only by the horny plug of the primitive shell-sac. The permanent shell is a new formation on a new area, should be distinguished as a *secondary shell*.

The ctenidia, it will be observed, have not yet been mentioned, and they are indeed the last of the chief Mollusc organs to make their appearance in ontogeny. A possible relation to the pra-oral and post-oral ciliated bands of embryos similar to the Trochosphere are discussed by the writer in the *Quart. Jour. Micr. Sci.*, vol. xv. p. 423. The Veliger, as soon as its shell begins to assume a definite shape, is no longer of a form common to various classes of Mollusca, but acquires characters peculiar to its class. At this point, therefore, we shall for the present leave it.

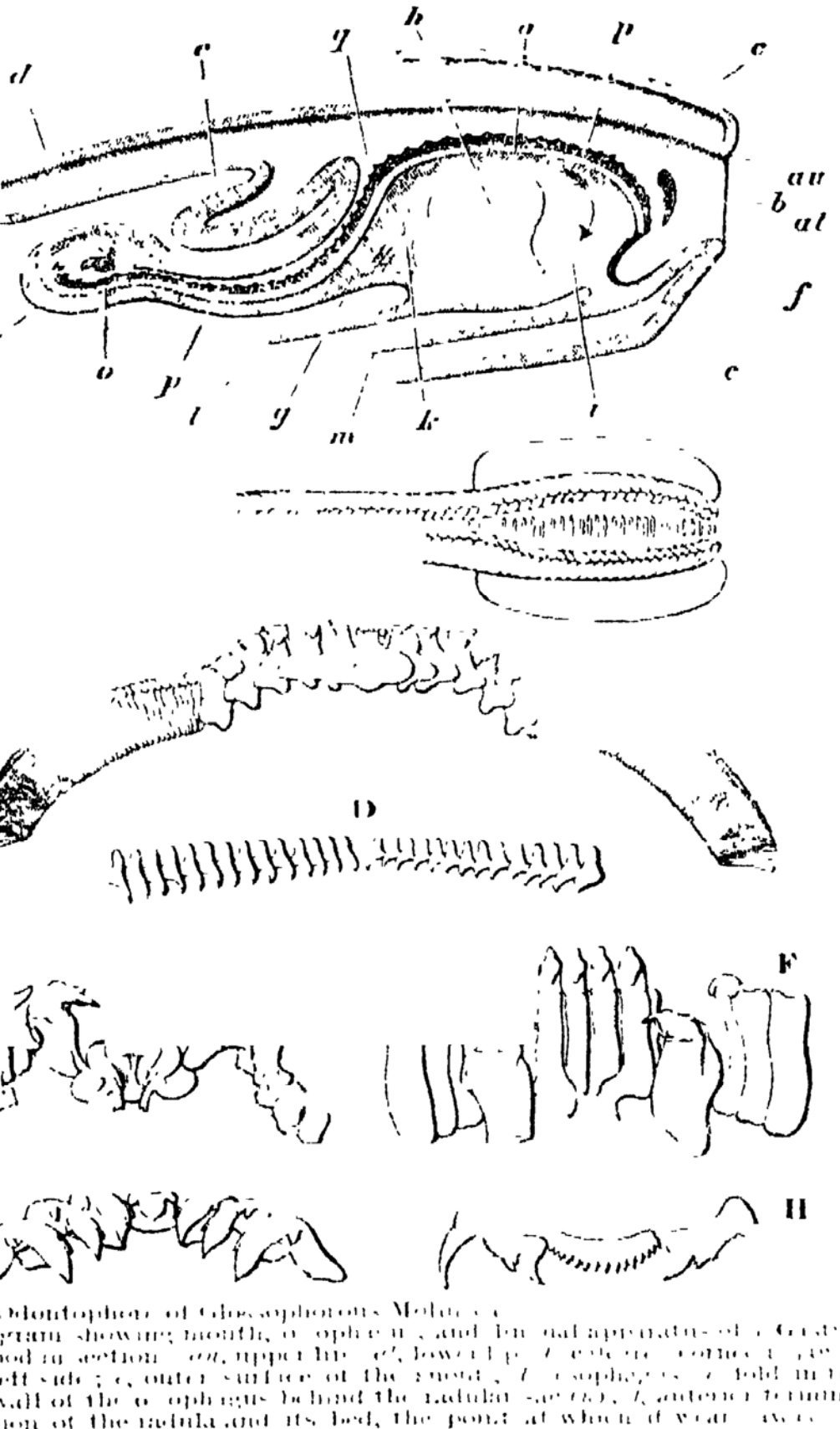
Systematic Review of the Classes and Orders of Mollusca.

We are now in a position to pass systematically to review the various groups of Mollusca, showing in what way they conform to the organization of our schematic Molluse, and in what special ways they have modified, even suppressed parts present in it, or phases in the representative embryonic history which has just been sketched. It will be found that the foot, the shell, the mantle, and the ctenidia, undergo the most remarkable changes of form and proportionate development in the various classes, changes which are correlated with extreme changes of elaboration in the respective functions of those parts.

Division of the Phylum into two Branches. The Mollusca are sharply divided into two great lines of descent or branches, according as the pro-tomial region is atrophied on the one hand, or largely developed on the other.

The probabilities are in favour of any ancestral form of the hypothetical ancient Mollusc which connected the Mollusca with their non-Molluscan forefathers having succeeded, as do all the more primitive forms of Cœlomata, a well-marked pro-tomium, and consequently a head, one series of Mollusca descended from the primitive head-bearing Mollusc have acquired an organization in which the Molluscan characters have become modified in definite relation to a sessile or inactive life. As the most prominent result of the adaptation to such sessile life they exhibit an atrophy of the cephalic region. They form the branch Prosoneura—the mussels, oysters, cockles, clams. The other Mollusca have retained an active, in many cases a highly aggressive, mode of life; they have, correspondingly, not only retained a well-developed head, but have developed a special aggressive organ in connection with the mouth, which, on account of its remarkable nature and the peculiarities of the details of its mechanism, seems to indicate a very close genetic connexion between all the animals which possess it. This remarkable organ is the odontophore, consisting of a lingual ribbon, rasp, or radula with its cushion and muscles. On account of the possession of this organ this great branch of the Mollusca phylum may be best designated Glossophora. Any

merely points to the possession of a head is objec-
e, since this is common to them and the hypotheti-
hi Mollusca from which they descend. The term
phora, which has been applied to them, is also un-
, since the organ which characterizes them is not a
but a tongue.



odontophore of Gasteropodous Mollusca
gram showing mouth, œsophagus, and lingual apparatus of a Gastero
ood in section. *ou*, upper lip; *ol*, lower lip; *b*, cephalic cornua; *au*, ori
ft side; *c*, outer surface of the snout; *d*, œsophagus; *e*, fold in the
wall of the œsophagus behind the radular sac (*n*); *f*, anterior termina
ion of the radula and its bed, the point at which it wears away; *g*,
ra of the radular sac or recess of the pharynx; *h*, radula-moat piec
developed in the floor of the pharynx beneath the radula, and serving
or the attachment of numerous muscles, and for the support of the
adula; *i*, anterior muscles; *l*, posterior muscle attached to the carti
ge; *k*, muscle acting as a retractor of the buccal mass; *m*, muscle
ttached to the lower lip; *n*, posterior extremity of the radular sac;
, the bed of the radula or layer of cells by which its lower surface is
ormed; *p*, the horny radula or lingual ribbon; *q*, opening of the radular
ac into the pharynx or buccal cavity; *r*, cell at the extreme end of
he proximal portion of the radular sac which produces a transverse
eries of the row of teeth of the upper surface of the radula
dular ribbon of *Patella vulgata*, stripped from its bed, a
hat is called its protect
th from the radula of *Trochus cinerarius* Rhipido
th from the radula of *Doridopsis fusca* Pteroglossate
th from the radula
single row of te
single row of teeth from the radula of *Ne*
formula, 1.1.1. The tongue of Whelk is similar to the

general structure of the odontophore (tooth
, in allusion to the rasp-like ribbon) of the glosso
a Mollusca may be conveniently described at once.
ially it is a tube like outgrowth the *radular sac* (fig.
l, *n*) —in the median line of the ventral floor of the
læum, upon the inner surface of which is formed a
ous band (the radula) beset with minute teeth like a

rasp (*p*). Anteriorly the ventral wall of the divert
is converted into cartilage (*h*), to which protractor
tractor muscles are attached (*k*, *i*), so that by the ac
the former the cartilage, with the anterior end of the
resting firmly upon it, may be brought forward in
space between the lips of the oral aperture (*au*, *a*
made to exert there a backward and forward rasping
by the alternate contraction of retractor and pro
muscles attached to the cartilage. But in many
phora (*e.g.*, the Whelk) the apparatus is complicated
fact that the diverticulum itself, with its contained
rests but loosely on the cartilage, and has special m
attached to each end of it, arising from the body
these muscles pull the whole diverticulum or radu
alternately backwards and forwards over the surface
cartilage. This action, which is quite distinct fr
movement of the cartilage itself, may be witnesse
Whelk if the pharynx be opened whilst it is alive.
also been seen in living transparent Gastropods. T
tinous ribbon is continuously growing forward fr
tube like diverticulum as a finger nail does on its be
thus the wearing away of the part which rests on t
tilage and is brought into active use, is made up
the advance of the ribbon in the same way as the w
down of the finger-nail is counterbalanced by its o
ward growth. And, just as the new substance
finger nail is formed in the concealed part, sunk post
below a fold of skin, and yet is continually carried f
with the forward movement of the bed on which it
and which forms its undermost layers, so is the ne
stance of the radula formed in the compressed ext
of the radular sac (*n*), and carried forward by the f
movement of the bed (*o*) on which it rests, and by
is formed its undermost layer. This forward-movi
is not merely the ventral wall of the radular diverti
but includes also that portion of the floor of the ora
to which the radula adheres (as far forward as the
in fig. 9, A). At the spot where the radula ceases, t
ward growth-movement of the floor also ceases, jus
the case of the finger-nail the similar growth-mo
cease at the line where the nail becomes free.

The radula or cuticular product of the slowly-r
bed can be stripped off, and is then found to consi
ribbon " e area, upon which are set numerous toc
proces of various form in transverse rows, which
one an et elo-ely, and exactly resemble one another
form of their teeth (fig. 9, B). The tooth-like proces
single tran verse row are of very different shape an
ber in different members of the Glossophora, and it
sible to use a formula for their description. Thu
in each row there is a single median tooth with thre
on each side of it more or less closely resembli
another, as in fig. 9, C, we write the formula 3.1.3.
there are additional lateral pieces of a different s
those immediately adjoining the central tooth, w
cate them by the figure 0, repeated to represen
number, thus 0000.1.1.1.0000 is the formula
lingual teeth of *Chiton Stelleri*. A single median
an admedian series, and a lateral series may be t
tinguished In some Glossophora only median te
present, or large median teeth with a single sm
median tooth on each side of it (fig. 9, H); th
termed Rachiglossa (formula, —.—.1.— or 1.1.1). In
number of Glossophora we have three admedian
side and one median, no lateral pieces (fig. 9, G)
are termed Taenioglossa (formula, 3.1.3). Those with
rous lateral pieces, four to six or more admedian
and a median piece or tooth (fig. 9, C) are termed
doglossa (formula, x.6.1.6.x, where x stands for a
finite number of lateral pieces). The Toxogloss

the central tooth being absent and the lateral teeth
rly long and connected with muscles. The term
lossa (fig. 9, D) is applied to those Glossophora
ch the radula presents no median tooth, but an
ite and large number of admedian teeth, giving
mula x.0.x. When the admedian teeth are inde-
forty to fifty), and a median tooth is present, the
Myriaglossa is applied (formula, x.1.x). It must be
tood that the pieces or teeth thus formulated may
lves vary much in form, being either flat plates, or
lated, hooked, or spine like bodies. We shall revert
terms thus explained in the systematic descriptions
groups of Glossophora.

muscular development in connexion with the whole
mass, and with each part of the radular apparatus,
edingly complicated,—as many as twenty distinct
s having been enumerated in connexion with thi

In addition to the radula, and correlated with its
oment, we find almost universally present in the
ohora a pair of horny jaws (usually calcified) de-
l as cuticular productions upon the epidermis of the
g. 9, A, *b*). The radula and the shelly jaws of the
ohora enable their possessors not only to voraciously
vegetable food, but the radula is used in some in
for boring the shells of other Mollusca, and the
r crushing the shells of Crustacea, and for wound-
n Vertebrata.

PHYLUM MOLLUSCA.

BRANCH A.—*GLOSSOPHORA*.

racters.—Mollusca with head-region more or less
ently developed; always provided with a peculiar
g-tongue—the odontophore rising from the floor of
cal cavity.

Glossophora comprise three classes, chiefly distin-
l from one another by the modifications of the foot.

Class 1.—GASTROPODA.

racters.—Glossophora in which (with special excep-
swimming forms) the FOOT is simple, median in
n, and flattened so as to form a broad sole like sur
the contractions of which the animal crawls, often
into three successive regions—the pro-, meso-, and
odium—by lateral constrictions.

Gastropoda exhibit two divergent lines of descent
ed by the term sub-class (see p. 619).

Sub-class 1.—GASTROPODA ISOPLEURA.

racters.—Gastropoda in which not only the head
ot but also the visceral dome with its contents and
ntle retain the primitive BILATERAL SYMMETRY of
hi-Mollusc. The anus retains its position in the
line at the posterior end of the body. The whole
l mass together with the foot is elongated, so that
s joining mouth and anus is relatively long, whilst
rso-pedal axis at right angles to it is short. The
IA, the NEPHRIDIA, GENITAL DUCTS, and CIRCULA
RGANS are paired and bilaterally symmetrical. The
nd visceral NERVE-CORDS are straight, parallel with
other, and all extend the whole length of the body;
nglionic enlargements are feebly or not at all deve
The Isopleura comprise three orders.

Order 1.—**Polyplacophora** (the Chitons).

racters.—Gastropoda Isopleura with a metameric re-
n of the shell to the number of eight. The shells of
nitive type are partially or wholly concealed in shell-
mparable to the single embryonic shell-sac of other
ca. On the surface of the mantle-flap numerous calcified spines and knobs are frequently developed
ctenidia are of the typical form, small in size, an
merically repeated along the sides of the body

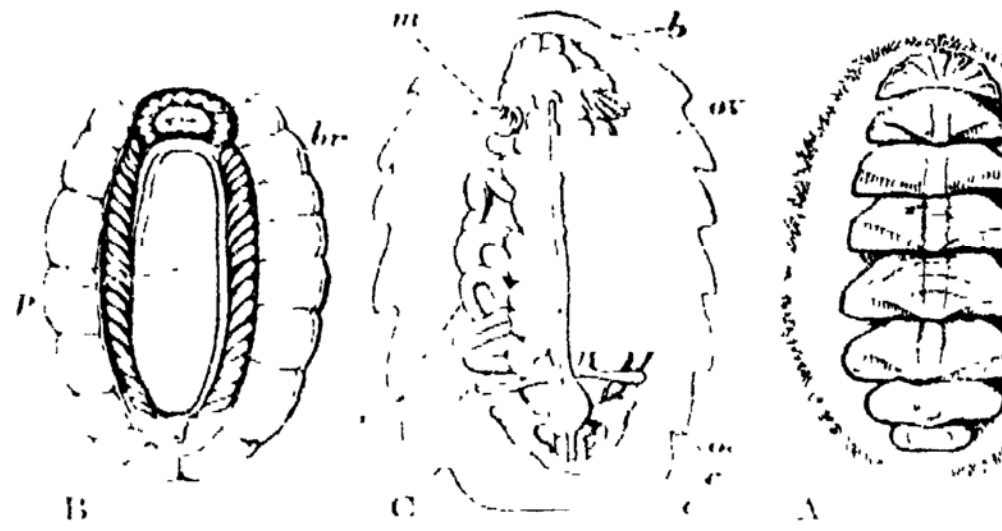


FIG. 10.—Three views of Chiton. A, Dorsal view of *Chiton Hu*
Middendorff) showing the eight shells. B, View of the ventral surface of a specimen of Chiton from the Indian Ocean, showing the mouth at the other end of the foot is seen the anus, situated on a pap
genital furrow, *br*, the branchiæ or ctenidia (branchial plumes) protrudi
these, and all round the animal is the mouth-fold. (After Cuvier.) C, Dorsal view of one specimen of Chiton, with the shells removed and the dorsal mantle reflected. *b*, buccal mass; *m*, retractor muscle of the buccal mass; *ov*, ovary; *ovd*, oviduct; *r*, coil of intestine; *v*, aorta; *v*, left auricle and ventricle.

number of sixteen or more; an osphradium or "olfactory epithelium" (Spengel) is found at the each ctenidium. The other organs are not subj metameric repetition. The odontophore is highly oped; the teeth of the lingual ribbon are varied in t several in each transverse row (fig. 9, E). Paired ducts distinct from the paired nephridia are present

The order Polyplacophora contains but one fam *Chitonida*, with the genera: *Chiton*, Lin. (figs. 10, I *Cryptochiton*, Midd., 1847, and *Cryptoplax* (= *Chito* Blainv., 1818.

Order 2. **Neomeniæ.**

Characters.—Gastropoda Isopleura devoid of which is replaced by innumerable microscopic plates or spicules set in the dorsal epidermis; man not lateral, but reduced to a small collar surroundi

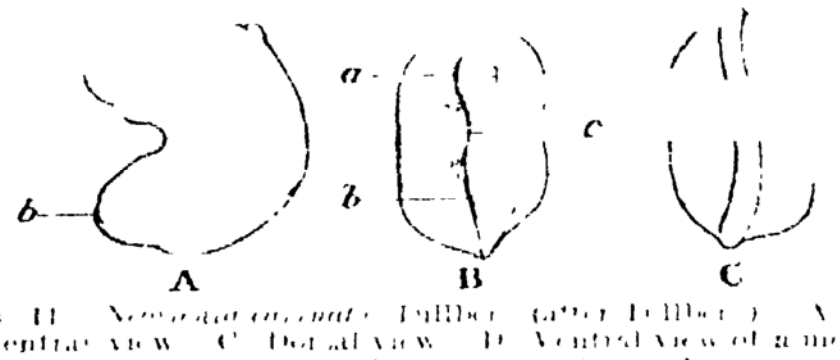


FIG. 11.—*Neomenia carinata*, Tullberg (after Tullberg). A, Lateral v Ventral view. C, Dorsal view. D, Ventral view of a more extend mal. *a*, anterior; *p*, posterior extremity; *s*, furrow, in which th foot is concealed.

anus, ctenidia represented by a symmetrical group dinal filaments on either side of the anus, foot very sunk in a groove, odontophore feebly developed, radula many-toothed; gonads placed in the peric discharging by the nephridia; no special generative

The order Neomeniæ contains the two genera *Ne* Tullberg (*Solenopus*, *Sars*) (fig. 11); and *Prone* Hubrecht.

Order 3. **Chætoderma**

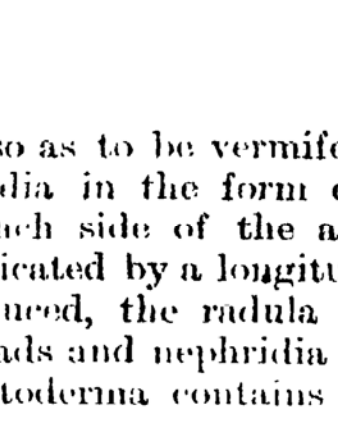
Characters.—Gastropoda Isopleura devoid of which is replaced by numerous minute calcareous

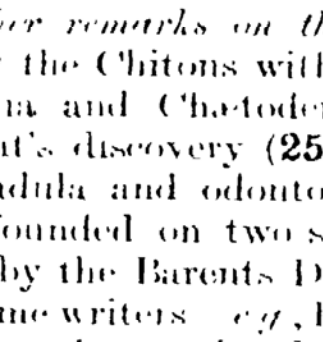
FIG. 12.—*Chætoderma nitidulum*, Loven (after Graff). The cephalic mental (*c*) to the left, the anal chamber (reduced genital chamber, *c* the concealed pair of ctenidia) to the right.

standing up like hairs on the surface of the body

longated so as to be vermiform; mantle-flap as in
niæ; ctenidia in the form of a pair of branchial
one on each side of the anus; foot aborted, its
being indicated by a longitudinal furrow; odonto-
reatly reduced, the radula only represented by a
oth; gonads and nephridia as in Neomenia.
order Chætoderma contains the single genus *Chæ-*
(fig. 12).

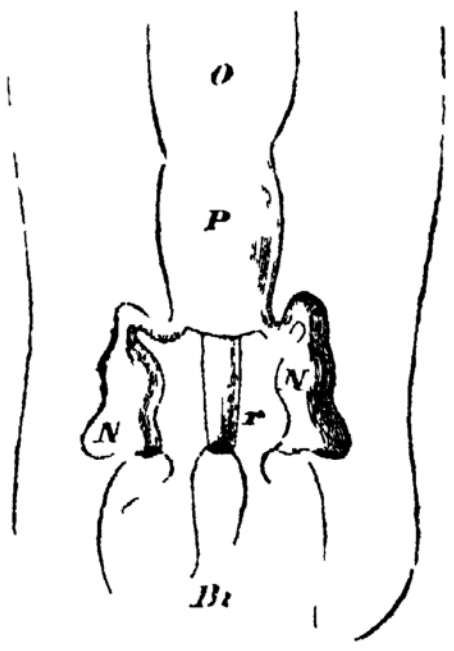
er remarks on the Isopleurous Gastropods. The
the Chitons with the remarkable worm like forms
a and Chætoderma was rendered necessary by
t's discovery (25) in 1881 of a definitely consti-
adula and odontophore in his new genus Proneo
ounded on two specimens brought from the arctic
by the Barents Dutch expedition.
ne writers *e.g.*, Keferstein the Chitons have been
nately associated with the other Gastropoda, whilst,
other hand, Gegenbaur seems to have gone a great
far in separating them altogether from the other
as a primary subdivision of that phylum, inas-
much as they are inti
mately bound to the
other Glossophora by
the possession of a
thoroughly typical
and well developed
odontophore. They
undoubtedly stand
nearer to the archi
Mollusca than any
other Glossophora in
having retained a com
plete bilateral sym
metry and the primi-
tive shell-sac, though
the metameric repe-
tition of this organ
and of the ctenidia is
a complication of, and
departure from, the
primitive character.
It is not improbable
that in the calcareous
spines and plates of
the dorsal integument
of Neomenia and Cha-
toderma, which occur
also on the part of
the dorsum uncovered
by shell in Chiton, we
have the retention of
ion preceding the development of the solid Mol-
hell, or a reversion to it. The minute calcareous
ay have the same relation to a compact shell which
een denticles of the sharks have to a continuous
one.

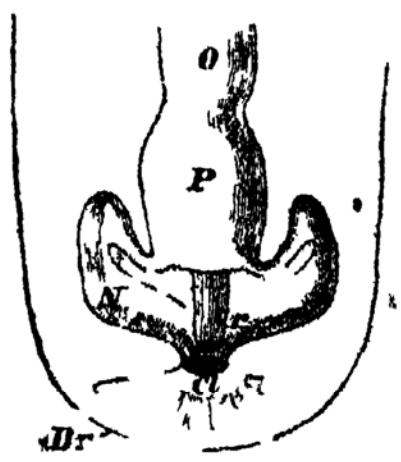


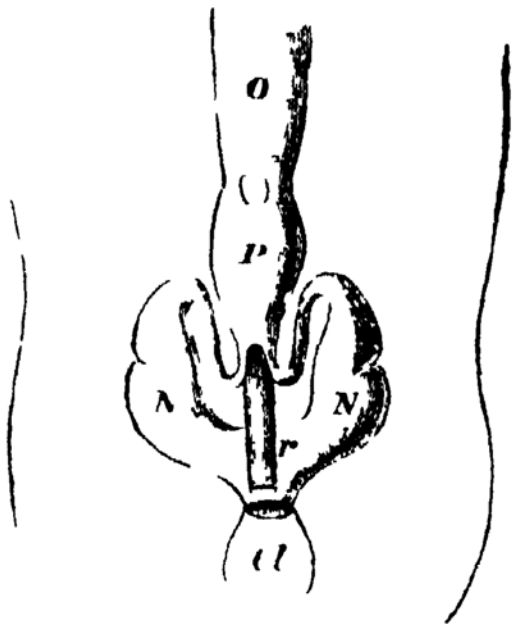


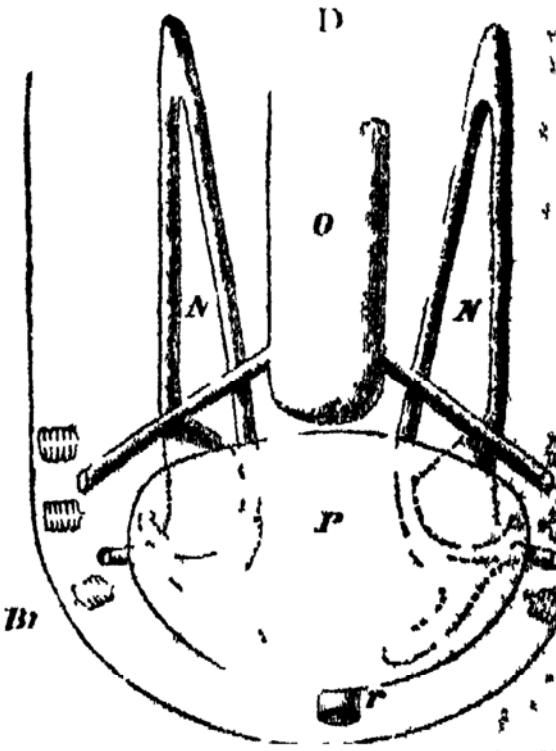
iagrams of the alimentary canal of
(from Hubrecht). *o*, mouth; *d*, anus; *a*, alimentary canal; *l*, liver (digestive gland). A. Neomenia and Proneomenia. B.

natomy of the Gastropoda Isopleura has been largely
d within the past year by the researches of
t and of Sedgwick, who have been the first to
e method of sections to the study of this group.
eading points in the modifications of mantle-flap,
l ctenidia are set forth in the preceding summaries,
he accompanying references to the figures. With
to other organs, we have to note the form of
nentary canal (fig. 13), which is simplest in
rma, symmetrically sacculated in Neomenia, and
upon itself, forming a few coils, in Chiton. The
as a compact liver with arborescent duct, which is
ted by the sacculi in Neomenia and by a single
cæcum in Chætoderma. Salivary glands are present in Chiton and in Proneomenia. The radula is highly developed in Chiton, and, though present in Proneomenia, has not been described in Neomenia. A single tooth in Chætoderma appears to represent the radula in a reduced state. The circulatory organs of Chiton alone are known with any degree of detail (fig. 10, C). There is a median dorsal blood-vessel—the aorta—which is enlarged to form a ventricle in the posterior region of the body. On either side the ventricle is connected to a well-developed auricle, which pours into it the aerated blood from the gills (ctenidia). The extent to which vascular trunks are developed has not been determined, but vessels to and from the ctenidia, and in the mid-line of the foot, are known. As in other Mollusca, the vessels do not extend far, but lead into lacunæ between the organs and tissues. Dorsal and ventral vessels have been detected in Neomenia and Chætoderma, but no specialized heart.









A–C. Excretory and reproductive organs of Isopleura (after Hubrecht). *O*, ovary; *P*, pericardium; *N*, nephridium; *u*, external aperture of nephridium; *g*, external aperture of the genital duct of Chiton; *r*, rectum; *Cl*, cloacal or pallial chamber of Neomenia and Chætoderma; *Br*, ctenidia (branchial plumes). A. Chætoderma. B. Neomenia. C. Proneomenia. D. Chiton.

The heart of Chiton lies in a space which is to be regarded as a specialized part of the cœlom, and, as in other Mollusca, is termed the pericardium. In front of this space in Chiton lies the ovary (fig. 14, D). In the other Isopleura the genital bodies (gonads) lie in the pericardium, which has a longer form and extends dorsally above the intestine. Opening into the pericardium equally in all the Isopleura (fig. 14) is a pair of bent tubes which lead to the exterior. These are the nephridia, which in Chiton are essentially renal in function. Their disposition has been determined by Sedgwick (26), who has shown that each nephridium is much bent on itself, so that, as in the

ridia of Conchifera (organ of Bojanus), the internal ture lies near the external. From the folded stem of nephridium very numerous secreting caeca are given off, mitted in the dia- (fig. 14, D), but rately drawn in 5. The sexes in on are distinct, the ovary or testis, he case may be, gh lying in and g a chamber of original coelom, not discharge into pericardium, but its own ducts, h pass to the ex r just in front of e of the nephridia 14, D, *g*, and fig. In this respect on is less primi- than the other Iso- ra, and even than other Gastropods Zygobranchia), some Conchifera ndylus, &c.), which no special genital tures, but make use he nephridia for purpose. In *Chiton cepans*, in which e are sixteen pairs enidia, the orifices he nephridia are cident with the six- th pair of ctenidia, e of the genital s with a point between the thirteenth and fourteenth idia.

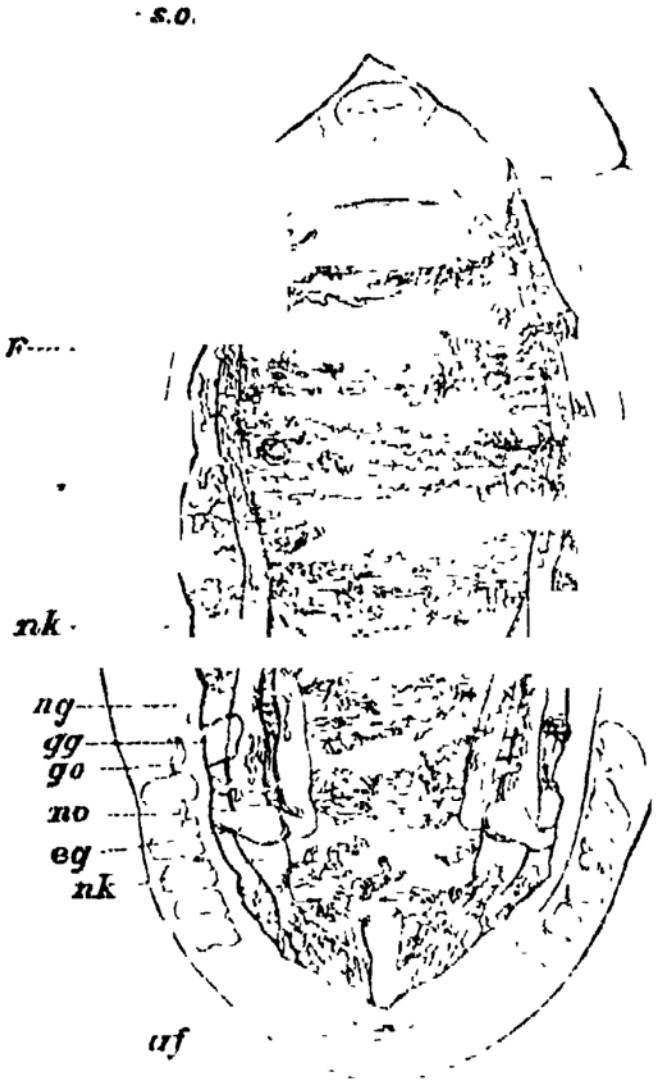


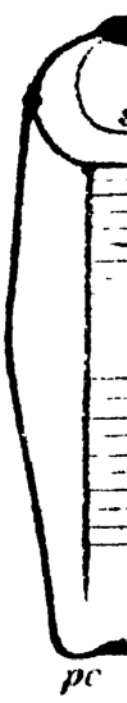
FIG. 15.—Dissection of the renal organs (nephridia) of *Chiton squamosus*, after Haller (*Arbeiten, Zool. Instit.*, Vienna, 1882). *f*, foot; *l*, edge of the mantle not removed in the front part of the specimen; *s.o.*, œsophagus; *af*, anus; *no*, genital duct; *go*, external opening of the same; *eg*, stem of the nephridium leading to *no*, its external aperture; *nk*, reflected portion of the nephridial stem; *ng*, fine cæca of the nephridium, which are seen ramifying transversely over the whole inner surface of the pedal muscular mass.

n the Neomeniæ and Chætoderma the nephridia are short and wide (*N* in fig. 14, A, B, C), and function as excretory ducts for the genital products, the gonads being lodged in the long pericardium. Their separate or united apertures open near the anus into the small chamber formed by the restriction of the mantle-skirt to the immediate neighbourhood of the anus.

16.—Ovary and oviducts *Chiton siculus* (after Hal- loc. cit.). *vb*, *hb*, anterior posterior suspensor of ovary; *U*, uterus (en- ged part of oviduct); *a*, duct.

The nervous system of the Gastropoda Isopleura is represented in the diagram fig. 17. In all it is important to observe that nerve ganglion cells are by no means limited to special swellings—the ganglia—but are abundant along the whole course of the four great longitudinal trunks. This is a primitive character comparable to that presented by the nerve-cords of Nemertine worms, and of the Arthropod Peripatus. Higher differentiation in other Mollusca leads to predominance if not an exclusive

sence of nerve-*fibres* in the cords, and of nerve-*ganglion* in the specialized ganglia. The numerous transverse nexions of the pedal nerve-cords in Chiton and Neomenia (seen also in Fissurella (fig. 36) and some Gastropods) are comparable to the transverse com of the ventral nerve-cords of Chætopod worms and Arthropods. In the abundance of the nervous network connected with its longitudinal nerve-tracts, Chiton appears to retain something of the early condition of the Coelomate nervous system when it had the form of a subepidermic network or nerve tunic (seen more clearly in Planarians and some Nemertines), and when the concentration into definitely compacted cords had not set in.



Ganglia are, however, distinguishable on the nervous cords of Chiton (fig. 18). The cerebral ganglia are not distinguishable as such, but a pair of buccal ganglia (B in fig. 18) are developed on two connectives which pass forward from the cerebral region to the great muscular mass of the mouth. These buccal ganglia are special developments connected with the special muscularity of the lips and odontophore, and are found in all Glossophora, but not in the Lipocephala. Such special ganglia related to organs (and not introduced in our schematic Moll

16.—Ovary and oviducts *Chiton siculus* (after Hal- loc. cit.). *vb*, *hb*, anterior posterior suspensor of ovary; *U*, uterus (en- ged part of oviduct); *a*, duct.

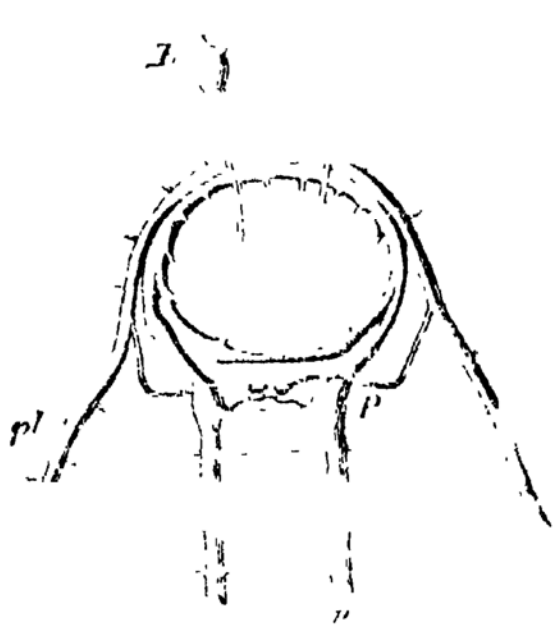


FIG. 18.—Anterior part of the nervous system of *Chiton cinereus*, in more detail (from Gegenbaur's *Elements of Comparative Anatomy*). *B*, buccal ganglia (connected with the odontophore); *C*, cerebral nerve-mass; *P*, pedal ganglion and commencement of pedal nerve cord; *p'*, visceral nerve cord. The sublingual ganglia are not lettered.

1) we find in connexi the siphons of the phala, and in vario tion upon the viscera cords of other Mollus Glossophora and Lipo A pair of pedal gan little developed (*p* in and a special group lingual ganglia are pr Chiton. On the wh nervous system of pleura is exceedingly and archaic, whilst it well serve as a ty which to compare other Mollusca on ac the small amount of tration of its nerve cells into ganglia, suc find well developed forms.

The development of Neomenia and Chætoder

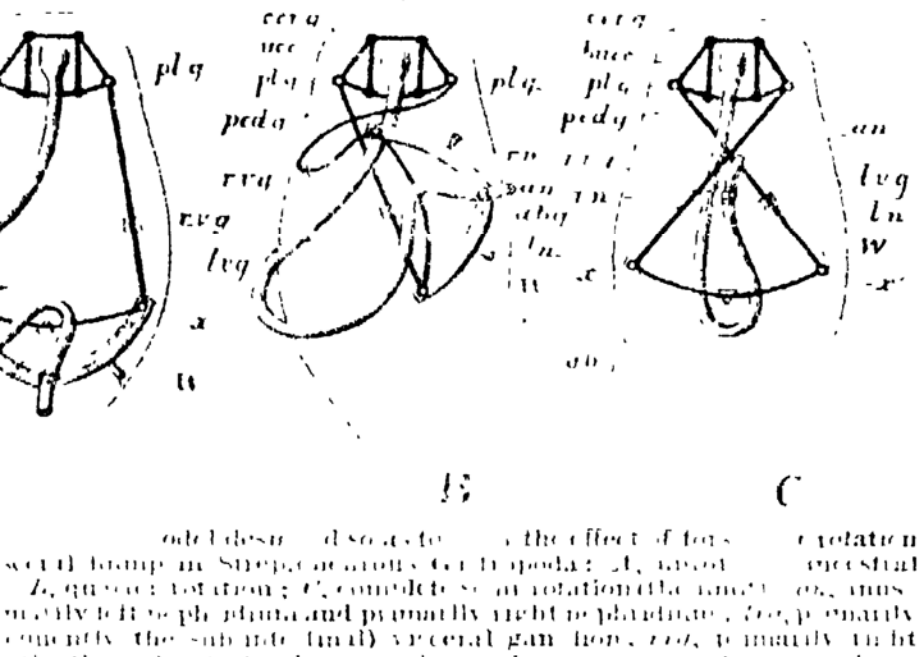
g is entirely unknown, that of Chiton only par- Impregnation is effected when the eggs have been ged and are lying beneath the mantle-skirt. A phere larva is developed from the Diblastula of (Loven).

Chitons are found in the littoral zone in all parts of ld and are exclusively marine. Neomenia, Proneo nd Chaetoderma have hitherto been dredged from able depths (100 fathoms and upwards) in the a, Proneomenia also in the Mediterranean (Marion).

Sub-class 2. GASTROPODA ANISOPLEURA.

Definition. Gastropoda in which, whilst the head and am the bilateral symmetry of the archi-Mollusca, eral dome, including the mantle-flap dependent from he region on which are placed the ctenidia, anus, ve and nephridial apertures, have been subjected ation tending to bring the anus from its posterior position, by a movement along the right side, to a position above the right side of the animal's even to the middle line above the neck. This connected mechanically with the excessive vertical of the visceral hump and the development upon e of a heavy shell. The shell is not a plate en n a shell-sac, but the primitive shell-sac appears ppears in the course of embryonic development, and vely large mantiloid shell (with rare exceptions) over the whole surface of the visceral hump and hart. Whilst such a shell might retain its median in a swimming animal, it and the visceral hump ly fall to one side in a creeping animal which hem uppermost.

hell and visceral hump in the Anisopleura incline



B *C*

Fig. 20.—Nervous system of Aplysia as a type of the long looped Euthyneurous condition. The unitwisted visceral loop highly shaded. *cer*, cerebral ganglion; *pl*, pleural ganglion; *ped*, pedal ganglion; *ab*, abdominal ganglion which represents also the supra-intestinal ganglion of Streptoneura and gives off the nerve to the osphradium (olfactory organ) *o* and another to the left-lying supra-intestinal ganglion. The buccal nerves and ganglia omitted. (After Spengel.)

ode (desmid) so as to show the effect of torsion and subsequent rotation of the visceral hump in Streptoneurous Gastropoda: *A*, incipient torsion; *B*, greater rotation; *C*, complete torsion (the latter rotation being chiefly in the pleural region); *an*, anus; *ctenidium*, primarily left or pleural and primarily right or pedal ctenidium; *lvg*, primarily left (subsequently the sub-intestinal) visceral ganglion; *rvg*, primarily right (subsequently the supra-intestinal) visceral ganglion; *cer.g*, cerebral ganglion; *pl.g*, pleural ganglion; *ped.g*, pedal ganglion; *abg*, abdominal ganglion; *buc.c*, buccal connectives; *w*, wall of the mantle-cavity; *x*, pins fastening the elastic cord (dotted) along the visceral loop in *B*.

to the right side of the animal. As mechanical there arise a one-sided pressure and a one-sided together with a one-sided development of the muscles which are related to the shell and foot. TORSION THROUGH A SEMICIRCLE of the base of the dome and the continued heliotropic spiral growth visceral dome itself, which is very usual in the ura, appear to be traceable to these mechanical es. Atrophy of the representatives on one side ody of paired organs is very usual. Those placed ly on the left side of the rectum, which in virtue sion become the right side, are the set which suffer 19). Some Anisopleura, after having thus acquired ly marked inequilateral character in regard to such s the ctenidia, nephridia, genital ducts, heart, and appear by further change of conditions of growth to quired a superficial bilateral symmetry, the second

ary nature of which is revealed by anatomical examination (Opisthobranchia, Natantia).

In all groups of Anisopleura examples are numerous in which the shell is greatly developed, forming a "house" into which the whole animal can be withdrawn, the entrance being often closed by a second shelly piece carried upon the foot (the operculum). The power of rapidly extending and of again contracting large regions of the body to an enormous degree is usual, as in the Lipocephalous Mollusca. In spite of the theories which have been held on this matter, it appears highly probable that no fluid from without is introduced into the blood, nor is any expelled during these changes of form. A large mucous gland with a median pore is usually developed on the ventral surface of the foot, comparable to the similar gland and pore in Lipocephala, and in some cases (*e.g.*, Pyrula, fig. 37, B) this has been mistaken for a water-pore.

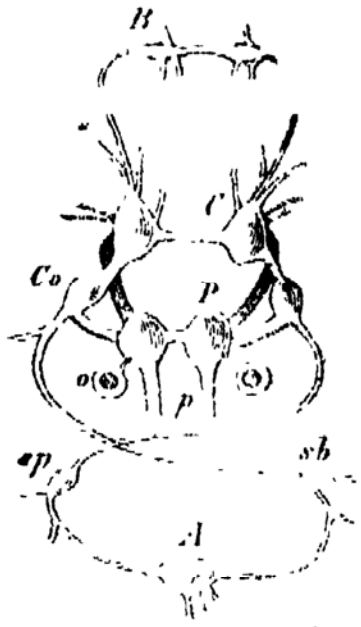


Fig. 21.—Nervous system of Paludina as a type of the Streptoneurous condition. *B*, buccal (sub-oesophageal) ganglion; *C*, cerebral ganglion; *Co*, pleural ganglion; *P*, pedal ganglion with otocyst attached; *p*, pedal nerve; *d*, abdominal ganglion at the extremity of the twisted visceral "loop"; *sp*, supra-intestinal visceral ganglion on the course of the right visceral cord; *sh*, sub-intestinal ganglion on the course of the left visceral cord. (From Gegenbaur, after Jhering.)

The heliotropic torsion of the visceral dome has had less deep-seated effect in one series of Anisopleura than in another. Accordingly, as the loop formed by the two VISCERAL NERVES (fig. 19) is or is not caught, as it were, in the twist, we are able to distinguish one branch or line of descent with straight visceral nerves—the EUTHYNEURA

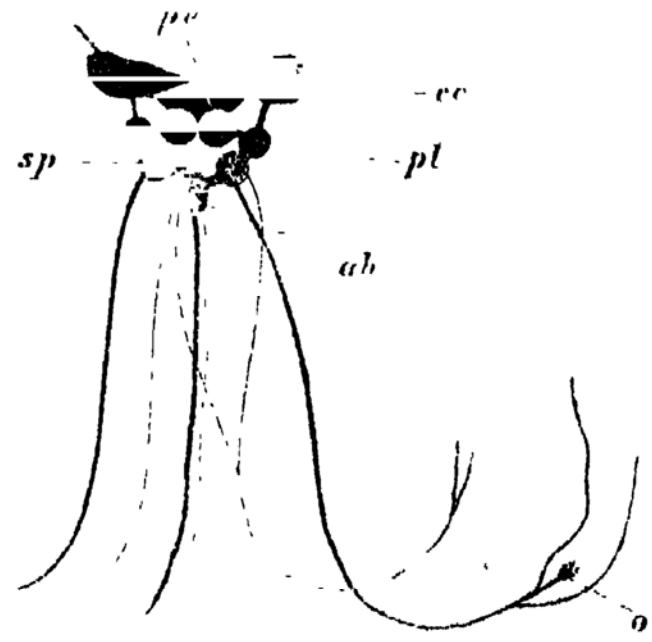


Fig. 22.—Nervous system of the Pond-Snail, *Limnæus stagnalis*, as a type of the short looped Euthyneurous condition. The short visceral "loop" with its three ganglia is lightly-shaded. *ce*, cerebral ganglion; *pe*, pedal ganglion; *pl*, pleural ganglion, *ab*, abdominal ganglion; *sp*, visceral ganglion of the left side, opposite to it is the visceral ganglion of the right side, which gives off the long nerve to the olfactory ganglion and osphradium *o*. In Planorbis and in Auricula (Pulmonata, allied to Limnæus) the olfactory organ is on the *left* side and receives its nerve from the *left* visceral ganglion. (After Spengel.)

(fig. 20)—from a second branch with the visceral nerves

into a figure-of-eight—the STREPTONEURA (fig. Probably the Euthyneura and the Streptoneura veloped independently from the ancestral bilater nmetrical Gastropods. The escape of the visceral oop from the torsion depends on its having acquired what deeper position and shorter extent, previously commencement of the phenomenon of torsion, ancestors of the Euthyneura than in those of reptoneura. In the ancestral Streptoneura the loop was lateral and superficial as in the living ra.

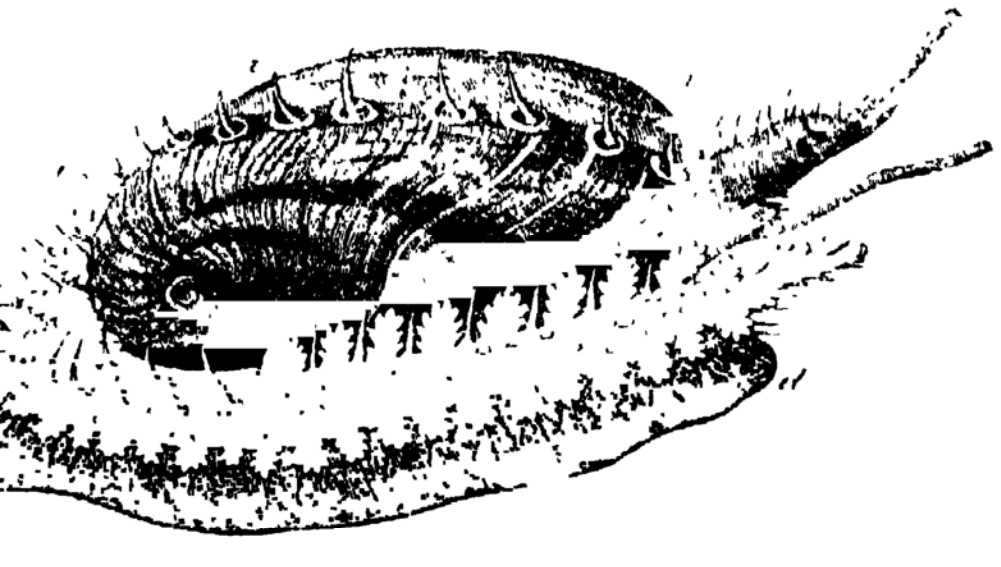
anch *a.*—*STREPTONEURA* (Spengel, 1881)

racters.—Gastropoda Anisopleura in which the "loop" (the conterminous visceral nerves) was nt to the body-wall and so shared in the torsion of ceral hump, the right cord crossing above the left form a figure-of-eight (see fig. 19).

Streptoneura comprise two orders the Zygoa and the Azygobranchia

Order 1.—Zygobranchia.

racters.—Streptoneura in which, whilst the visceral is very complete so as to bring the anus into the line anteriorly or nearly so, the atrophy of the voly left-side organs is not carried out The right t ctenidia, which have now become left and right ively, are of equal size, and are placed symmetrically er side of the neck in the pallial space Related is a simple pair of osphradial patches Both right



Haliotis tuberculata. *d*, foot; *t* tentacle of the mantle (From Owen, after Cuvier)

t nephridia are present, the actual right one being arger than the left. Two auricles may be present nd left of a median ventricle (Haliotis), or only one a). The **Zygobranchia** are further very definitely erized by the archaic character of absence of special ducts. The generative products escape by the nephridium. The sexes are distinct, and there is ulatory or other accessory generative apparatus. eth of the lingual ribbon are highly differentiated doglossate). The visceral dome lies close upon the cker-like foot, and is coextensive with its prolongathe aboral direction.

Zygobranchia comprise three families, arranged in two sub-

Sub-order 1. *Ctenidiobranchia*

rder.—Large paired ctenidia acting as gills

1.—*Haliotidæ.*

a: *Haliotis* (Ear-Shell, Ormer in Guernsey); mostly tropical, *notis.*

2.—*Fissurellidæ.*

a: *Fissurella* (Key-hole Limpet) (figs. 24, 36), *Emarginula.* *rmophorus* (fig. 25); mostly tropical.

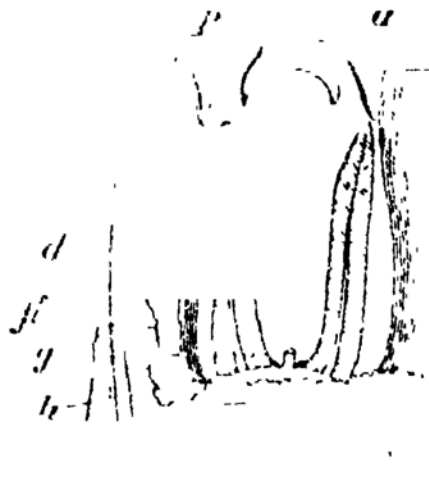
Sub-order 2. *Phyllidiobranchia.*

acters.—Ctenidia reduced to wart-like papillæ; special sub-pallial lamellæ, similar to those of the Opisthobranch phyllidia, perform the function of gills

Family 3.—*Patellidæ.*

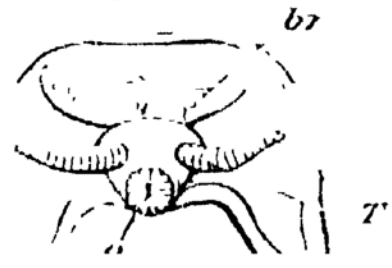
Genera. *Patella* (Limpet, figs. 26, &c.), *Nacella* (Bonnet-L *Lottia.*

Further Remarks on Zygobranchia. The Common L is a specially interesting and abundant example remarkable order Zygobranchia A complete and ac account of its anatomy has yet to be written. H have only space for a brief outline. The foot Limpet is a nearly circular disc of muscular tissu



front, projecting from and raised above it, are the head and neck (figs. 26, 30). The visceral hump forms a low conical dome above the rib cordate foot, and standing out all round the base of the dome so as to completely overlap the head and foot, is the circular mantle-skirt. The depth of free mantle-skirt is greatest in front, where the head and neck are covered in by it Upon the surface of the visceral dome, and extending to the edge of the free mantle-skirt, is the conical shell. When the shell is taken away (best effected by immersion in hot water) the surface of the visceral dome is found to be covered by a black coloured epithelium, which may be removed, enabling the observer to note the position of some organs lying below the transparent integument (fig. 27). attaching the foot to the

Haliotis tuberculata. *d*, foot; *t* tentacle of the mantle (From Owen, after Cuvier)



The [illegible] nephridium [illegible] from the pallial surface [illegible] mouth; *z* cephalic tentacle; *k* one of the two visceral gills placed on the neck. (Of natural size.)

The muscular colum front, external to which is t mantle kurt The limits large area formed by the fu the head and neck (*cc*) can be and we note the anal papill ing through and opening on th shoulder, so to speak, of the into the large anterior region sub-pallial space. Close to t small renal organ (*x*, mediad) large renal organ (*k*, to th and posteriorly) are seen, a pericardium (*l*) and a coil of te tine (*int*) embedded in th pact liver

On cutting away the anteri of the mantle skirt so as to the sub-pallial chamber in the of the neck, we find the rig left renal papilla (discovered kester (**27**) in 1867) on eith the anal papilla (fig. 28), but n If a similar examination be of the allied genus Fissurel 21, *d*), we find right and left of the two renal ap a right and left gill plume or ctenidium, which h presence here and in Haliotis furnish the distinctiv acter to which the name Zygobranchia refers. In no such plumes exist, but right and left of the n seen a pair of minute oblong yellow bodies (fig. which were originally described by Lankester as possibly connected with the evacuation of the ge

ducts. On account of their position they were termed
ium the "capito pedal orifices," being placed near the
rtion of head and foot. Spengel (**24**) has, however, in
ost ingenious way shown that these bodies are the repre-
atives of the typical pair of ctenidia, here reduced to a
rudiment. Near to each rudimentary ctenidium Spengel

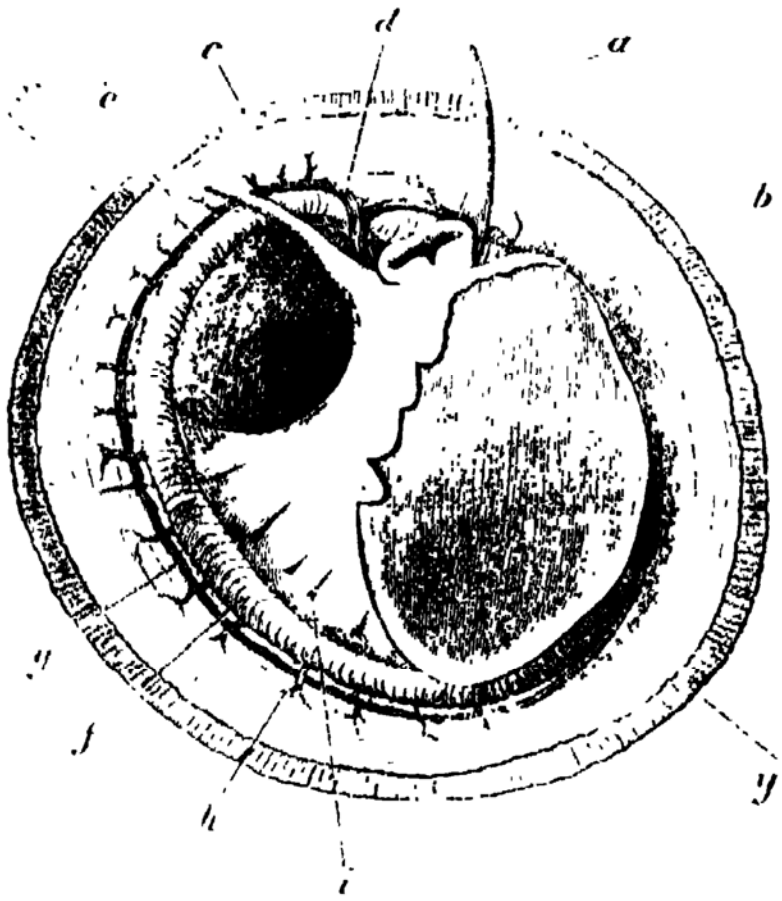


FIG. — Left side of Limpet (*Patella*) [illegible] on the pedal
[illegible] the median antero-posterior [illegible] *a*, cephalic tentacle; *b*,
[illegible] surface of the foot; *c*, free edge of the shell; *d*, the branchial cte-
[illegible] directed backwards and here interrupting the
[illegible] of the mantle-skirt; *f*, gill lamella (*not* to
[illegible] but special papilla-growths, comparable to those of Pleurophyllidia);
g, branchial afferent vessel; *h*, factor of the branchial advehent vessel;
[illegible] between the pericardial tubercle of the roof of the foot, causing
[illegible] (Original.)

discovered an olfactory patch or osphradium (consisting
odified epithelium) and an olfactory nerve ganglion
32). It will be remembered that, according to
gel, the osphra
of Mollusca is
itely and inti
ly related to the
plume or cteni
being always
d near the base
t organ; further,
gel has shown
the nerve-supply
s olfactory organ
ays derived from
i-cerebral loop. Ac
ngly, the nerve
ly affords a means
sting the conchu-
that we have in
[illegible] capito
] bodies the rudi
ary ctenidia. The
mpanying dia
s (figs. 31, 35) of
nervous system of
lia and of Haliotis
termined by Spen
show the identity in the origin of the nerves passing
the visceral loop to Spengel's olfactory ganglion of
Limpet, and that of the nerves which pass from the
ral loop of Haliotis to the olfactory patch or osphra
, which lies in immediate relation on the right and
he left side to the right and the left gill-plumes
idia) respectively. The same diagrams serve to de-

FIG. — Dorsal surface of the Limpet removed
from its shell and deprived of its black pig-
mented epithelium, the internal organs are
[illegible] through the transparent body-wall; *a*,
[illegible] muscular bundles forming the roof of the foot
and adhered to the shell; *b*, free mantle-
[illegible] lateral [illegible] region of the same;
[illegible] (left) nephridium; *f*, larger (right)
[illegible] pericardium; *g*, fibrous septum,
behind the pericardium; *h*, heart; *int*, intes-
[illegible] area of the mantle-skirt over-
[illegible] the head (cephalic hood). (Original.)

monstrate the Streptoneurous condition of the viscera
in Zygobranchia.

Thus, then, we find that the Limpet possesses a
metrically-disposed pair of ctenidia in a rudimentary
dition, and justifies its position among Zygobranchia. At the same time it possesses a totally distinct series of *fune tional* gills, which are not derived from the modification of the typical Mollus can ctenidium. These gills are in the form of delicate lamellæ (fig. 26, *f*), which form a series extending com pletely round the inner face of the depending mantle skirt. This circlet of gill lamellæ led Cuvier to cla
Limpets as Cyclobranchiata, and, by erroneous iden
tion of them
the series of
merically rep
ctenidia of C
to associate
latter Mo
with the fo
The gill-la
of Patella
processes o
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able to the
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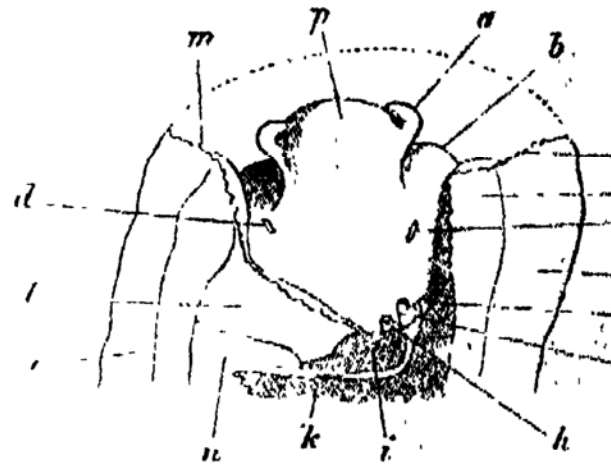


FIG. 28.—Anterior portion of the same Limp
the overhanging cephalic hood removed.
phalic tentacle, *b*, foot; *c*, muscular su
forming the roof of the foot; *d*, the capu
organs of Lankester (= rudimentary cten
mantle-skirt; *f*, papilla of the larger nephr
g, anus, *h*, papilla of the smaller nephrid
smaller nephridium; *k*, larger nephridium
cardium, *m*, cut edge of the mantle-sk
lives; *p*, snout. (Original.)

FIG. 29.—The same specimen viewed from the left
front, so as to show the sub-anal tract (*ff*) of the
larger nephridium, by which it communicates with
the pericardium. *a*, mouth, other letters as in fig. 28.

other Gastropoda (*e.g.*, Buccinum and Haliotis). Th
termed pallial gills. The only other Molluscs in
they are exactly represented are the curious Opistho
branchs Phyllidia and Pleurophyllidia (fig. 57). In these, as in Patella, the typical ctenidia are aborted, and the branchial function is assumed by close-set lamelliform processes arranged in a series beneath the mantle-skirt on either side of the foot. In fig. 26, *d* the large branchial vein of Patella bringing blood from the gill-series to the heart is seen; where it crosses the series of lamellæ there is a short interval devoid of lamellæ.

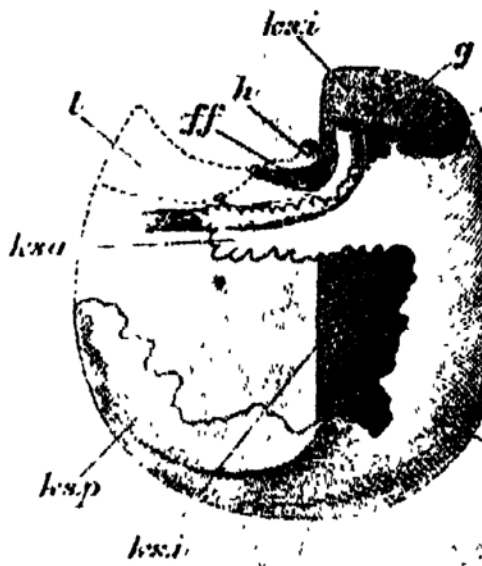
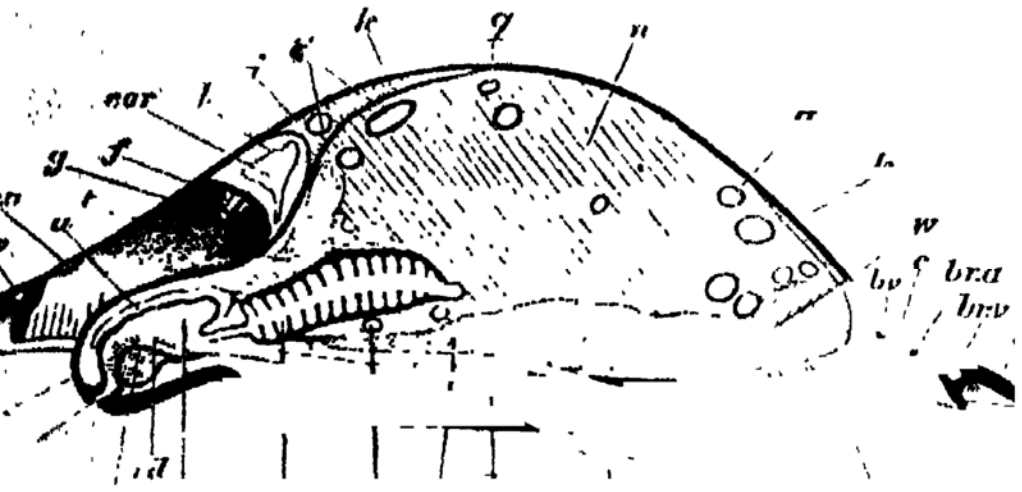


FIG. 30.—Diagram of the two rena
(nephridia), to show their relatio
rectum and to the pericardium
pilla of the larger nephridium
papilla with rectum leading fro
papilla of the smaller nephridiu
is only represented by dotted o
l, pericardium indicated by a dot
line, at its right side are seen
reno-pericardial pores; *ff*, the
tract of the large nephridium
near its papilla and seen thro
unshaded smaller nephridium;
terior superior lobe of the l
phridium; *ks.l*, left lobe of sam
posterior lobe of same; *ks.t*,
sub-visceral lobe of same. (Or

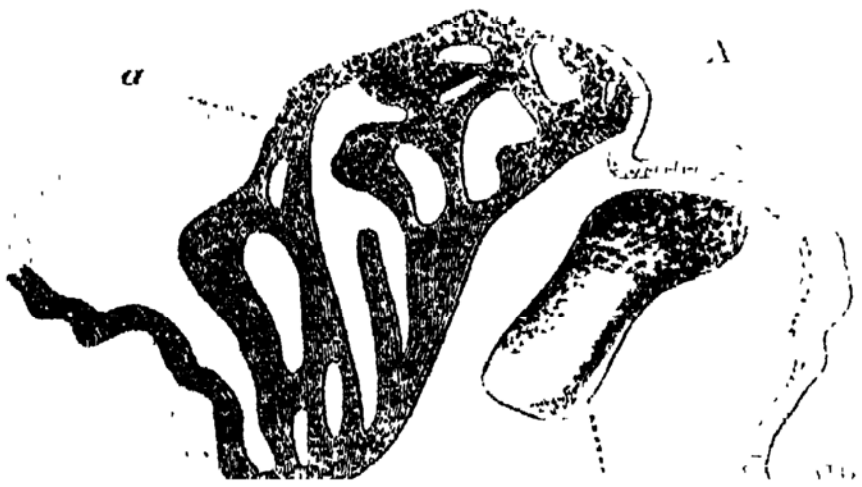
The heart in Patella consists of a single auricle (not two as in Haliotis and Fissurella) and a ventricle; the former receives the blood from the branchial vein, the latter distributes it through a large aorta which soon into irregular blood-lacunæ.

e existence of two renal organs in Patella, and their
on to the pericardium (a portion of the coelom) is



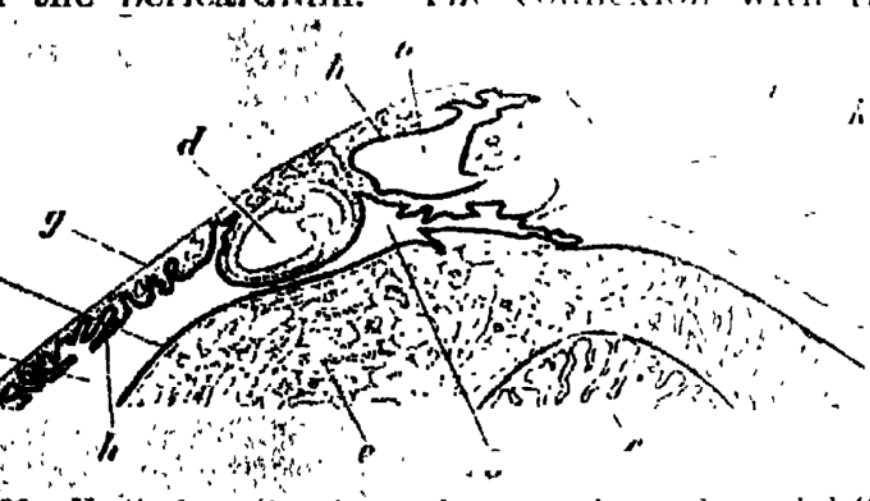
1.—Diagram of a vertical antero-postero-median section
ers as in figs. 28, 29, with following additions: *q*, into the
on; *r*, lingual sac (radular sac); *rd*, radula; *n*, dilated stomach; *l*, gonad; *b*, *a*, branchial vessel (vein); *bv*, blood vessel (artery); *brv*, branchial efferent vessel; *odm*, muscles and cartilage of the odontophore; *co*, heart within the pericardium. (Original.)

rtant. Each renal organ is a sac lined with glandular



32.—A, Section in a plane vertical to the surface of the neck of Pate
ough *a*, the rudimentary ctenidium (Lankester, *ctn*), and *b* the
ory epithelium (osphradium); *c*, the olfactory (osphradial) ganglio
ter Spengel.) B, Surface view of a rudimentary ctenidium
ised and viewed as a transparent object. (Original.)

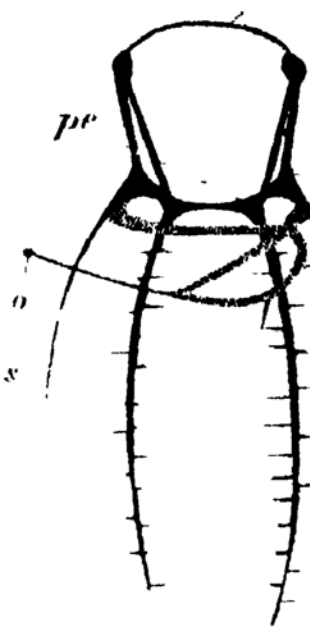
the exterior by its papilla, and by a narrow passag
the pericardium. The connexion with the



33.—Vertical section in a plane running and left through
erior part of the visceral hump of Patella, to sho the two renal or
their openings into the pericardium. *a*, large or external or right
an; *ab*, narrow process of the same running *b* the intestine and
by *k* into the pericardium; *b*, small or med renal organ; *c*,
dium; *d*, rectum; *e*, liver; *f*, nanyphes; *g*, epithelium of the dorsal
e; *h*, renal epithelium lining the renal sacs; *i*, aperture connecting
all sac with the pericardium; *k*, aperture connecting the large sac w
pericardium. (From an original drawing by Mr J. T. Cunningham, Fel
University College, Oxford.)

n of the smaller of the two renal organs was deme
ted by Lankester in 1867, at a time when the fa t

that the renal organ of the Mollusca, as a rule, op
the pericardium, and is therefore a typical nep
was not known. Subsequent investigations (27)
under the direction of the same naturalist have shown that the larger as well as the smaller renal sac is in communication with the pericardium. The walls of the renal sacs are deeply plaited and thrown into ridges. Below the surface these walls are excavated with blood-vessels, so that the sac is practically a series of blood vessels covered with renal epithelium, and forming a mesh-work within a space communicating with the exterior. The larger renal sac (remarkably enough, that which is aborted in other Anisopleura) extends between the liver and the integument of the visceral dome very widely. It also bends round the liver as shown in fig. 30, and forms a large sac on half of the upper surface of the muscular mass of the foot. Here it lies close upon the genital body (ovary or testis), and in such intimate relationship with it that, when ripe, the gonad bursts renal sac, and its products are carried to the ex the papilla on the right side of the anus (Rob This fact led Cuvier erroneously to the belief tha existed leading from the gonad to this papill position of the gonad, best seen in the diagr



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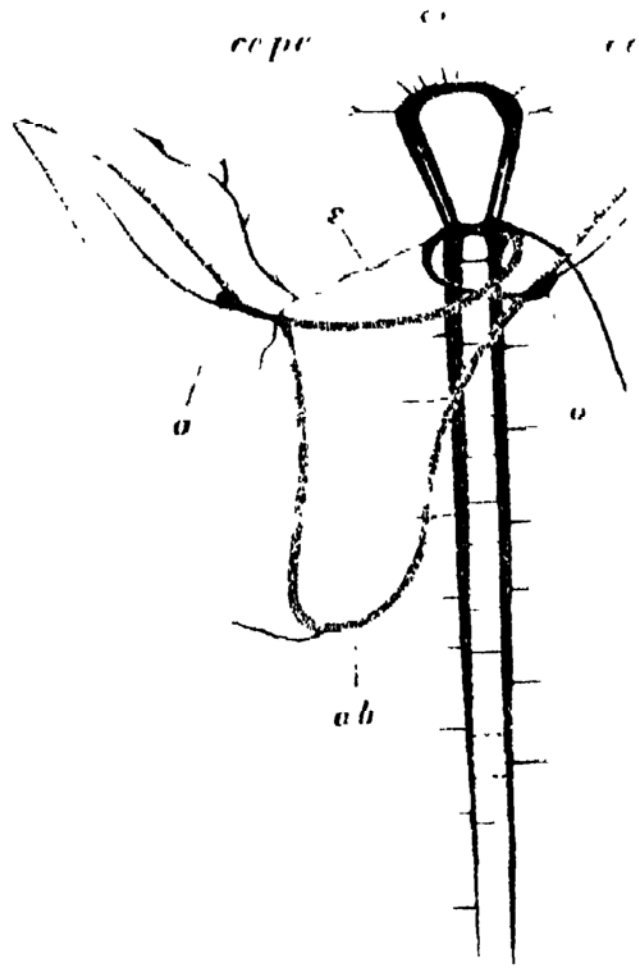


Nervous system of Haliotis, the visceral loop is ligh
the ... ganglia; *cc*, cerebral ganglion; *pl pe*, the
and pedal ganglia; *pe*, the right pedal nerve; *cc pl*, the cerebro
nective; *cc pe*, the cerebro-pedal connective; ..., right and
nerves; *ab*, abdominal ganglion or site of same; ..., right and l
glia and osphradia receiving nerve from visceral loop. (After

section (fig. 31), is, as in other Zygobranchia, a special duct communicating with the exter condition, probably an archaic one, distinguishes t branchia among all Glossophorous Mollusca.

The digestive tract of Patella offers some in features. The odontophore is powerfully develo radular sac is extraordinarily long, lying coiled in

m the mass of the liver and the muscular foot. The has 160 rows of teeth with twelve teeth in each row. airs of salivary ducts, each leading from a salivary open into the buccal chamber. The œsophagus leads remarkable stomach, plaited like the manyplies of a and after this the intestine takes a very large num- turns embedded in the yellow liver, until at last it between the two renal sacs to the anal papilla. A s ridge (spiral? valve) which secretes a slimy cord is upon the inner wall of the intestine. The general ne of the Molluscan intestine has not been suffi- inv stigated to render any comparison of this struc- Patella with that of other Molluscs possible. The the Limpet (28) deserve mention as example of st primitive kind of eye in the Molluscan series. re found one on each cephalic tentacle, and are minute open pits pressions of the ns, the epidermic ining them bene- ated and connected rves (compare fig.

pallial ne and gan- commis- and sub-œsopha ganglion on each side, *E* buccal ganglia, *F*, *F* cerebral ganglia, *f* cerebral commissure, *o*, otocysts attached to the cerebro-pedal connectives. (From Gegenbaur, after Huxley.)

Limpet breeds he southern Eng- a-t in the early April, but its de- ent has not been ed. It has simply ated as far as the ion of a Diblastula acquires a ciliated and becomes a spherical Trocho- It is probable he Limpet takes years to attain owth, and during eriod it frequent- ne spot, which s gradually sunk the surrounding , especially if the carbonate of lime tide the Limpet a strictly inter- organism) is ex- o the air, and is und upon its spot of fixation; but when the water overs it, it (according to trustworthy observers) ts attachment and walks away in search of food e encrusting algæ), and then once more as the tide turns to the identical spot, not an inch in diameter, belongs, as it were, to it. Several million Limpets ve million in Berwickshire alone are annually used ea t coast of Britain as bait

Order 2. **Azygobranchia.**

racters. Streptoneura which, as a sequel to the of the visceral hump, have lost by atrophy the lly left ctenidium and the originally left nephridium, ng the right ctenidium as a comb-like gill plume to nal left of the rectum, and the right nephridium hich is the smaller in the Zygobranchia) also to the left of the rectum, between it and the gill plume. ht olfactory organ only i retained, and may assume n of a comb-like ridge to the actual left of the m or branchial plume. It has been erroneously d as the second gill, and is known as the para a. The rectum itself lies on the animal's right shoulder. The presence of glandular plication of the of the mantle flap (fig. 46, *c*) and an adrectal gland (gland, fig. 47, *gp*) are frequently observed. The se always distinct; a special genital duct (oviduct or duct) unpaired is present, opening either by the side anus or, in the males, on the right side of the neck nexion with a large penis. The shell is usually lar spiral; often an operculum is developed on the upp face of the hinder part of the foot. The dentition lingual ribbon is very varied. In most cases the hump and the foot increase along axes at right an one another, so that the foot is extended far behi visceral hump in the aboral direction, whilst the hump is lofty and spirally twisted.

This is a very large group, and is conveniently into two sections, the Reptantia and the Natantia former, containing the immense majority of the breaks up into three sub-orders, the Holochlamyda monochlamyda, and Siphonochlamyda, characterized presence or absence of a trough-like prolongation margin of the mantle flap, which conducts water respiratory chamber (sub-pallial space where the gil &c., are placed), and notches the mouth of the sh its presence, or again by adaptation to aerial tion. The sub-orders are divided into groups accor the characters of the lingual dentition. In some branchia the mouth is placed at the end of a more elongated snout or rostrum which is not capable of version (Rotifera), in the others (Proboscidifer rostrum is partly invaginated and is often of great It is only everted when the animal is feeding, and i drawn (introverted) by the action of special muscl over-worked term "proboscis" is applied to the re form of snout. The term "introversible snout," or "introvert," would be preferable. The presence or a of this arrangement does not seem to furnish so na division of the Reptant Azygobranchia as that affor the characters of the mantle skirt.

Section *a.* — *REPTANTIA.*

Characters. — Azygobranchia adapted to a creeping life; to wholly or only the mesopodium in the form of a creeping d

Sub-order 1. — *Holochlamyda.*

Characters. — Reptant Azygobranchia with a simple margi mantle skirt, and, accordingly, the lip of the shell unn mostly Rostrifera (*i.e.*, with a non-introversible snout), an tarian, marine, brackish, fresh-water, terrestrial.

a. Rhipidoglossa (x.4 to 7.1.4 to 7.x).

Family 1. *Trochidæ.*
Genera: *Turbo*, Lam.; *Phasianella*, Lam.; *Imperator*, *Trochus*, Lin.; *Rotella*, Lam.; *Euomphalus*, Low.

Family 2. *Neritidæ.*
Genera: *Nerita*, L.; *Neritina*, Lam.; *Pileolus*, Low; *Ne* Lam.

Family 3. *Pleurotomariidæ.*
Genera: *Pleurotomaria*, Defr.; *Anatomus*, Montf.; *S* Helbing

β. Ptenoglossa (x 0.x).

Family 4. *Scalaridæ*
Genus: *Scalaria*, Lam

Family 5. *Janthinidæ*
Genera: *Janthina*, Lam. (fig. 44); *Recluzia*, Petit.

γ. Taenioglossa (3.1.3).

Family 6. *Cerithidæ.*
Genera: *Cerithium*, Brug.; *Potamides*, Brong.; *Nerinæa*

Family 7. *Melaniidæ.*
Genera: *Melania*, Lam.; *Melanopsis*, Fér.; *Ancylotus*, L

Family 8. *Pyramidellidæ.*
Genera: *Pyramidella*, Lam.; *Stylina*, Flem.; *Actis*, Lov

Family 9. *Turritellidæ.*
Genera: *Turritella*, Lam.; *Cæcum*, Flem.; *Vermetus*, *Siliquaria*, Brug.

Family 10. *Xenophoridæ.*
Genus: *Phorus*, Montf. (fig. 39).

ULAR VIEW OF THE SUBDIVISIONS OF THE CLASS GASTROPODA, ARRANGED SO AS TO SHOW THEIR SUPPOSED GENE
RELATIONSHIPS.

Class.—GASTROPODA.
(*Archisopleurum.*)

s 1.— ISOPLEURA.

Sub-class 2. ANISOPLEURA.
(*Archæothyneurum.*)

Branch *a* - STREPTONEURA
(*Archæzygobranchiate Grade.*)

Branch *b* - EUTHYNEURA.
(*Archæopathobranchiate Grade.*)

Order 1.—ZYGOBRANCHIA

Order 2. AZYGOBRANCHIA
(*Archibolochlamydata.*)

Order 1.—OPISTHOBRANCHIA
(*Archæpallata.*)

Order 2. - PULMO
(*Archibasommata*

Sect. *a*
Ieptæna.

Sect. *b*
Natantia

Sect. *a*
Pallidæ

Sect. *b*
Non Pallidæ.

(Sub-order 1.—*Pectinibranchiata.*

" 2.—*Phyllidiadermatidæ.*

" 1.—*Heteropoda.*

" 2.—*Pteropoda.*

" 1.—*Tectibranchiata.*

" 2.—*Inferobranchiata.*

" 1.—*Nudibranchiata.*

" 2.—*Scutibranchiata.*

" 3.—*Cyclobranchiata.*

" 4.—*Pleurobranchidæ.*

11.— *Naticidæ.*
a: *Natica*, Lam.; *Sigaretus*, Lam; *Neritopsis*, Gratel.
12.—*Entoconchidæ.*
ngle genus and species *Entoconcha mirabilis*, discovered by . Muller in 1851, parasitic in *Synapta digitata* The adult a is not known.
13.— *Marsenidæ.*
a: *Marsenia*, Leach; *Onchidiopsis*, Beck
14.—*Acmæidæ.*
a: *Acmæa*, Eschsch.; *Lottia*, Gr.; (probably these will be nd to belong to the Zygobranchia).
15.—*Capulidæ.*
a: *Capulus*, Montf.; *Calyptræa*, Lam (fig. 40); *Trochita*, um.
16.—*Littorinidæ.*
a: *Littorina* (the Periwinkles, fig. 46); *Modulus*, Gray; una, Turt.; *Rissoa*, Frem.; *Hydrobia*, Hartm; *Assiminea*, ch.
17.—*Paludinidæ.*
a: *Paludina* (River-Snail) (figs. 7, 21); *Bithynia*, Gray; alia, Gray.
18.— *Valvatidæ.*
: *Valvata* (fig. 15), fresh-water.
19.—*Ampullaridæ*
: *Ampullaria* (can breathe air by means of the walls of pallial chamber as well as water by the gill, fresh-water tropical America, Africa, and East Indies).

Sub-order 2.— *Pneumonochlamyda*

cters.— Pallial chamber a lung sac; no gill; mouth on a not a retractile proboscis; terrestrial habit

20. *Cyclostomidæ.*
a: *Cyclostoma*, Lam.; *Cyclophorus*, Montf.; *Ferussina*, tel.; *Pupina*, Vignard.
21.—*Helicinidæ* (radula rhipidoglossate rather than tæno ssate).
a: *Stoastoma*, Adams; *Trochatella*, Swains.; *Helicina*, n.; *Proserpina*, Guild.
22.—*Aciculidæ.*
a: *Acicula*, Hartm.; *Geomelania*, Pfr.

Sub-order 3. *Stylommatophora*

Characters. Reptant Azygobranchs with the margin mantle drawn out to form a trough-like siphon which noto hip of the shell, shell always spiral usually an operculum, or limaciform, either a retractile proboscis, excl marine, mostly carnivorous.

Taxoglossa.

Family 1. *Stromb*
Genera *Strombus* L.; *Pter* Lam., *Rostellaria*,

Family 2. *Imperiidæ*
Genus: *Aporrhais*, Da Costa
Family 3. *Pedicularidæ*
Genus: *Pedicularia*, Swains
Family 4. *Ianthidæ*
Genera: *Cassis*, Lam., *Cassidaria*, Lam; *Ianthina*, Lam; Swains
Family 5. *Tritonidæ*
Genera: *Tritonium*, Cuv. (fig. 12), *Ranella*, Lam
Family 6.—*Cypræidæ* (the Cowries)
Genera: *Cypræa*, L., *Ovula*, Brug. (fig. 41); *Erato*, Ri

Toxoglossa (1.0.1)

Family 7. - *Conidæ*
Genus: *Conus*, L.
Family 8. *Terebridæ*
Genus: *Terebra*, Adams.
Family 9. *Pleurotomidæ*
Genus: *Pleurotoma*, Lam.
Family 10. *Canaliculidæ.*
Genus: *Cancellaria*, Lam.

Rachiglossa (1.1.1 or .1.)

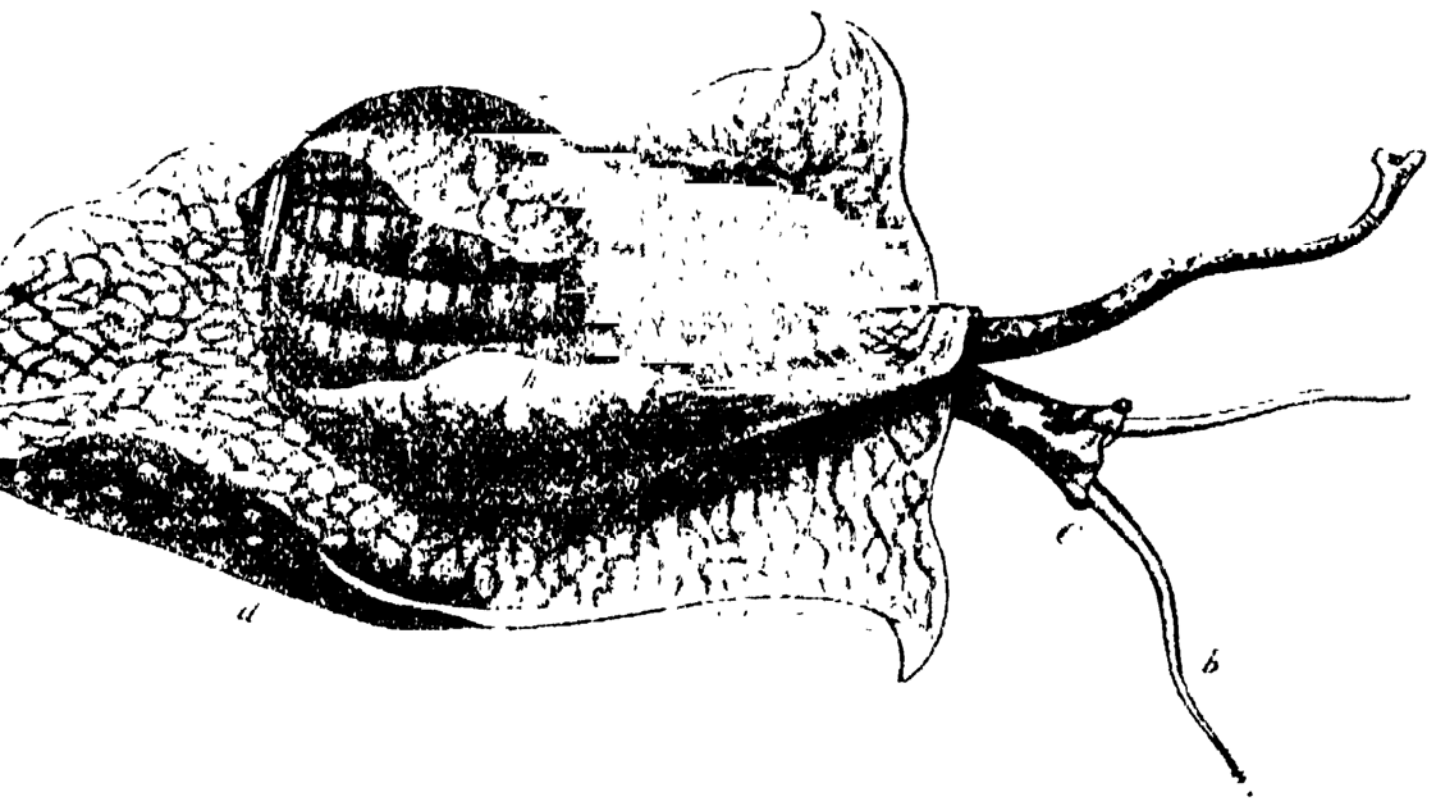
Family 11. *Muricidæ.*
Genera: *Murex*, L. *Typhon*, Montf., *Ricin*, Lam. (fig. 38), *Turbinella*, Lam
Family 12. *Buccinidæ*
Genera: *Buccinum*, L.; *Nassa*, Lam (fig. 5), *Purpura*, (fig. 17); *Concholepas*, Lam; *Magilus*, Montf.
Family 13. *Mitridæ*
Genus: *Mitra*, Lam.

14. *Olividæ*
Oliva, Brug.; *Ancilla*, Lam.; *Harpa*, Lam.
15.—*Volutidæ*
Voluta, L.; *Cymbium*, Montf.; *Marginella*, Lam.; *Mitra*, Lam.

Further Remarks on the Peplant Azygobranchia. The large assemblage of forms coming under this order are the most highly developed predaceous sea snails, many vegetarian species, a considerable number of

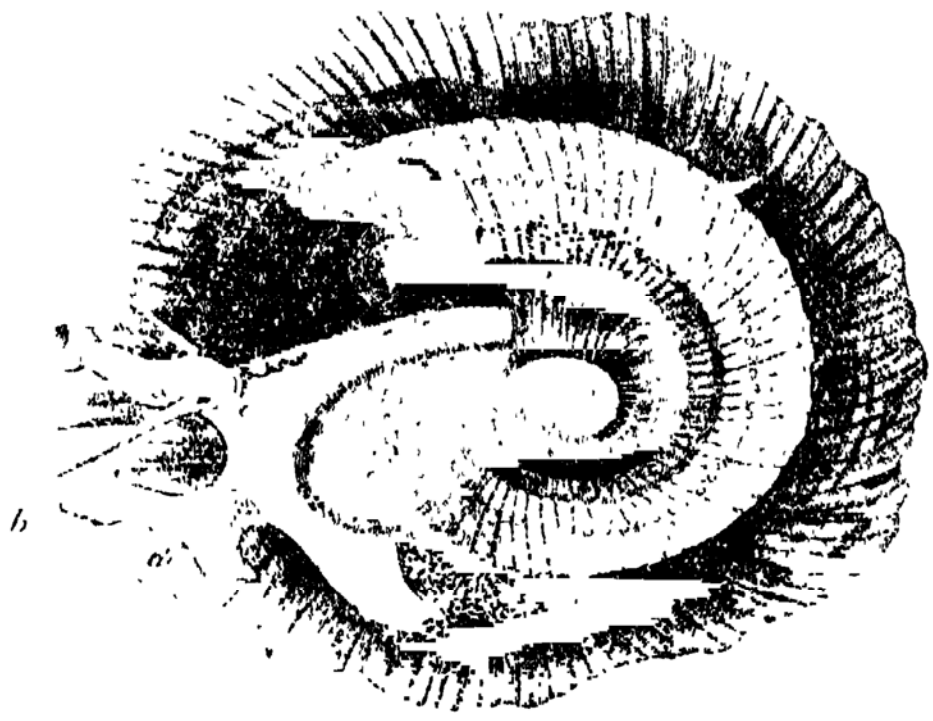
[illegible] Animal and shell of *Littorina*. [illegible] *a*, head, the letter placed on the side of the foot [illegible] (from Owen

water and some terrestrial forms. The partial dissection of a male specimen of the Common Periwinkle, *Littorina littorea*, drawn in fig. 16, will serve to exhibit the position of viscera which prevails in the group.



Animal and shell of *Lacuna*. [illegible] *a*, head, the letter placed on the side of the foot [illegible] (from Owen

branchial chamber formed by the mantle. But over the head has been exposed by cutting along a line backward from the letters *ol* to the back of the column *lc*, *cc*, and the whole roof of the chamber reflected from the right side of the animal's back has been thrown over to the left, showing the organs which lie on that side. No specimen in the body-cavity has been the ovary, which lies in the coiled visceral hump beneath its transparent walls. The head is seen resting on the foot and carrying a median non-retractile proboscis and a pair of cephalic tentacles, at the base of each of which is an eye. In many Gastropoda the eye is not thus sessile, but is borne on a pedicel or peduncle (fig. 69). To the right of the head is seen the auricular aperture, close to the termination of the vas deferens (*spd*, *ol*). The testis *t* occupies a median position in the dorsal visceral [illegible]. Behind the penis on the same side is the hooklike columella muscle, a development of the



Animal and shell of *Thais scalaris*. *a*, snout (not introversible); *c*, [illegible] *ctn*, right eye; *d*, pro and meso-podium, to the right [illegible] on the metapodium bearing the sculptured operculum.

Of the organs lying on the reflected mantle-skirt, that which in the natural state lay nearest to the vas deferens on the right side of the median line on the roof of the branchial chamber is the rectum *r*, ending in the anus *a*. It can be traced back to the intestine *i* near the surface of the visceral hump, and it is found that the apex of the coil formed by the hump is occupied by the liver *h* and the stomach *s*. The pharynx and œsophagus are concealed in the head. The enlarged glandular structure of the wall of the rectum is frequent in the Azygobranchia, as is also though not universally the gland marked *g*, next to the rectum. It is the adrectal gland, and in the genera Murex and Purpura secretes a colourless liquid which turns purple upon exposure to the atmosphere, and was used by the

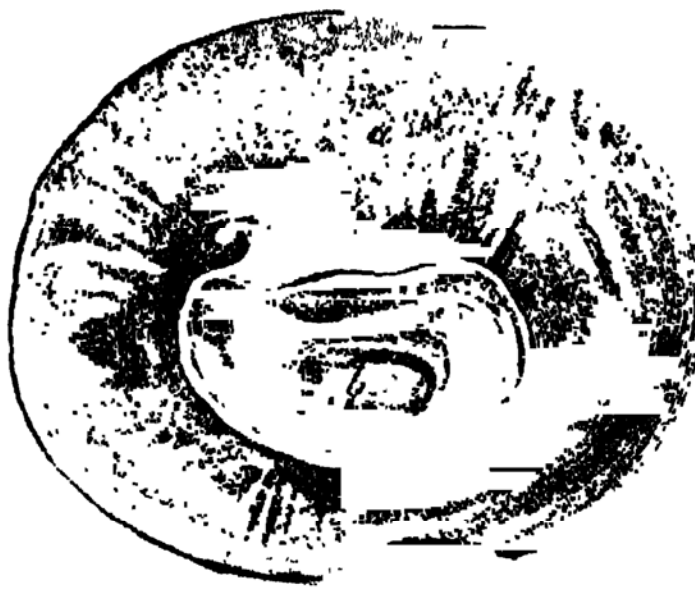


Fig. 40.—Shell of Calyptræa, seen from below so to show the inner whorl *b*, concealed by the c like outer whorl *a*.

ancients as a dye. Near this, and less advanced into the branchial chamber, is the [illegible] renal organ or nephridium *n*, with its opening to the exterior *e*. Internally the glandular sac presents a second slit or aperture which leads into the pericardium (as is now found to be the case in all Mollusca). The heart lying in the pericardium is seen in close proximity

al organ, and consists of a single auricle receiving rom the gill, and of a single ventricle which pumps ugh the body by an anterior and posterior aorta 105). The *x* of the between the and the gill- is thrown olds which y sea-snails s, &c.) are rongly deve- The whole surface ap o be active secretion of a mucous like substance The an- ne *br* lies to the left of the median line in natural . It corresponds to the the two primitive cten the untwisted archaic n of the Molluscan body, s not project freely into nchial cavity, but its attached (by concres- to the mantle-skirt (roof branchial chamber). It for the gill plume of an eurous Gastropod to ut freely as a plume. asionally this more ar ndition is exhibited, as ata (fig. 45) Next be- o the left of) the gill e find the so-called para a, which is here simple, metimes lamellated as in (fig. 47). This organ thout reason, been sup- o represent the second m of the typical Mollusc, t cannot do on account osition. It should be right of the anus were case. Recently Spengel own that the parabran- Gastropods is the typical y organ or osphradium ghly-developed condition The minute structure epithelium which clothes it, as well as the organ of

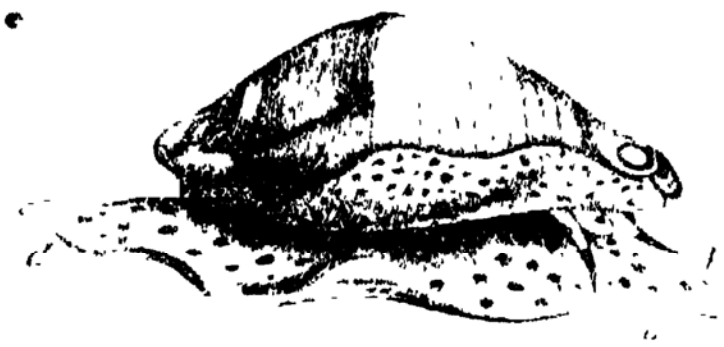


Fig. 41. Animal and shell of [illegible] with [illegible] tentacles; *d*, foot; *h*, [illegible] partially carried in a reflected [illegible] cover in the sides of the shell.

Fig. 42. [illegible] phonal notch of the mouth of the shell, [illegible] the whole of the shell, [illegible] exposed by the section [illegible] Cephalopoda or Univalves. The upper whorl of the shell [illegible] to be divided [illegible] for the formation of [illegible] (from Owen.)

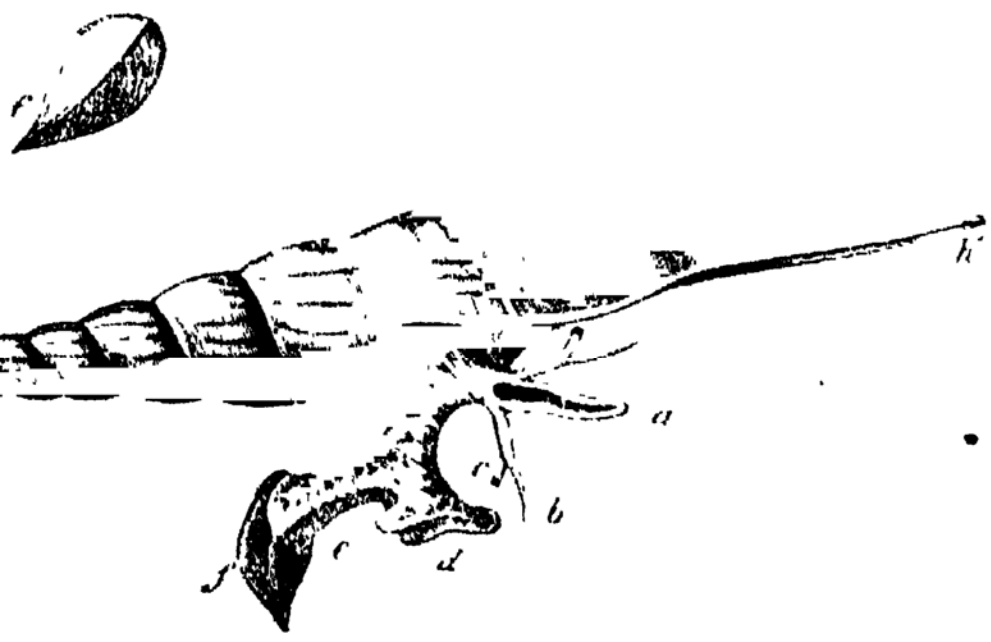
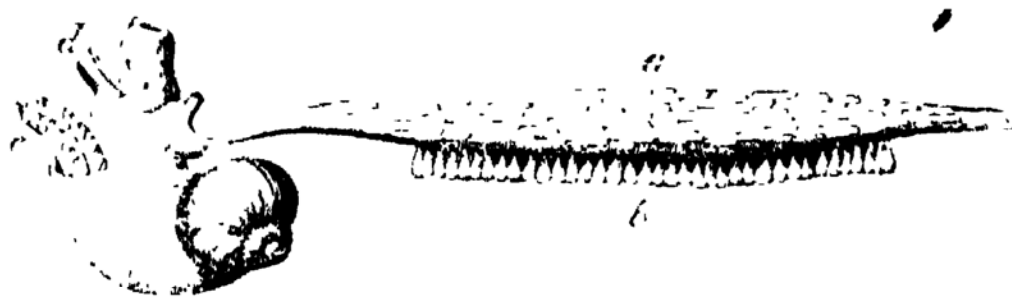


Fig. 43.—Animal and shell of *Rostellaria rectirostris*. *a*, [illegible] tentacle; *e*, eye; *d*, propodium; [illegible] operculum; *h'*, prolonged siphonal notch of the shell occupied by the [illegible] or trough-like process of the mantle skirt. (From Owen.)

ve which is distributed to the parabranchia, proves the same organ which is found universally in Mol

luses at the base of each gill-plume, and tests the ind current of water by the sense of smell. The nerve to



[illegible] (original right [illegible] of various A

[illegible] tion of [illegible] pedal, or cerebr

Fig. 46. Mass of [illegible] [illegible] Note the [illegible]

(fig. 139) visceral ganglion

The tenioglossate which are [illegible] branchia are in no [illegible] ently explained by the [illegible] ence attached to [illegible] A an excellent general type of the nervous system, attention may be directed to that of Paludina drawn in fig. 21. On the whole, the ganglia are [illegible] decided in the Azygobranchia, nerve cell tissue being concentrated in the ganglia and absent from the cords (contrast with Zygobranchia and Lipobranchia). At the same time, the junction of the visceral loop above the intestine prevents in all Streptoneura the shortening of the visceral loop, and it is rare to find a fusion of ganglia with either pleural, pedal, or cerebral, which can and does take place where the visceral loop is not above but below the intestine, *e.g.* in the Euthyneura (fig. 67), Cephalopoda (fig. [illegible]), and Lamellibranchia (fig. [illegible]). As contrasted with the Zygobranchia and the Lipobranchia, we find that in the Azygobranchia the pedal nerves are distinctly nerve-cords apart from the pedal ganglia, rather than cord-like nerve tracts containing both nerve cells and nerve fibres. Yet in some Azygobranchia (such as Chiton) the [illegible] of the two [illegible] nerve-cords. The [illegible] branchia has been detected (30). The histology of the nervous system of Mollusca has yet to be carefully inquired into.

The alimentary canal of the Azygobranchia [illegible] little diversity of character, except in so far as the [illegible] region is concerned. Salivary glands are present, and some carnivorous forms (Dolium) the [illegible] secrete [illegible]

…e acid (… noted … two per cent is present in the …tion), which … its the animal in boring holes by … of it … to prog tongue through the shells of other …ves …mon which it prey… A crop-like dilatation of …t and … convoluted intestine, embedded in the com… …Boas … brown liver, the duct of which open into it, … the rest of the digestive tract and occupy a large … of the … dorsal hump. The buccal … … present … … of fleshy jaws placed laterally upon the lips, and a … … of variation in the form of the denticles of the … …, the nature of which will be … … to … …, whilst the … remarkable … … how the particular form of den… … characteristic … … production … … ventral plicæ, … … tion of … pro… … no tubicolous … … further note … … ually pedicellate … … appears to be … … nchition of … … the mouth … … that … … ; but the … … cause of the … … to … … the … … ; but … … the … … ; but … … the … … ; but

which is also the condition presented by the mouth
region in nearly all other Gastropoda. One of the
amples of the introversible mouth-cylinder or pr
which can be found is that of the Common Whelk
immediate allies. In fig. 37 the proboscis is seen
everted state; it is only so carried when feeding,
withdrawn when the animal is at rest. Probably
is to enable the animal to introduce its rasping
king apparatus into very narrow apertures for the
of feeding, *e.g.*, into a small hole bored in the bod
her Mollusc
foot of the Azygobranchia, unlike the simple con
ise of the Isopleura and Zygobranchia often
into lobes, a fore, middle, and hind lobe epip
and meta podium, see figs. 39 and 140. Very usually
universally, the meta podium carries an operculum.
sion of the foot into lobes is a simple case of the
reater elaboration or breaking up into processes and
which it undergoes in the class Cephalopoda. Even
some Gastropoda (viz., the Opisthobranchia) we
e lobation of the foot still further carried [illegible]
ly Azygobranchia, on the other hand, in which the
s a simple oblong form without any trace of lobe
development of the Azygobranchia from the
llowed in several examples, *e.g.*, Paludina, Fissurella,
Vermetus, Neritina. Another Mollusc [illegible]
a wide variation in the early processes of the forma
the first embryonic cells, and their arrangement
stula dependent on the [illegible] of
lk which is present in the egg-cell when it enters
its embryonic changes. In fig. 7, the egg's [illegible]
ulana riuipara are represented. There is little
the food material in the egg of the Azygobranch
nsequently the Diblastula forms by invagination
stopore or orifice of invagination with the
nd never closes entirely. A well-marked Trochosphere
is formed by the development of an equatorial
band, and subsequently, by the disproportionate
of the lower hemisphere, the Trochosphere becomes
ger. The primitive shell-sac or shell-gland is well
l at this stage, and the pharynx is [illegible] a new
th (the stomodæum, about to fuse with and open
e primitively invaginated archenteron (fig. 7 F).
ther Azygobranchs (and such variation is repre
ve for all Mollusca, and not characteristic only of
branchia), we find that there is a very unequal
n of the egg-cell at the commencement of embryonic
oment, as in Nassa (fig. 5). Consequently there is
speaking no invagination (emboly), but an overg
(epiboly) of the smaller cells to enclose the larger
neral features of this process and of the relation of
astopore to mouth and anus have been explained
n treating of the development of Mollusca generally
n cases the blastopore may entirely close and both
and anus develop as new outgrowths (stomodæum
ectodæum), whilst, according to the observations of
zky, the closed blastopore may coincide in position
e mouth in some instances (Nassa, &c.), instead of
e anus. But in these epibolic forms, just as in the
e Paludina, the embryo proceeds to develop its [illegible]
nd and shell-gland, passing through the earlier con
of a Trochosphere to that of the Veliger. In the
stage many Azygobranchia (Purpura, Nassa, &c.)
, in the dorsal region behind the head, a contractile
f the body wall. This acts as a larval heart, but
to pulsate after a time. Similar rhythmically con
e areas are found on the foot of the embryo Pulmo
Limax and on the yolk-sac (distended foot-surface)
Cephalopod Loligo (see fig. 72**).

The history of the shell in the development of
branchia (and other Gastropods) is important
the primitive shell-sac aborts and gives place to a
or boat-like shell, so in some cases (Marsenia, Kro
this first shell has been observed to be shed, and a second
of different shape is formed beneath it.

A detailed treatment of what is known of the
connexion in relation to the cell-layers in the Mollusca
takes us far beyond the limits of the article which
exposing only the well-ascertained characters in
of the Mollusca and the various [illegible]
will suffice to give an accurate knowledge of the d
ment of the Gastropoda, a type for all characters of
The development of the cell (or cells) of the [illegible]
renal organs, and derivatives of the primitive
genital [illegible] are still quite imperfectly known.

One [illegible] of the development of the Azy
[illegible] mentioned. Many Gastropoda
the egg [illegible] [illegible], enclosed in a capsule of
Paludina or Vivipara, others, such as the Zygobra
[illegible] with the Lamellibranchia, [illegible]
[illegible] for the development without [illegible]
and therefore [illegible] the [illegible]
freely in the [illegible]
[illegible] enclosed [illegible]
eggs capable [illegible] they are often
tough [illegible] [illegible]
[illegible] develop, [illegible]
[illegible], or a small portion [illegible]
[illegible] development the [illegible]
[illegible] of cell-division [illegible]
The [illegible] embryo [illegible]
direct [illegible] the [illegible]
[illegible] study, [illegible]
[illegible] of Korotneff and [illegible]
In any case [illegible]
of the formation of a [illegible]
primitive ovary [illegible]
the absorption of [illegible]
the period at which the [illegible]
takes place [illegible]
the [illegible] of [illegible]
of others in the [illegible]

[illegible]
[illegible]
[illegible]

…p; upon the upper surface of the metapodium is developed an …culum.

…nera: *Pneuda*, *Organtrus* … Probably here belong the Palæozoic fossils *Bellerophon*.

Sub-order 2 *Carinariacea*

Characters Visceral hump greatly reduced in relative size; … small cap-like, [illegible] …ubium; cerebral plum… …ts from the wall of … cavity; body exter… … of … tentacles only … metapodium prominent, … ended with a sucker, and … of literally … to … a vertical plane … …ctures from the ventral … the propodium bou… …ly the ventral surface of … anterior portion of the … …eal body, with its … …dium … … of pedal …

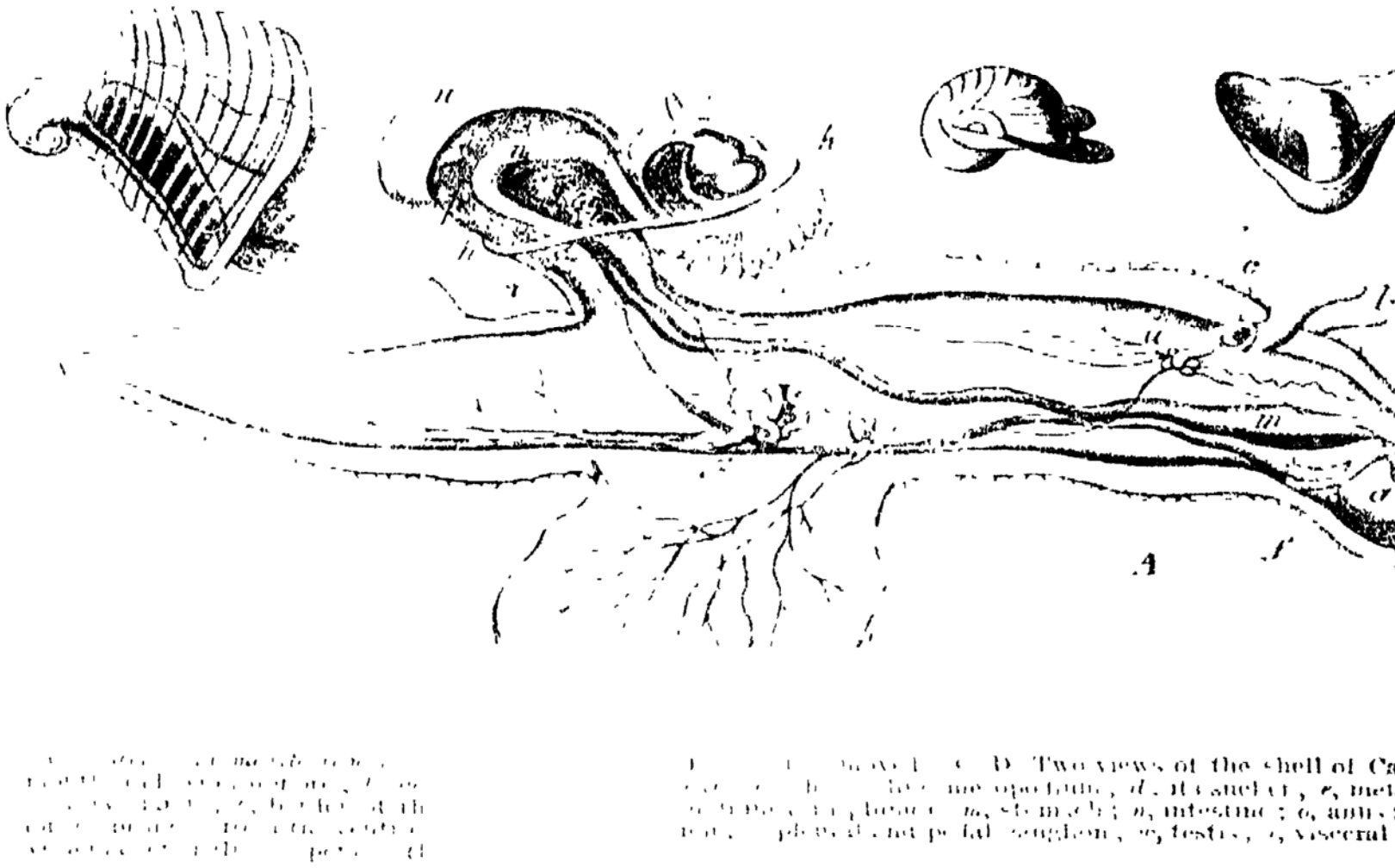
…order … *Pterotracheacea* … *Characters* Visceral hump … further reduced, becom… …e oval sac embedded … …osterior dorsal region of … shell; … … … the … …ence … … the … absent from … …ed animal with long …

Further Remarks on the … Natantia

…erally the Natantia should stand as we have placed them, … as a special branch or section of the Nucleobranchia, …ed to them somewhat as the Birds to the Reptil… …are true Nucleobranchia which have … into a pelagic … and the peculiarities of structure which they exhibit …

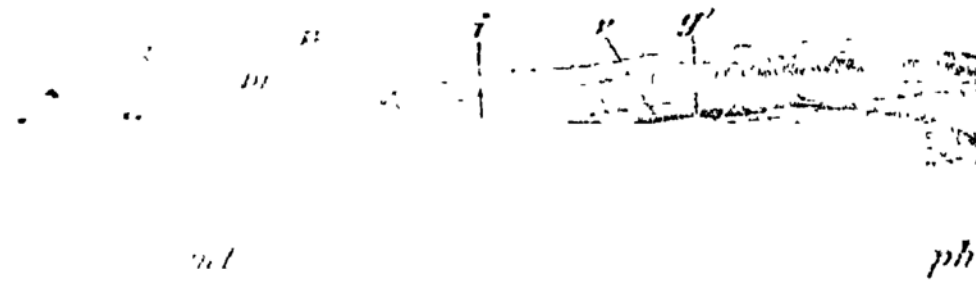
…tricly adhering … …ctures common to them … the Nucleobranchia … upon their changed … of life. Such modi… …lessness of the … which still show … …dibranchia (compare … 79 and fig. 299).

…e cylindrical body of Pterotracheacea paralleled by …ng-like forms of Euthyneura. Spengel has shown that



…A, B. Two views of the shell of Ca… …, *b*, spiral spectrum, *d*, its nucleus, *e*, met… …; *m*, stomach; *n*, intestine; *o*, anus; … pleural and pedal ganglion, *w*, testis, *z*, visceral …

…the visceral loop of the Natantia is Streptoneurous. … to the Natantia is the high elaboration of the … ribbon, and, as an agreement with some of the … branchiate Euthyneura but as a difference from the … branchia, we find the otocysts closely attached to the … ganglia. This is, however, less of a difference than … at one time supposed to be, for it has been shown by … Dutheil, and also by Leydig, that the otocysts of … branchia even when lying close upon the pedal g… (as in fig. 234) yet receive their special nerve (wh… …ven … readily isolated) from the cerebral gangl… (fig. 361). Accordingly the difference is one of position … otocyst and not of its nerve-supply. The Natantia are … remarkable for the high development of their cephal… … and for the typical character of their osphradium (Sp… olfactory organ). This is a groove, the edges of wh… …ised and ciliated, lying near the branchial pl… … the ctenidium which possesses that organ, whilst in Fir… … which has no branchial plume, the osphradium occ… …corresponding position. Beneath the ciliated gro…



…*al* *ph*

…ventral view from the right side. *a*, pouch for … …ciliated; *c*, pericardium; *ph*, pharynx; *or*, ceph… … cerebro-pedal ganglion; *pr*, foot (mesopod… … so-called nucleus; *br*, branchial plume (cte… … (osphradium); *z*, caudal appendage. (Af… …)

…pleural or olfactorial ganglion (olfactory ganglion) con… … to the supra-intestinal (therefore the prim… …dy transposition of the long visceral nerve-loop, the … …which cross one another, this being characteri… Streptoneura (Spengel).

The Natantia belong to the "pelagic fauna" occ… near the surface in the Mediterranean and great oc… company with the Pteropoda, the Siphonophorous Hyd… Salpæ, Leptocephali, and other specially modified … pelagic swimming representatives of various groups … animal kingdom. In development they pass throu… typical trochosphere and veliger stages provided with … like shell

ranch *b.* — *EUTHYNEURA* (Spengel, 1881).

racters. — Gastropoda Anisopleura in which the l loop (the contermmous visceral nerves) does not n the torsion of the visceral hump, but, being sunk y below the body wall, remains straight and un l. Although the anus is not brought so far forward

Bulla ventricosa (Chemnitz), as see thys, fig. 67, B), possibly a continu s. (From Owen.)

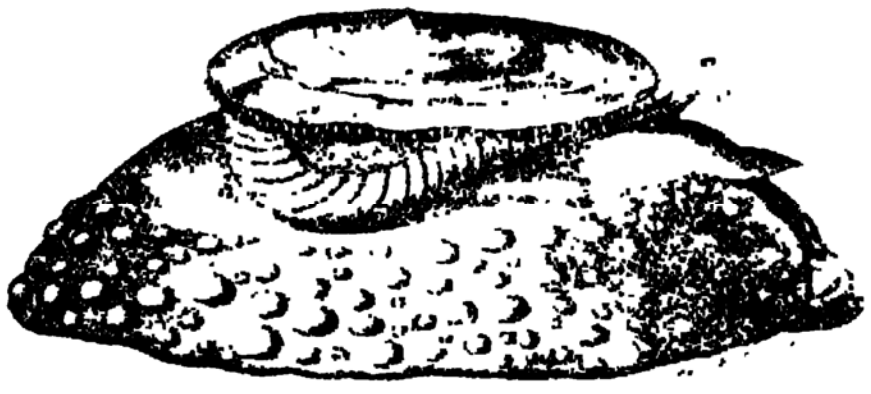
visceral torsion as in the Streptoneura, and may even *dary* growth assume a po-terior median position, yet, y developed, an asymmetry has resulted as in the branchia, only the original right renal organ right ium (if any), right osphradium right auricle of the heart ght genital ducts being retained. All the Euthyneura are hermaphrodite. The lingual ribbon has very numerous fine denticles rentiated into series in ow. The shell is light tle calcified; often it is developed in the adult, present in the embryo. ereulum, often found in lbryo, is never present in ult (except in Tornatella,). Many Euthyneura show a tendency to, or a te accomplishment of, the suppression of the mantle s well as of the shell, also of the etenidium, and at the same time a more or less cylindrical (slug-like) f body.

Fig. 5. — Tornatella. *h*, shell; *a*, mouth; *f*, foot; *o*, operculum.

Euthyneura comprise two orders, the Opisthobranchia and the Pulmonata.

Order 1.—Opisthobranchia

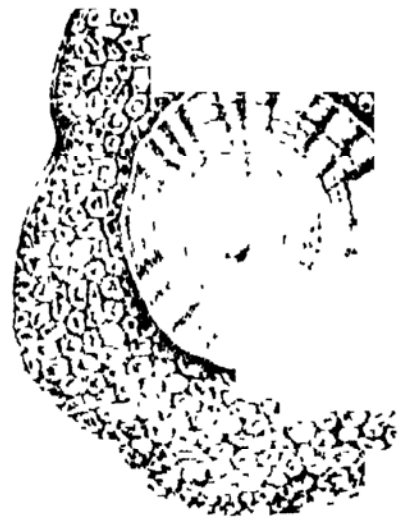
ine Euthyneura the more archaic forms of which relatively large foot and a small visceral hump, the base of which projects on the right side a short e-skirt. The anus is placed in such forms far back



—*Umbrella mediterranea*. *a*, mouth; *b*, [illegible] dium). The free edge of the mantle is seen to ell (compare with Aplysia, fig. 63). (From Ow

d the mantle-skirt. In front of the anus, and only lly covered by the mantle skirt, is the etenidium with o end turned backwards. The heart lies in front of, l of to the side of, the attachment of the etenidium. ee Opisthobranchia as opposed to "Prosobranchia,"

which correspond to the Streptoneura. A shell is pos in the adult state by but few Opisthobranchia, but a through a veliger larval stage with a nautiloid shell (fi



Many Opisthobranchia have by a process of atrophy lost the typical etenidium and the mantle-skirt, and have deve loped other organs in their place. As in some Azygobranchia, the free margin of the mantle-skirt is frequently reflected over the shell when a shell exists, and as in some Azygobranchia, broad lateral outgrowths of the foot (epipodia) are often developed which, as does not occur in Azygobranchia, may be thrown over the shell or naked dorsal surface of the body.

The variety of general development of structure accompanying the atrophy of typical organs and general degeneration of organization renders the classification of this order may be determined Mollusc-can mantle-cavity (branchial shed, and with each section

Section 1. *PHANEROPNEUSTA*. Typical shell or mantle

Sub-order I.

Pa

Family 2. *Ac*
Genus *Ac*
Mont
Mod
Family
Genus *A*
Ac
Family *A*
Genus *A*
Ac

PLEUR

Section 2. *CRYPTOPNEUSTA*. Typical shell or mantle

Sub-order I. *Pteropoda*.

The etenidium and the foramen of the right o are lost the respiratory water-cavity

Pore

ment may occur with a the

Family 6. *Doridida*.

Genera: *Doris*, *Goniodoris*, Forbes; *Tritonia*, Johnston; Leach; *Thecacera*, Fleming; *Polycera*, Cuvier; *Idalia*, Lovén; *Okenia*, Lovén; *Crimonia*, Adams; *Stachelaris*

Sub-order 2. *Ctenobranchia*

Characters.—The typical Mollusean ctenidium is not developed; on the dorsal surface developed a more or less numerous series of lindrical or branched processes, the cuticle of each of which the testine is prolonged into a process, and dorsal, median, or right sided, anally. *Pectinibranchia*

Genera *Fissurella*, Cuvier; *Scalaria*, L.; *Pileopsis*, Lam.; fig. 62, B; *Trochus*, Linn., A and B; *Turbo*, Olen

anch. *Phyllobranchia*

Genera *Aplysia*, Cuvier, fig. 61, A; *Gasteropteron*, Forster; *Pleurobranchus*, A and B; *Umbrella*, Lam.; *Tylodina*, A and B; *Pleurophyllidia*, A and B; *Notarchus*, A and B; *Dendronotus*, Alder; *Doris*, Linn.

Sub-order 3. *Hypobranchia*

Characters.—No ctenidium or gills, but the vascular or other pro the body-wall, degenerate tentacles, or cirri.

Family 1. *Tectibranchiata*

Genera *Phyllirhoe*, Peron and Lesueur, fig. 63, A; *Scyllaea*, Linn.

Family 2. *Pteropoda*

Genera *Limacina*, Rang (fig. 64, B); *Clione*, Pallas; *Cymbulia*, Peron A and B; *Pneumodermon*, Lesueur; *Hyalea*, Rang, &c.

Further Remarks on the Opisthobranchia.—The Opi branchia present the same wide range of superficial ppearance as do the Aspidobranchia. Strongly contrasted

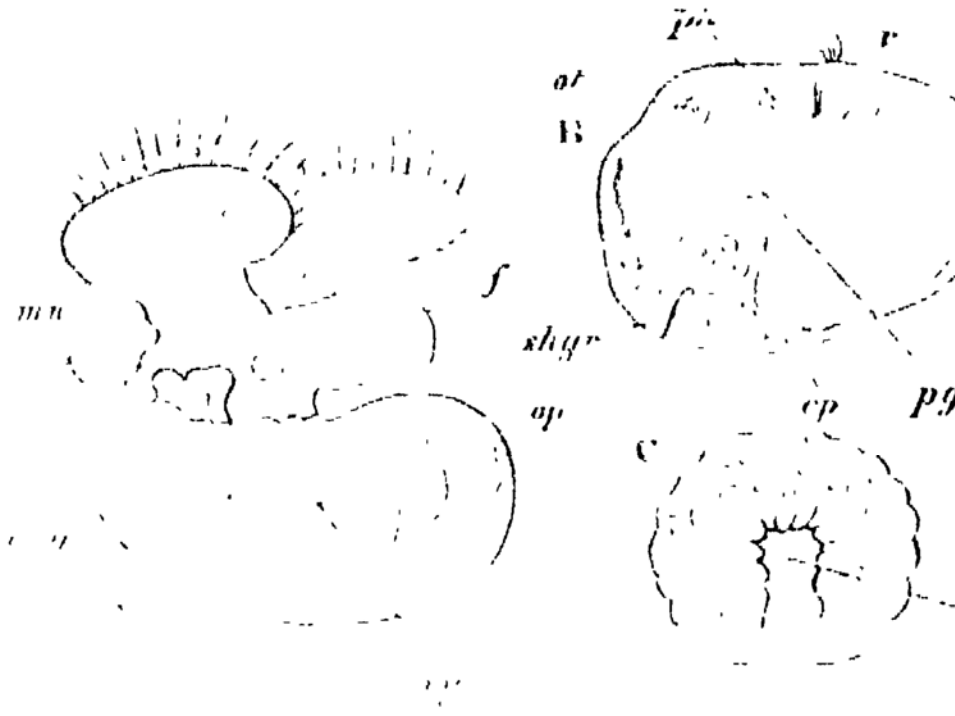
. 62.—Three views of *Aplysia punctata*. A, from the right side; B, from above; C, from in front; in all figures the parapodia are spread out. *ap*, parapodium; *ct*, cephalic tentacles; *m*, mouth; *rt*, rhinophore; *sh*, shell; *sip*, siphon. (After Cuvier.)

rying well-developed spiral shell and large mantle arts being included in the group, together with flattened cylindrical shell form. But in spect of the subdi ision of other part of the mantle. But nd by the diffe ences such e more essential Opi-thobranchia have hell, these Orders and also Opi thobranchs ha rking example of egeneration from aplocheetal, has g none of those re ions or processes of he body developed hich distinguish he archaic Mollusca om such flat worms the Dendrocoel Planarian. Indeed were it not for their

. 63.—A, *Phyllirhoe bucephala*, twice the ; a transparent pseudo-pelagic branch. The internal organs are shown ly transmitted light. *a*, mouth; *b*, radu *c*, œsophagus; *d*, stomach; *e*, intestine; *g*, *g'*, *g''*, the four lobes of the liver pericardium and ventricle); *l*, the renal pneumostome; *o*, the orifice common to ct ductus seminalis and the pore-opening of the ejaculatory sac); *p*, the cerebral ; *q*, the oral tentacles; *s*, the genital ; *v*, the oviducal gland; *w*, the parasitic bival ; *x*, the ganglionic nerve-collar round the œsophagus; *y*, the pedal ganglia. B, *Scyllaea pelagica*, a pelagic Opisthobranch. (After Cuvier.)

. 64.—A, Single row of teeth of the radula of *Limax* (Pulmonata). B, Single row of teeth of the radula of *Limacina* (Pteropoda). (After Lankester.)

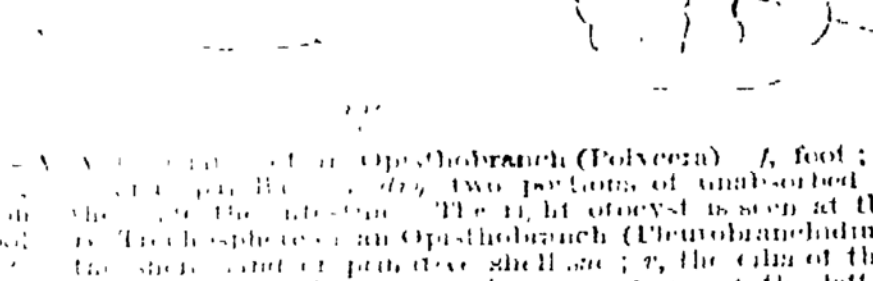
ntact of the animal. Such epipodia are common, by no means universal, among Opisthobranchia tion of the visceral hump is not carried out very



. 65.—A, Ventral view of an Opisthobranch (Polycera). *b*, foot; *op*, operculum; *pg*, dorsal tubercles; *shgr*, two portions of unabsorbed ; *mn*, the mantle. The left otocyst is seen at th Otocyst of Trochosphæra, an Opisthobranch (Pleurobranchidiu *sh*, the shell-gland or primitive shell-sac; *v*, the velum of th *pr*, the prostomium; *st*, stomodæum or oral invagination; *ot*, the left ; *tn*, tentacle-like processes; *ft*, flagellum. Diplacula of an Opisthobranc *cerat*, with calcareous spicules. (All from Lankester.)

Linapontia really belong to the Mollusca at all. The esting little *Rhalope Veranyi*, which has no odonto has been associated by systematists both with these s fied Opisthobranchs and with Rhabdoc el Planarians.

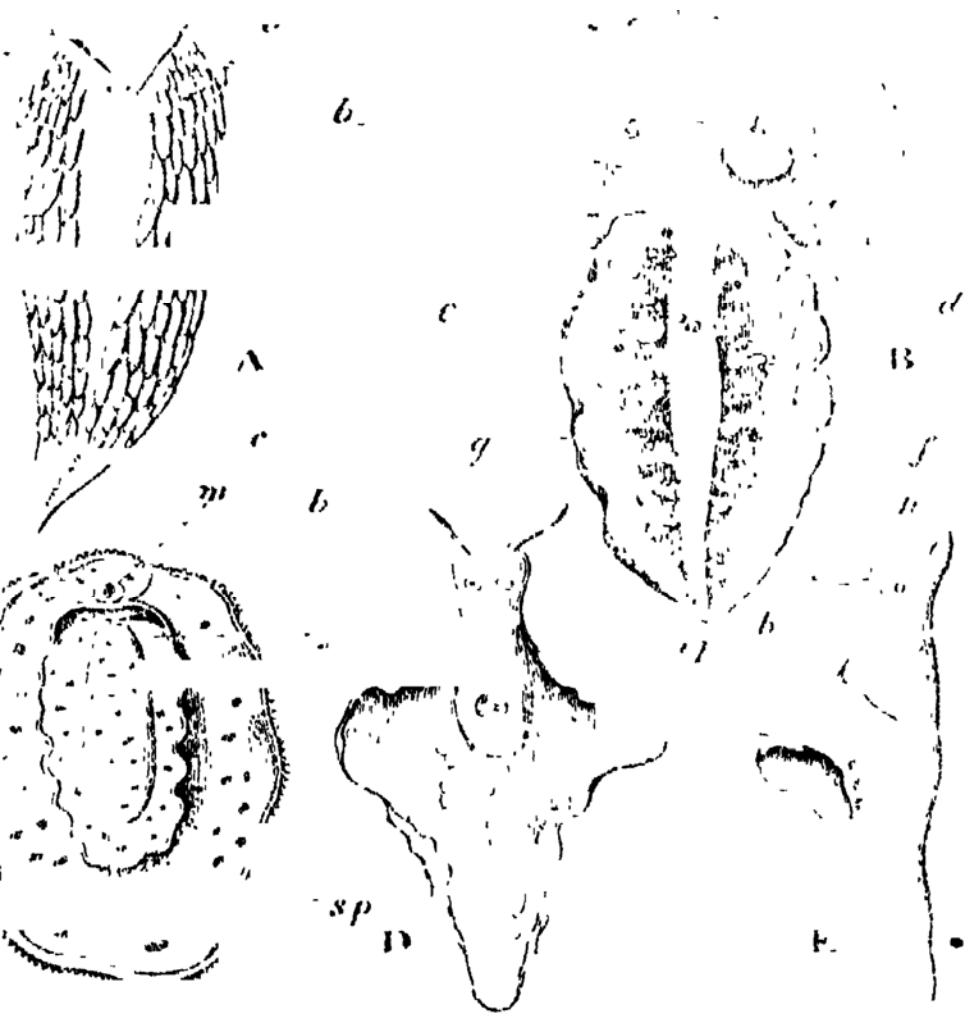
In many respects the Sea Hare (Aply ia) of which several pecies are known (some occurring on the Englis coast), erves as a convenient example of the ighest attainment of the following characteristics of Opisthobranchia. The woodcut (fig. 66) ves a rabbit's-eye view of the mobility of the cate ct part of the body. The head is well marked and joined to the body by a short constricted neck. It carries two pairs of co tentacles and a pair of sessile eyes. The visceral hu low and not drawn out into a spire. The foot is carries the oblong visceral mass upon it, and pro es a metapodium a little beyond it (*f*). Lateral foot gives rise to a pair of mobile fleshy lobes, the ep ges, which can be thrown up so as to cover in the



. 66.—Rabbit's-eye view of *Aplysia*. *ep*, epipodia; *t*, tentacles; *r*, rhinophores.

urface of the animal. Such epipodia are common, by no means universal, among Opisthobranchia tion of the visceral hump is not carried out very the consequence being that the anus has a posteric tion a little to the right of the median line abo metapodium, whilst the branchial chamber formed overhanging mantle-skirt faces the right side of th instead of lying well to the front as in Streptoneu as in Pulmonate Euthyneura. The gill-plume wh Aplysia is the typical Mollusean ctenidium is seen

jecting from the branchial sub pallial space. The
n of the delicate shell to the mantle is peculiar,
t occupies an oval area upon the visceral hump,
ent of which is indicated in fig.
but may be better understood
ance at the figures of the allied
Umbrella (figs. 54, 55), in which
argin of the mantle-skirt coin
just as it does in the Limpet,
e margin of the shell. But in
the mantle is reflected over
ge of the shell, and grows over
er surface so as to completely
it, excepting at the small cir
es where the naked shell re-
l. This enclosure of the shell
ermanent development of the
ment seen in many Steptoneura (*e.g.*, Pyrula, Ovulum, see fig.
41), where the border of the
can be, and usually is, drawn
e shell, though it is withdrawn
annot be in Aplysia when the
ntacted. From the fact that
commences its life as a free
ng Veliger with a mantle-lobe
ot enclosed in any way by fo
of the mantle, it is clear that
losure of the shell in the adult
condary process. Accordingly
ell of Aplysia must not be con
d with a primitive shell in it
e, such as we find realized in
lls of Chiton and in the plug
form in the remarkable tran
"shell-sac" or "shell-gland" of Mollusc embryos



s papillosa (Linn.), dorsal view. *a*, *b*, posterior and anterior te
Tentacles; *c*, the dorsal "cerata" (hence Cerebrobranchiata)
hys leporina, dorsal view. *a*, the cephalic head, *b* cephalic tent
c, neck; *d*, genital pore; *e*, anus; *f*, large cerata; *g*, smaller c
h, margin of the foot
ra (*Aclanocalus*) *tuberculata* (Cuv.) seen from the pedal surfa
mouth; *b*, margin of the head; *f*, sole of the foot; *sp*, the mesop
epipodium.
Dorsal and lateral view of *Elysia* (*Tethys*) *viridis*. *m*, epipodial
growths. (After Ketelaar.)

gs. 7, 68, and 72***). Aplysia, like other Mollusca,

develops a primitive shell-sac in its trochosphere st
development (fig. 68), which disappears and is suc
by a nautiloid shell (fig. 60). This forms the nuc
the adult shell,
and, as the ani
mal grows, be
comes enclosed
by a reflexion of
the mantle-skirt
In reference to
the possible com
parison of th
enclosed shell of
Aplysia and it
allies with those
of some Slugs and
of Cuttle-fish
the reader is re
ferred to the pre
ceding chapter
especially with
those Mollusc
Where the shell
of the Aplysia
well to the ba
the sub-pallial
pocket fully ex
posed as in fr
ms and the vari
ous apertures of
the body are seen
Posteriorly we
have the anus, to front of this the lobate gill; thi
tween the two there opens a pocket-like
the Aplysia much as we have the aperture of the
organ. In front, near the anterior attachment of t
plume, is the cephalaspic collection of calcareous
spangled, yellowish in colour, in
the typical position and overly
ing an otocyst connected with
visceral nerve-ganglion (see fig.
20). To the right is a sperma
ceph-duct or the opening of
prostate gland which lies when
dissected out, the form of a lobed
of grains of calcareous salt to
be present. On the inner sur
of the free edge of the mantle-
mented the male sexual pore
terminal gland which in the
Aplysia punctata and other
pore from the purple secretion
which is known to the ancients
in front of the ctenidium the
mode sexual pore, the aperture
of the oviduct or hermaphrodite
duct. Behind the mantle-lobe
to the dorsal surface of the visceral hump
side of the head a groove be
ginning in front of the tentacle
groove down which
the spermatic fluid passes. In
other Lophocercate this groove may
close up and form a canal. At
its termination by the side of the head a ciliated
retracted penis. In the hinder part of the
brown mantle of the discrete
mucous forming gland very often

foot.

h regard to internal organization we may commence
he disposition of the renal organ (nephridium), the
al opening of which has already been noted. The
n of this opening and other features of the renal
have been determined recently by Mr. J. T. Cunning
Fellow of University College, Oxford, who writes as
from Naples, February 1883.

re is considerable uncertainty with respect to the names of
s of Aplysia. There are two forms which are very common
f of Naples, and which I have used in studying the mor
the genital organs of the sexes. One is quite black in colour,
tures when out of the water to a length
ly to eight inches and of a proportionately
ndrical body. The
nt, and can be made
e opposite
e appears to be developed
t yields a beautiful
ds, which I take to be males of
ecimens of the latter
Both Forbes and Garner state that the
ne by *A. punctata*, but I consider it to be certainly not
the *A. depilans* of Gmelin. The other species, *A. fasciata*,
n to be found in small numbers
ed to the left hand
ches of the latter
the left hand
chamber and the
Lastly the left hand
it has been traced over to the left
ith the kidney on the attached
specimens
ortion of the
both have just been described as being

branches on the deeper part
ght branch of the canals to
ppear on the left
ches
ction of an organ, the
ll appearance of the
ed
, the pericardium
ntricle and auricle

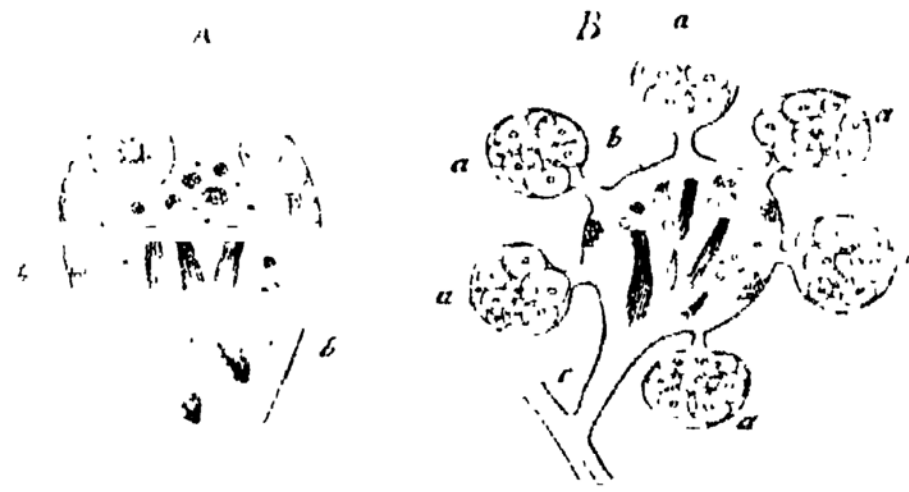
ated to the left of and
the renal opening
ent of the left pericardial wall
of the pericardium and the
ved and contracted forcibly
ch is situated the
ht ventricle is very large and

dney in Aplysia is reduced to
ness through the
to the internal opening
ween the two it dilates
to the part adjacent to

Aplysia is known to conform to
The heart lying within the adjacent
ard forms a single auricle and ven
ricle is not extensive, the arterial
ed to convey to the which builds
pericardial and dorsal body wall.
with the usual buccal
ch is not armed with horny
ed in other Opisthobranchs;
ral ganglia, and a pair of salivary
pair is the largest
ds expand
rious gizzard, which is armed internally with large
processes, some broad and thick, others spinous, used
as a masticating instrument. From this we pass to a
n and a coil of intestine imbedded in the lobes of a
our liver. A cæcum of large size is given off near

the commencement of the intestine. The liver op
two ducts into the digestive tract.

The generative organs lie close to the coil of in
and liver, a little to the left side. When dissected o
appear as represented in fig. 64. The essential repro



—Hermaphrodite genads of Euthyneurous An
of Helix; of Doloba. *a*, ovary; *b*, developing spermatozoids
ther duct.

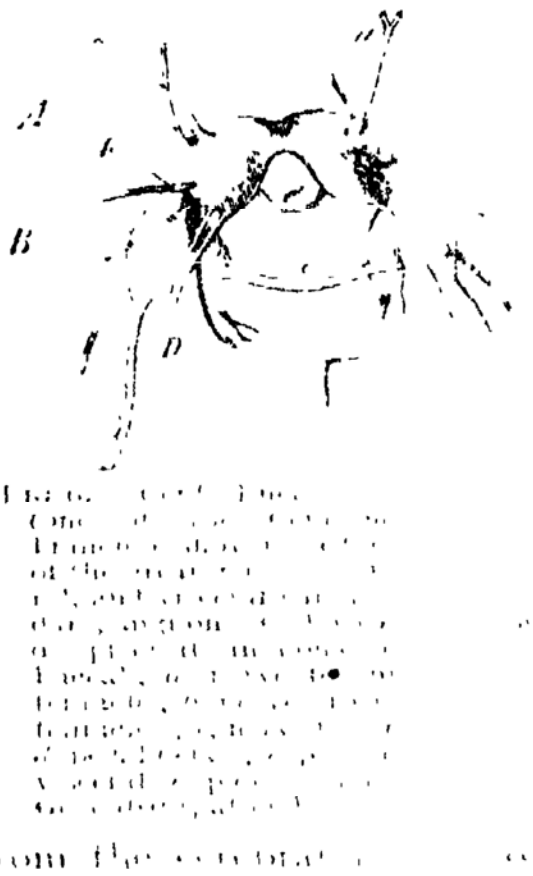
organ or gonad consists of both ovarian and te
cells (see fig. 63). It is an ovo-testis. From it p
common or hermaphrodite duct, which very soon b
entwined in the spire of a gland - the albuminiparou
The latter opens into the common duct at the point
here also is a small diverticulum of the duct *g*.
on, we find not far from the genital pore a glandular sp
body (the spermatheca *s*) opening by means of a
duct into the common duct, and
when we reach the pore (fig. 63,
k). Here the female apparatus
terminates. But when the male
erection of the ovo-testis is
active, the seminal fluid passes
from the genital pore along the
ciliated groove (fig. 63,) to
the penis, and is by the aid of
that ever-notable muscular organ
introduced into the genital pore
of a second Aplysia, whence it
passes into the spermatheca there
to await the activity of the fe
male element of the ovo-testis of
this second Aplysia. After an
interval of one days possibly
week the ova of the second
Aplysia commence to descend
the hermaphrodite duct, they
become enclosed in albuminous
tion at the point where the al
buminiparous gland opens into
the duct intertwined with it;
and on reaching the point where
the spermathecal duct debouches they are impregn
the spermatozoa which escape now from the sperm

Fig. 66. Enteric canal o
papillosa. *ph*, pharynx
gut, with its hepatic ap
h, all of which are no
e, hind gut; *an*, anu
Gegenbaur, after Alder
cock.)

The development of Aplysia from the egg present
points of interest from point of view of comp
embryology but in relation to the morphology
Opisthobranchs it is sufficient to point to the occ
of a trochosphere and a veliger stage (fig. 60), an
shell gland or primitive shell sac (fig. 68, *shs*), which
ceeded by a nautiloid shell.

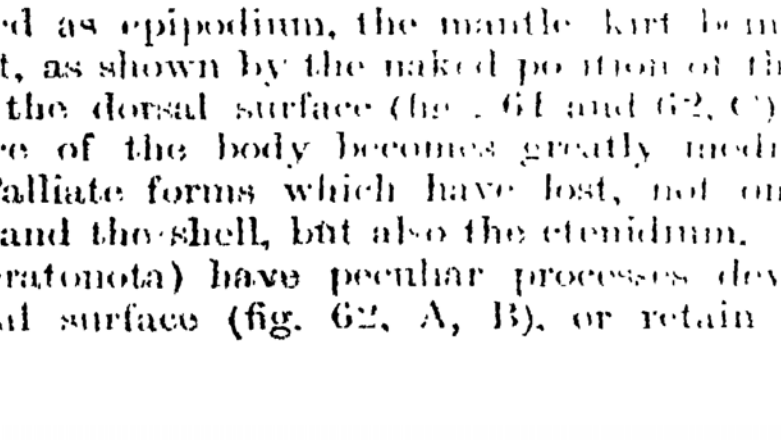
The nervous system of Aplysia will be found c
parison on fig. 70, which represents it, with our sel
Mollusc (fig. 1, D) to present but little modification
in fact a nervous system in which the great ganglia
are well developed and distinct. The Euthyneurous
loop is long, and presents only one ganglion (in
cumulus, but two distinct ganglia joined to one and

hybrida of the English coast), placed at its extreme
epresenting both the right and left visceral ganglia
e third or abdominal ganglion, which are so often
ely present. The diagram (fig. 20) shows the nerve
ing this abdomino-
l ganglion with the
ry ganglion of Spen
t is also seen to be
ted with a more re-
anglion - the genital.
special irregularities
development of gan
on the visceral loop,
one or more of the
erves connected with
, as the figures of
an nervous system
in this article show,



equent. Our figure
nervous system of
a does not give the
air of buccal ganglia
are, as in all Glosso
s Molluses, present
the nerves passing from the cerebral to the
ophore.

a comparison of various Opisthobranch
nd to present a convenient setting for
f the more typical Opisthobranchs, that
ngs to the section Palliata, but other mem
a, namely, Bulla and Tornatella (fig.
s abnormal than Aplysia in regard to the
rm of the visceral hump. They have naked or partially
d shells which may be concealed from view in the
animal by the expansion and reflexion of the epipodia,



Young veliger larva of an Opisthobranch (Pleurobranchus
b; *c*, ciliated band marking off the velum; *d*, shell-gland
ing from epiblast, within the velum; *e*, foot; *f*, mantle
epiblast; *h*, hook; *i*, intestine; *m*, mouth; *n*, anus; *s*,
shell-sac or shell gland. (From Fol.)

re not enclosed by the mantle, while Tornatella is
kable amongst all Euthyneura for possessing an oper
like that of so many Streptoneura.

e great development of the epipodia seen in Aplysia
ual in Palliate Opisthobranchs, it occurs also in Dyn
62, D) among Non-Palliata; in Doris it seems probable
that the mantle-like fold overhanging the foot is to
terpreted as epipodium, the mantle skirt being also
r absent, as shown by the naked position of the gill
ums on the dorsal surface (fig. 61 and 62, C). The
e surface of the body becomes greatly modified in
Non-Palliate forms which have lost, not only the
le-skirt and the shell, but also the etenidium. Many
ese (Ceratonota) have peculiar processes developed
he dorsal surface (fig. 62, A, B), or retain purely
negative characters (fig. 62, D). The chief modifica
internal organization presented by these forms, as com
with Aplysia, is found in the condition of the alim
canal. The liver is no longer a compact organ op
by a pair of ducts into the median digestive tract, b
find very numerous hepatic diverticula on a sho
axial tract (fig. 66). These diverticula extend usual
into each of the dorsal papillæ or 'cerata' when the
present. They are not merely digestive glands, b
sufficiently wide to act as receptacles of food, and in
the digestion of food proceeds partly in the axial p
similar modification of th
or great dorsal gland is found in the Scorpions,
the axial portion of the digestive canal is short and st
and the lateral ducts unusually wide to admit fo
the communication of the gland there to be direct,
as in the Spider the gland is confined to a series of
ducts.

The typical character is retained by the heart
ventricle, and the communication of pericardium and renal
in all Opisthobranchs. Amongst the Nudibranchs, for example, the
branchia by the fish-like transparent Phyllirhoe (fig.
in which it is possible to see the blood actively moving
in the animal, by means of the microscope, the con
the blood system, and also the direct pericardial com
cation. With reference to the question of pores p
the vascular system in open communication wi
surrounding water, or the parenchyma as to Mollusca
ally. In a form closely allied to Aplysia (Pleurobran
such a pore is situated outwards from the branchial ve
been precisely described by Professor Dohrn. No su
detected in Aplysia. In many of the Non-
Opisthobranch the nervous system presents a con
tion of the ganglia (fig. 67), contrasting greatly wit
we have seen in Aplysia. Not only are the pleural
ved to the cerebral but also the pedal to these
ortherillustrat the
Pomacea, fig. 2
and more advanced stage, fig.
identifi
ve and fo
cum, which
ar
bit compare
The Ce

larva
ed dra

placed in the
resemble the
and of the Ce
Pl
recently
to Opisthobranchs
Pleurobranchus
But it is not
fact
the two
the
bodies
Ne
Opisthobranchs
ved by a well marked shell. The
60 and 61. The transition from the free-swimming
larva with its mantle-shell (fig. 60) to the adult fo
not been properly observed, and many interesting p
to the true nature of fold (whether epipodia or m
volume have yet to be cleared up by a knowledge
development in forms like Tethys, Doris, Pleuro

other Mollusean groups, we find even in closely
genera (for instance, in Aplysia and Pleurobran-
, and other genera observed by Lankester) the
t difference as to the *amount* of food-material by
the egg-shell is encumbered. Some form their
ula by emboly (fig. 7), others by epiboly (fig. 5);
the later history of the further development of the
trocht (archenteron) very marked variations occur
ly allied forms, due to the influence of a greater or
sence of food-material mixed with the protoplasm

Order 2 (or the Euthyneura) **Pulmonata**

Euthyneurous Metapleurous Gastropoda
ly derived from ancestral forms similar to the
Copithoracic or retrotorted terrestrial hy-
notomous streptoneurous stock of the marine class
l to the dorsal mid-line and by concentration, except at
ut which leaves the aperture of the mantle-chamber
ward and is only closed at
Anus admitted
ne for respiratory and hydrostatic purposes, and it
comes a lung. As a rule, although not always,
t here, the alimentary tract presents
the intermediate Pulmonata
sence of
of feature
are to the Pulmonata. The
nata are like the other Euthyneura, hermaphrodite
ment derived ancestral type of sexual organs.
Like other Euthyneura, they have very transverse
ervous system. The
or the
pper
ghtly
ibbons
ous
ibes. Not uncommonly we find the osphradium to
of the original left side with another Lamina-
of the original right one.
ome Pulmonata crawl with the foot extended at right
to the ventral longitudinal
l a coil as in Streptoneura; in others the ventral
is not elevated, but is expanded with the foot, and
ll is small or absent.

Pulmonata are
of the

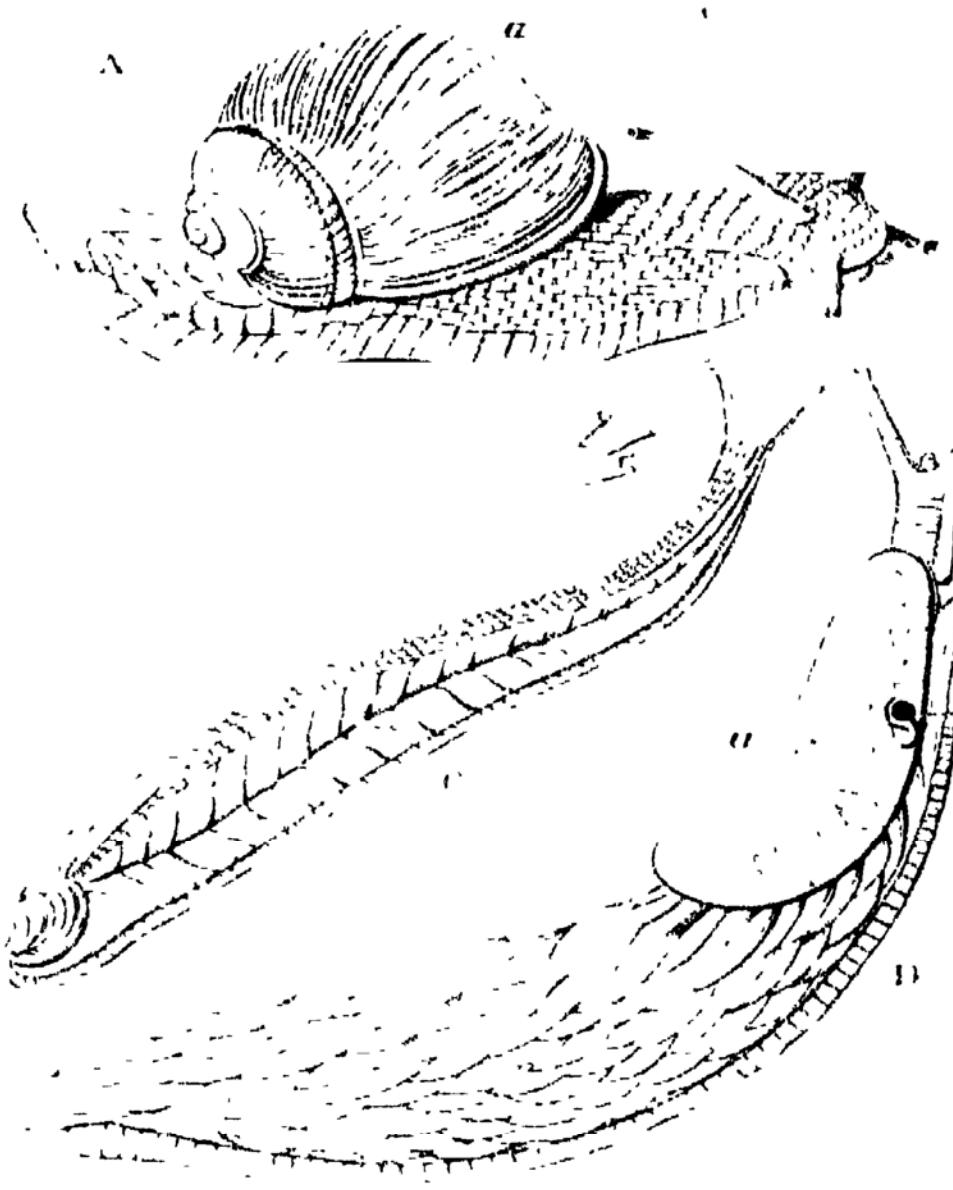
Pulmonata are
to the
ion of
lobes, other
, pneumostome, and development
, pneumostome, and development
by ventral lamina well developed
quatic or habit

f

f

f

Pulmonata, into a lung, and the ctenidium or bra
plume aborted. The Pneumonochlamyda (represent
England by the common genus Cyclostoma) have a t



f

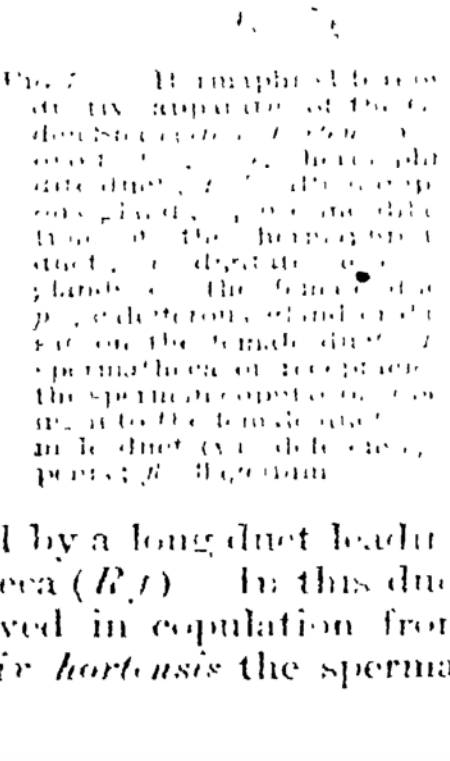
f

f

same general range of body form is shown in Pul as in the Natant Azygobranchia and in the Opis- nchia: at one extreme we have Snails with coiled hump, at the other cylindrical or flattened Slugs 69). Limpet like forms are also (fig. 71, Ancylus). The foot is al mple, with its flat crawling surface ng from end to end, but in the Limnæus (fig. 4, H) it shows a character, which leads on to the on characteristic of Pteropoda. adaptation of the Pulmonata to fr life has entailed little modification interna l organization. The vascular s more complete in them than in other G ssels and even capillaries being present , in which arteries and veins find their The subject has not, however, been r proper methods of recent histology and

f it, as of the vascular system of Moll t unsatisfactory. In one genus (H of the blood is coloured red by he only instance of the pre s f this body in the blood of phorous Mollusca, though it in corpuscles in the blood bivalves Area and Solen ster, **31**).

generative apparatus of the Helix may serve as an ex of the hermaphrodite appa common to the Pulmonata Opisthobranchia (fig. 72) the ovo-testis, which lie e apex of the visceral coil, mon hermaphrodite duct *e.d* ds, which receives the duct compact white albuminif gland *E.d.*, and then be much enlarged, the additi width being due to the pment of glandular folds, are regarded as forming a *u*. Where these folds cease mmon duct splits into two s, a male and a female ale duct *e.d* becomes fleshy uscular near its termination genital pore, forming the . Attached to it is a diver *fl.*, in which the sperma- which have descended from o-testis are stored and mo into sperm ropes or sperma es. The female portion of uct is more complex. Soon quitting the uterus it is joined by a long duct leadi a glandular sac, the spermatheca (*R.f*). In this duct ae the spermatophores received in copulation from r snail are lodged. In *Helix hortensis* the sperma-



theca is simple. In other species of Helix a secon (as large in *Helix aspersa* as the chief one) is given o the spermathecal duct, and in the natural state is adherent to the wall of the uterus. Thus second d normally no spermathecal gland at its termination, is simple and blunt. But in rare cases in *Helix a* second spermatheca is found at the end of the secon Tracing the widening female duct onward we now to the open ... duct there are accessory glands *d, d,* ... junction of the oviduct the ... a thick walle ... adhere to the fluted rod ... of lime is found. It is sup ... a store of lime in copulation, be

... of seve ... to appe ... enable ... veins to ... arteries ... able to ... of the r ... theca ... in the ... sea poi ...

... with that ... y of the right ... cross the nerve ... ral nerve loop. Th ... d nerve of b ... oviduct with whi ... d passes the esoph ... ry at discovery ... connected to the ... ... to Pleurobra ... ... genera of exce ... (so to speak) ne ... on the left s ... cerebral ganglion, the ... second. The ... are ... be ... in all ... the Pulmonate A ...

... though always lig ... developed spiral ... row of ..., and, al ... yet in Helix the a ... ed by a complete ... heart on its nerve ... In ... ... a peculiar n ...

... the mouth of the shell, and la ... In Lymnæus the permanent ... ed on the columella by a well-marked bell ... native bell (fig. 7****), at ... time supposed ... developed, but known by Lang to be fo ... h the ... bell-gland" discovered by Leydig ... ea (Pteropoda, Pleurobranchidæa, Scaphopoda &c.) ... or Gastropoda Anteoplenta, this ... may ... ally develop a plug of chitinous matter, but ... flattens out and disappears, whilst the ... like rudi ... the permanent shell is shed out from the

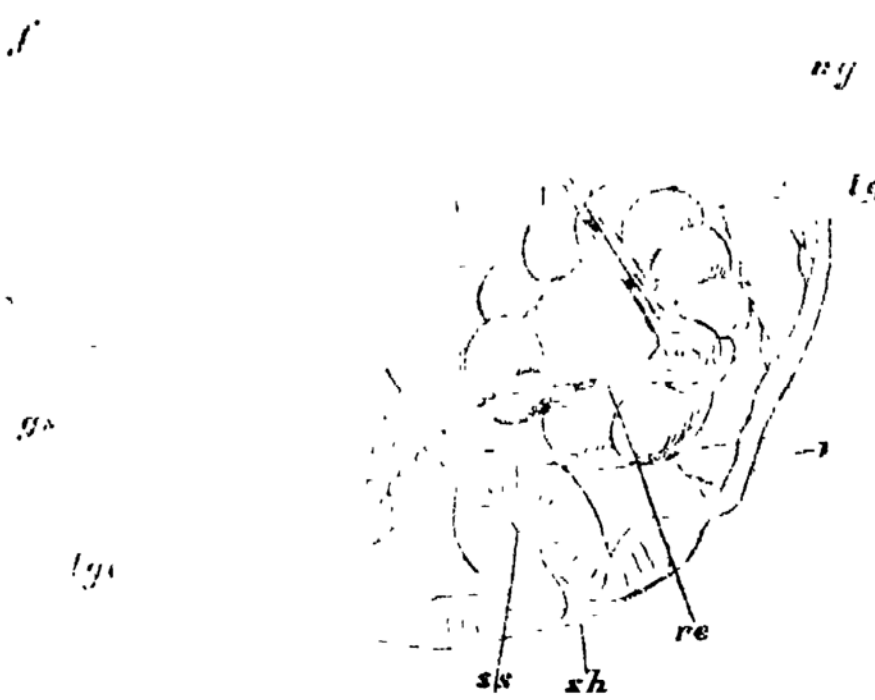
the visceral hump, in the centre of which the shell sac
sted for a brief period.
n Clausilia, according to the observations of Gegenbaur,
primitive shell sac does not flatten out and disappear,
takes the form of a flattened closed sac. Within this
ed sac a plate of calcareous matter is developed, and
r a time the upper wall of the sac disappears, and the
areous plate continues to grow as the nucleus of the
manent shell. In the lung Testacella (fig. 69, C) the
ll plate never attains a large size, though naked. In
o lungs, namely, Limax and Arion, the shell sac remains
nparently closed over the shell plate, which in the latter
ers another more or less calcareous line
permanent primitive shell sac in these lungs is
ount of considerable interest. It is clear enough that
sac is not a differentiation from that of Aplysia (described
the section on the Opisthobranchia), being primitive
ead of secondary. It seems probable that a rudimental
h one of the openings in which each shell plate of a
ation is formed, and the cuticular plate like imbrication
ich are placed behind the mouth, which are on the dorsum
the curious lung Pneumophorus, next to the peculiarity
the formation of a series of shell sacs on the back of
t animal similar to the shell we find in Chiton
ether the closed primary shell sac of the adult (and
h at the transient embryonic shell gland of all other
llusca) gives rise in the same manner to the closed sac in
ich the calcareous portion or shell of the Cephalopod Sepia

[illegible] Comparison of [illegible] and also Cephalopoda. [illegible] gastrula, [illegible] plane eye, *t* tuft of tentacles [illegible] the hinder part of the body [illegible] the pending formation of the [illegible] blastopore [illegible] (Ohlin.)

med, is a further question, which we
l dealing with the Cephalopoda. It
important here to note that Clausilia [illegible]
lacks [illegible] nce of the *continuity* of the shell
[illegible] the primitive shell sac with the
[illegible] Mollusca (Amphineura
Gastropoda) there is a want of
[illegible] new shell is contributed by
[illegible] only a very minute knob
[illegible] Pelecypoda). It flattens out and
[illegible] of [illegible] ences the permanent shell
[illegible] there is a period at this stage,
[illegible] Murex and Echinospira) there
[illegible] be a bu[illegible] ing, the mucous shell formed
the larva not [illegible] new shell of a different form
ng [illegible] some [illegible] several lumps
r, then, with the [illegible] so much shell of primary,
ondary and tertiary [illegible] in Mollusca recognizing the
that they may be merely pushed [illegible] by continuity
growth so as to form but one shell, or that in other
they may be present [illegible] a separate individual
ge, no trace of the non-development of the later phases,

or in virtue of sudden changes in the activity of the
surface causing the shedding or disappearance of on
of shell formation before a later one is entered upon

The development of the aquatic Pulmonata fr
egg offers considerable facilities for study, and
Limnæus has been elucidated by Lankester, while
has with remarkable skill applied the method of
to the study of the minute embryos of Planorbis
chief features in the development of Limnæus are ex
in the woodcuts (figs. 3, 4, and 72***). There is
very large amount of food material present in the
this snail, and accordingly the cells resulting from
are not so unequal as in many other cases. The fo
first formed are of equal size, and then four smal
are formed by division of these four so as to
one end of the first four (the pole correspon
that at which the "directive corpuscles" *d* are e
and remain). The smaller cells now divide and
over the four larger cells (fig. 3); at the same time



[illegible] Embryos of *Limnæus stagnalis* at a stage when the Tr
[illegible] of and shell gland and becoming a Veliger, seen as a t
[illegible] under side of pre-oral [illegible] *pb*, pharynx (stomodæal invaginat
[illegible] formed band marks out the velum; *ng*, cerebral nerve ga
Shell gland (left side), probably an evanescent embryonic nephr
the primitive shell sac or shell gland; *pp*, the rectal peduncle or
[illegible] ectoderm is coincident with the
[illegible] of the constricted blastopore of fig. 3, C; *lgs*, mesoblast
[illegible] nerve cords; *re*, the blinded arch enteron
[illegible] endoderm which will develop into liver;
(Ohlin, after.)

the cleavage cavity or blastocœl forms in the
of the mulberry-like mass. Then the large cells
mence the process of division and sink into the
of the sphere, leaving an elongated groove, the bla
on the surface (fig. 3, C, and fig. 4, G). The inva
cells (derived from the division of the four big cel
the endoderm or arch-enteron, the outer cells are t
derm. The blastopore now closes along the middle
it comes, which coincides in position with the future
One end of the blastopore becomes nearly closed,
ingrowth of ectoderm takes place around it to fo
stomodæum or fore gut and mouth. The other
not close, but the invaginated endoderm cells re
continuity with this extremity of the blastopore, a
the "rectal peduncle" or "pedicle of invaginat
canal etc. (see also the account and figures (fig. 15
the development of the bivalve Pisidium), altho
endoderm cells retain no contact with the middle
of the now closed up blastopore. The anal openin
at a late period by a very short ingrowth or proc
coinciding with the blind termination of the rectal
(fig. 72***, *pp*).

The body cavity and the muscular, fibrous, and
tissues are traced partly to two symmetrically-

lasts," which bud off from the invaginated arch-, partly to cells derived from the ectoderm, which ry early stage is connected by long processes with aginated endoderm, as shown in fig. 3, D. The ex form of the embryo goes through the same changes ther Gastropods, and is not, as was held previously xester's observations, exceptional. When the middle nder regions of the blastopore are closing in, an ial ridge of ciliated cells is formed, converting the into a typical "Trochosphere" (fig. 4, E, F).

foot now protrudes below the mouth (fig. 4), and the al hemisphere of the Trocho-phere grows more rapidly e anterior or velar area. The young foot shows a form (fig. 4, D, *f*). Within the velar area the eye cephalic tentacles commence to rise up (fig. 4, D, the surface of the post-oral region is formed a cap ell and an encircling ridge, which gradually increases inence and becomes the freely depending mantle The outline of the velar area becomes distinctly nated and can be traced through the more mature s to the cephalic lobes or labial processes of the Limnæus (fig. 70).

permanence of the distinction of the part known velar area through embryonic life to the adult is exceptional among Molluscs, and is therefore a point of l interest in Limnæus. None of the figures of Limnæus in recent works on Zoology show properly n of the head and these velar lobes, and accordingly ures here given have been specially described for the article. The increase of the ventral disc, its twisting, and the gradual closure of the space over by the mantle-skirt so as to convert it into a sac with small contractile aperture, belong to stages in the pment later than any represented in our figures.

may now revert briefly to the internal organization eriod when the Trochosphere is becoming to show a nt foot growing out from the area which is the mid of the elongated blastopore which is situated, and having ore at one end of it the mouth and at the other the Fig. 72*** represents such an embryo under a light ession as seen by transmitted light. The ciliated of the left side of the velar area is indicated by a tending from *v* to *v*; the foot *f* is seen between the nx *ph* and the pedicle of invagination *pe*. The ma arch enteron or invaginated endodermal sac has on a bilobed form (compare Planorbis, fig. 15 *b*), and s are swollen (*gs* and *lyc*). This bilobed sac becomes y the liver in the adult; the mid-gut and stomach rmed from the pedicle of invagination, whilst the nx, œsophagus, and crop form from the stomodæal nation *ph*. To the right (in the figure) of the pedunele is seen the deeply invaginated shell gland h a secretion *sh* protruding from it. The shell gland tined in Limnæus to become very rapidly stretched nd to disappear. Farther up, within the velar area, diments of the cerebral nerve ganglia *ne* are seen ting from the ectoderm. A remarkable coiled cell g a position just below the integument on each f the head. In the figure the coil of the left side marked *re*. This paired organ consists of a string of which are perforated by a duct. The opening of the at either end is not known. Such canalized cell aracteristic of the nephridia of many worms, and it that the organs thus formed in the embryo Limnæus mbryonic nephridia. The most important fact about is that they disappear, and are in no way connected the typical nephridium of the adult. In reference ir first observer they are conveniently called "Stiede's." Other Pulmonata possess, when embryos, Stiede's in a more fully-developed state, for instance, the common slug Limax (fig. 72**, *pk*). Here too they d pear during embryonic life. Further knowledge con ing them is greatly needed. It is not clear whether is anything equivalent to them in the embryos of m Gastropoda or other Mollusca, the ectodermal cells "embryonic renal organs" in some Gastropod embryos ing only a remote resemblance to them. The three of transient embryonic nephridia of the mesodermal the ciliated cephalic pits of Nemertine, and the ant nephridia of Cephyrean, all suggest themselves for parison with the segmental canal.

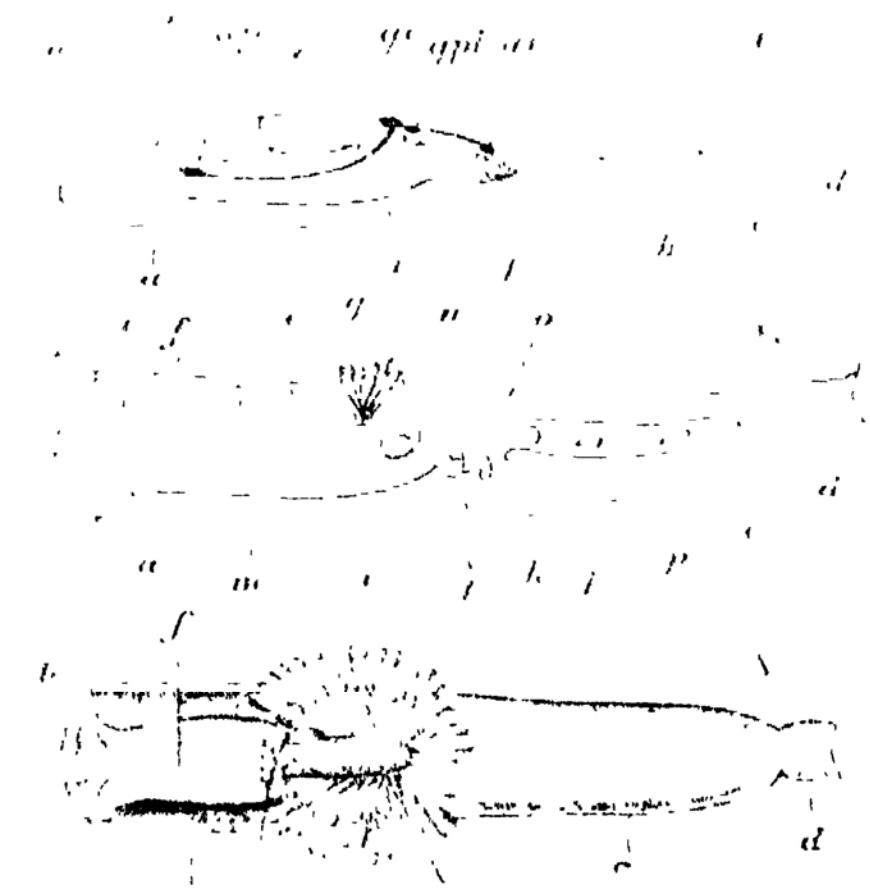
Water Pulmonata. Whilst the Pulmonata are truly a terrestrial and not a water group, there are many of the Pulmonata which frequent the ers (Pereira, fig. 72), whilst there are numerous ecies (Limnæa, Planorbis) found in more or less fresh water per (33) has shown that these have no additio the normal pair of cephalic eyes, a number of eyes develo upon the dorsal mantle-tract. These eyes are perfect in children, possessing lens, retina, optic nerve cerebral ganglion, and optic nerve. Correctly en however, they differ from the cephalic Molluscan eye an account of which see the Ilead, in the fact that, the vertebrate eye, the fibres of the optic nerve te the retina, but are connected with the rods and nerve cells near the base instead of with the opp end. The importance of this arrangement is not kn but it is important to note, as shown by Hensen, Hes and others, that in the Lamellibranch Pecten and Spond which also have eyes upon the mantle-tract, distinct cephalic eyes are absent. The nerve relationships Onchidium of the optic nerve to the retinal elements the In both Onchidium and Pecten the pedal eyes have probably been developed by the modification of tentacles a curious and modified form with the eyes Onchidium are, according to Semper, protected by the hooked tip of the Peroephthalmus, and are of a special value to them in order to from this enemy.

Cl. II. SCAPHOPODA

Characters. Mantle-cavity open at both ends; foot ad ... TEE

and to a much greater extent the mantle-cavity and the are elongated along the primitive antero-posterior (or

…d retain, both externally and in the disposition of … organs, the archi Molluscan BILATERAL SYMMETRY. … of the mantle-skirt of opposite sides (right … remain below the foot and fuse by concrescence; … small extent in front and a small extent behind of … each rosarium is left unfused. Thus a CYLINDRICAL … invested by the mantle, and on its surface a TUBU… … incomplete along the ventral line in the younger … … (fig. 73, D). The foot is greatly elon… … can be protruded from the anterior mantle … … a characteristic lavate form (fig. 74, … … typical CEPHALOPODA are symmetrically deve… … the form of numerous cell-filament (fig. 74, A, a)



… at the base of the cylindrical phallic prominence … (fig. 74, c). A pair of SIPHUNCULI (fig. 74, b) are … opening near the anus (fig. 74, A, s). The radu… … as a ventral diet, the left is apparently renal in … The LIVER (p) is large and buried the lobe… … four principal lobules. The AURAL CAVITY are … each of which is well-marked cerebral, pleural, pedal, … visceral ganglia, the typical pleural pair being closely … to the cerebral. The visceral loop or commissure is … twisted (fig. 75, D). In all, the Scaphopoda are DIOECIOUS. … The sexual products, ripe ova and spermatozoa are not developed, a… … blood-vessels are confined to the commissures and network … by the body-cavity. The GONADS are either male … male, the … typical tubular form.

… embryo … a ciliated velum bearing five ciliated … pretrochal to the mouth. The larval and adult characters to… … the phylogenetic history and condition of Mollusca generally. … rings are comparable to those of the larva of Pneu… … (fig. 84), and like them disappear.

… the Scaphopoda is not divisible into orders or … . H. Simroth's three genera *Dentalium*, L. (figs. …), *Siphonodentalium*, Sars; and *Entalium*, Dur. … They inhabit exclusively the sand on the sea co… … depths of from 10 to 100 fathoms.

It is worthy of remark that the Scaphopoda con… among the Glossophora a parallel to the sand boring … so common among the Lipocephala (such as Solen and … This parallelism is seen in the special mode of elon… of the body, in the form of the foot, and in the … form of the mantle brought about by the concresc… its ventral margins, as in the Lipocephala men… The cylindrical shell of Dentalium is also compara… the two semicylindrical valves of the shell of Sole… better, to the tubular shell of Aspergillum and T… Nevertheless it is necessary to consider the Scaphop… standing far apart from the Lipocephala, and as hav… genetic but only a homoplastic relationship to… in consequence of their possessing a well developed … places the characteristic organ of the Glossophora… possessed by any Lipocephala.

Cls. III. CEPHALOPODA.

Characters.—Molluscs Glossophora with the foot … ally adapted for a DEEP-SWIMMING mode of life; … archi Molluscan BILATERAL SYMMETRY predominate… in the external and internal organs generally, the … many cases (especially the smaller forms) a one-sid… placement of primitively median organs and a suppr… of one of the primitively paired organs is to be note…

An ANTERIOR, MEDIAN, and POSTERIOR region … foot can be distinguished (figs. 75, (1), (5), (6)), … pending on but probably not derived from the pro-,

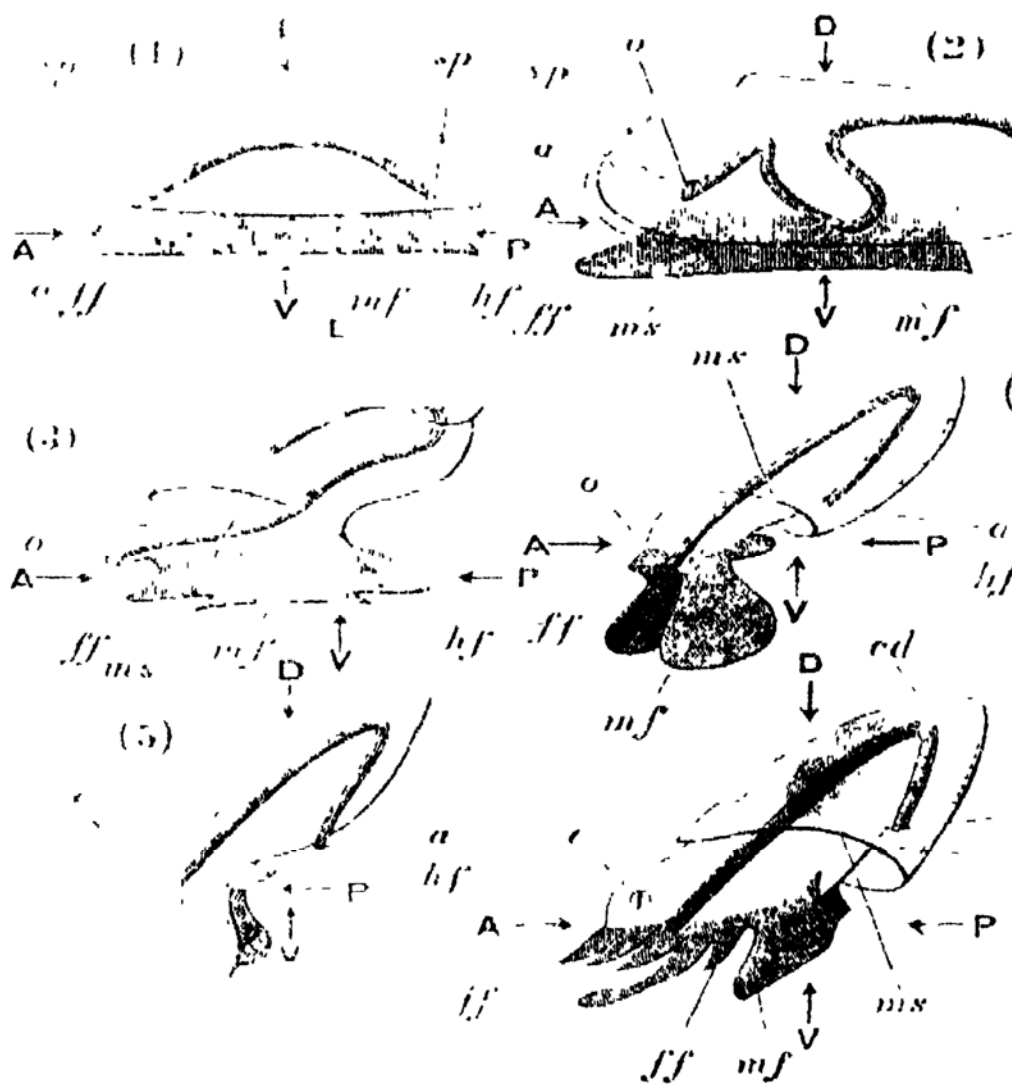


FIG. 75.—Diagrams of a series of Mollusca to show the form of the fo… … and the relation of the visceral hump to the antero-post… dorso-ventral axes. (1) A Chiton. (2) A Lamellibranch. (3) An Ar… or Gastropod. (5) A Heteropod or Pteropod. (6) A Gymno… Pteropod. (6) A Cephalopod (Cuttle). A, P, antero-posterior … axis; V, dorso-ventral vertical axis at right angles to A, P; … anterior edge of the mantle-skirt or flap; *sp*, sub-pallial cl… *ff*, fore-foot; *mf*, mid-foot; *hf*, hind-foot; *e*, cephalic eyes; … ventral part (or cavity).

and meta-podium of Gastropoda. The fore-foot inv… hy… the HEAD MERGED into it, and grows up on ea… (right and left) of that part so as to surround the … the two upgrowths of the fore-foot meeting on the … aspect of the snout, whence the name Cephalopod… the more typical forms of both branches of the cl… peri-oral portion of the foot is drawn out into paire…

ocesses, either very short and conical (Clio, Eurybia), hy (Pneumodermon, Octopus); these may be beset ckers or hooks, or both. The mid foot (fig. 75, *mf*) nded into a pair of muscular lobes right and left, ither are used for striking the water like the wings tterfly (Pteropoda), or are bent round towards one so that their free margins meet and constitute a be, - the siphon or funnel (Siphonopoda). The hind ither very small or absent.

stinctive feature of the Cephalopoda is the ABSENCE hing like the TORSION of the VISCERAL MASS in isopleurous Gastropoda, although as an exception rsion occurs in one family (the Limacinidæ).

ANS, although it may be a little displaced from han line, is (except in Limacinidæ) approximately and posterior. The MANTLE-EDGE may be aborted osomatous Pteropoda); when present it is deeply d posteriorly, forming a large subpallial chamber the arms. As in our schematic Mollusc (fig. 75), the ad arms are placed the simple or paired apertures of the DIA, the GENITAL APERTURE (paired only in Nau female Octopoda, female Onchidium, etc.), the e), and the paired TENTACLES on head (A SCERAL HUMP or dome is elevated and m elongated (see fig. 75, *vh*), forming a at right angles to the primary body-axis 75) of the foot.

HELL is frequently, but not invariably, sceral hump and mantle-skirt of Cephalo are both Pteropoda and Siphonopoda. The shell is usually highly differentiated, chambers in correlation with the free activity of the Cephalopoda. It may be e or boat like, or internal, when it is ons minute pigmented sacs (*pigment-spots* or *eyes*) near tion, and known as CHROMATOPHORES, are found t in the integument in both branches of the cla s of both sexes are developed in one molluscoid lopoda (Pteropoda), in other the sexes are separat ST ORGANS, especially the cephalic eyes and the oto are very highly developed in the higher Cephalopoda. sphradia have the typical form and position in the forms, but appear to be more or less completely d by other olfactory organs in the higher. The L NERVE GANGLIA are present, but the connectives ned, and the ganglia concentrated and fused in the ic region. Large specialized ganglia (optic, stellate, a bneeal) are developed in the higher forms (Siphon

Cephalopoda exhibit a greater range from low to rganization than any other Mollusc class, and hence re difficult to characterize in regard to several group ans; but they are definitely held together by the ce in all of the encroachment of the fore foot on a round the head, and by the functionally important ATION OF THE MID-FOOT.

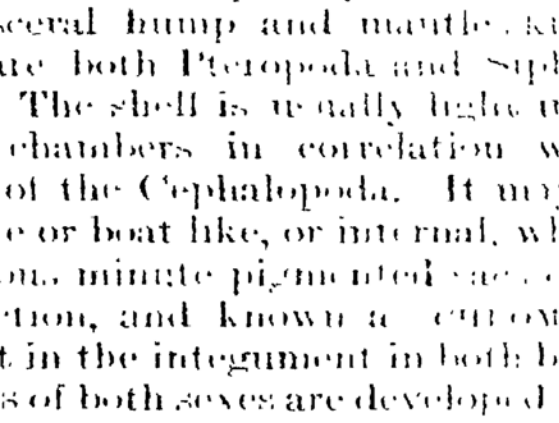


Fig. 76.

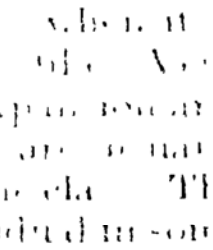
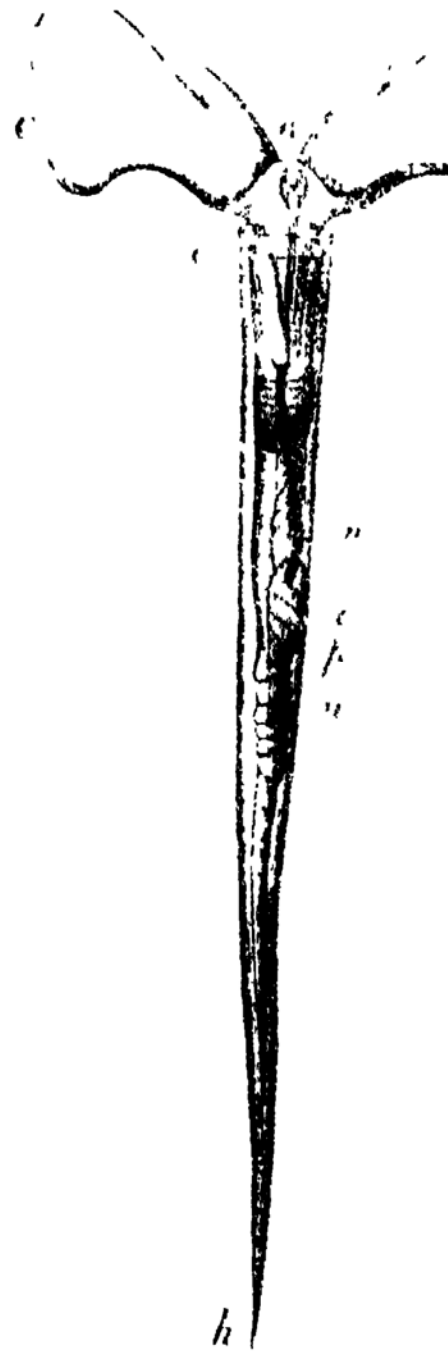


Fig. 77

Spiratella balmondi. Soul, one of the Limacinidæ, enlarged (from Gegenbaur). *c*, *c*, pteropodial lobes of the mid-foot; *f*, operculum carried on the foot; *g*, spiral shell.
Operculum of Spiratella enlarged.

Two very distinct branches of the Cephalopoda may be recognized: the one, the Pteropoda, [illegible] the condition of its bilobed mid-foot, including a number of minute, and in all probability degenerate, genera, forms of simplified and obscure organization; the other, the Siphonopoda, containing the Family Nautilidæ and the Octopoda, which have for the most there to [illegible] dominated, among the Mollusca, [illegible] habitat of the [illegible] no more highly [illegible] an special [illegible] varied [illegible] most [illegible]

PTEROPODA.
[illegible]



[illegible] the foot [illegible] separated w primitive [illegible] comparatively [illegible] developed and drawn out into a pair of wing-like parapodia bearing the tentacles of the siphon of the Siphonopoda which are used as paddle (see fig. 74, *ep*). The hind region of the foot often aborted but may [illegible] an operculum (fig. 75, *f*). The fore region of the foot (that embraces the head also often [illegible] may be drawn out into [illegible] or more pairs of tentacles, [illegible] and provided with [illegible]

The mode [illegible] is not two [illegible] the Limacinidæ [illegible] [illegible] [illegible] [illegible] [illegible] aperture [illegible] with Siphonopoda. The [illegible] the exception of the presence [illegible] of the end of the foot, of Pneumodermon. The nervous system [illegible] that of the Gastropoda. The rudimentary phragma [illegible] tubular body corresponding [illegible] right nephridium [illegible] cal pair of the typical Mollusc. The anal aperture is usually placed a little to the left of the median line, [illegible] to the right. In the Limacinidæ it becomes [illegible] position, owing to the torsion of the visceral mass. Anisopleurous Gastropoda.

Fig. 78. Sagitta [illegible] enlarged (from Lowe). *a*, *a*, *a*, lateral lobes of the mid-foot; *b*, hood of same; *c*, caudal fin; *d*, pointed extremity of tail; *e*, ventral portion of the [illegible]; *f*, ovary; *g*, liver; *h*, hermaphrodite [illegible]

ws and a lingual ribbon are present as in typical
oplora, the dentition of the ribbon and the number of
ieces presenting a certain range of variation. Sense-

Fig. 45.

[illegible] From Pl. Mer. [illegible] the [illegible] the [illegible] [illegible] [illegible]

he fore part of the foot which surrounds the mouth, as l Cephalopoda, is drawn out into four or five pairs of s, sometimes short, but usually elongated and even fili-

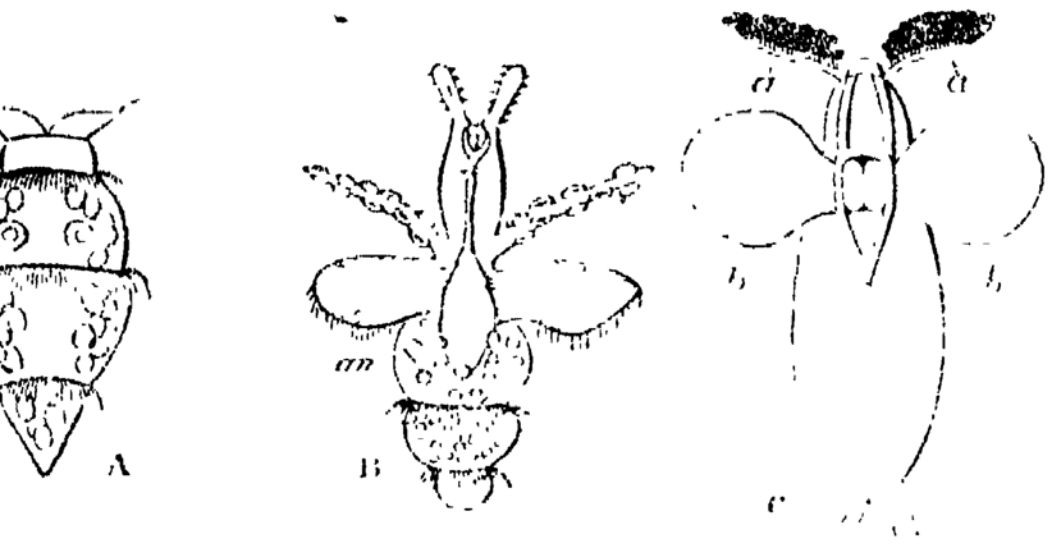


Fig. 84

A, Larva of Pneumodermon (from Bell on ... B, Larva ... oral ciliated band of the trochosphere ... are post-oral circlets of cilia are present. ... rudiment of a pair of ... ciliated ... as compared with the adult (fig. 85) ... ing processes on each side of the mouth ... forefoot. ... process (foot) provided with sucker ... equatorial lobe ... Pneumodermon ... bearing arms, ... as seen ... animal can crawl ... system.)

These lobes either carry peculiar sheathed tentacles (Nautilus), or, on the other hand, acetabuliform suckers which be associated with claw-like hooks. ... hind foot is probably represented by the ... nds from the inner ... of the siphon in ... y cases.

shell (figs. 89, 100) ... ry generally present, ... ding protection to ... visceral mass and ... chment for muscles. ... ay be external or en- ... d in dorsal upgrow- ... folds of the mantle, ... h (except in Spirula) ... up at an early period ... evelopment, so as to ... a shut sac in which ... hell is secreted. The ... dia are well deve- ... d as paired gill-plumes, serving as the efferent bran ... organs (figs. 101, 103, ... fig. 2, B).

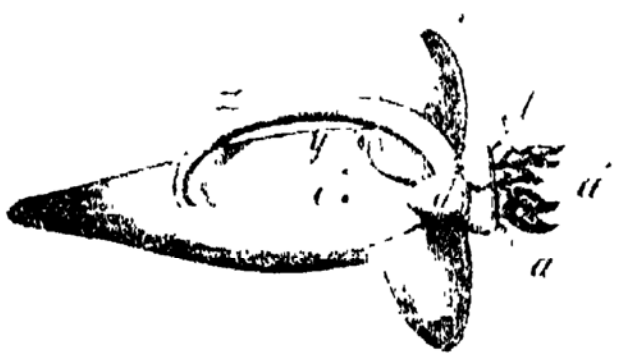


Fig. 86. ... diameter; ... cephalic region; ... cephalic cone, ... arrounded by a ... and *b*, the ... retractile eye-tentacles ... placed dorsally ... *d*, the ... anus; *a*, the velum; *p*, the ... (From Owen after ... Huxley.)

The vascular system is ... highly developed; the ... t consists of a pair of ... cles and a ventricle (figs. ... 105). Branchial hearts ... ormed on the advehent ... ls of the branchiae. It ... t known to what extent ... minute subdivision of ... arteries extends, or ... her there is a true ... llary system.

The pericardium is ex- ... ed so as to form a very ... sac passing among ... viscera dorsal wards and ... etimes containing the ... y or testis. the viscero ... cardial sac ... which opens to the exterior either directly

Fig. 87. ... centres of Pneumoderm ... after Semper). ... cerebral ganglion, ... *Pl G*, left pleural ganglion, *Pe*, right pedal ganglion, *Vis G*, left visceral ganglion; *Vis R*, right visceral ganglion; *cpl*, left cerebro-pleural connective; *cpe*, right cerebro-pedal connective; *Oesp*, œsophagus connected by a nerve with the right visceral ganglion.

or through the nephridia. It has no connexion wi ... vascular system. The nephridia are always paired ... the walls of which invest the branchial advehent ... (figs. 101, 108). They open each by a pore into the ...

Fig. ... Male ... pericardial sac except in Nautilus. The anal aperture is median and raised on a papilla. Jaw (fig. 2, B) and odontophore or lingual ribbon (fig. 107) are well developed. The jaws take the form of a pair of powerful beaks, either horny or calcareous (Nautilus), and are capable of inflicting severe wounds

ens organs are highly developed; the eye exhibits a special elaboration of structure in the Dibranchiata, a remarkable archaic form in the Nautilus. Otocysts present in all. The typical osphradium is not present,

pt in Nautilus, but other organs are present in

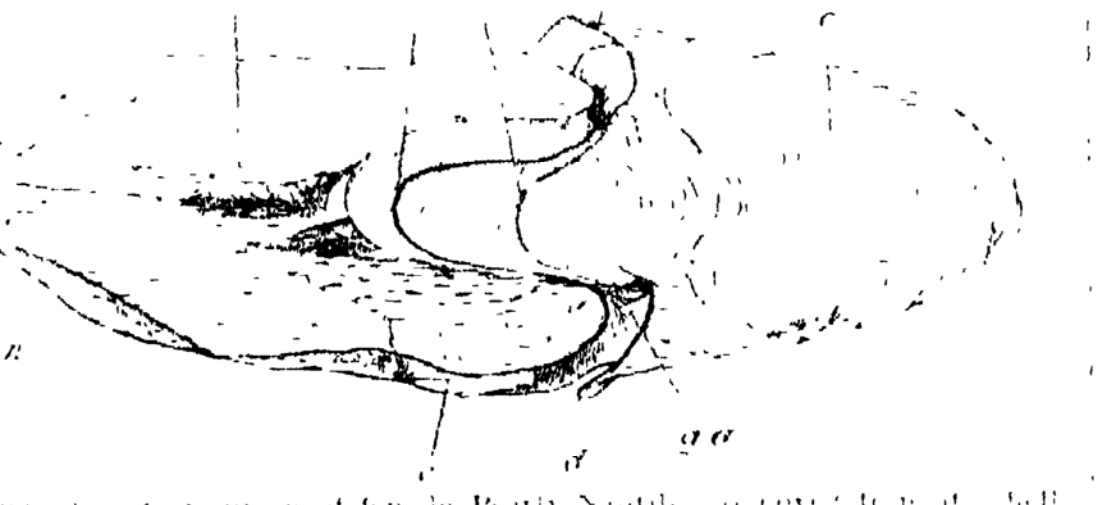
term hectocotylization is applied to this modificatio figs. 88, 95, 96). Elaborate spermatophores or sperm are formed by all Siphonopoda, and very usually the possesses special capsule-forming and nidamental glan providing envelopes to the eggs (fig. 101). The egg of all Siphonopoda is large, a development is much modified by the pr of an excessive amount of food-material d in the protoplasm of the egg cell. Troch and veliger stages of development are quently not recognizable.

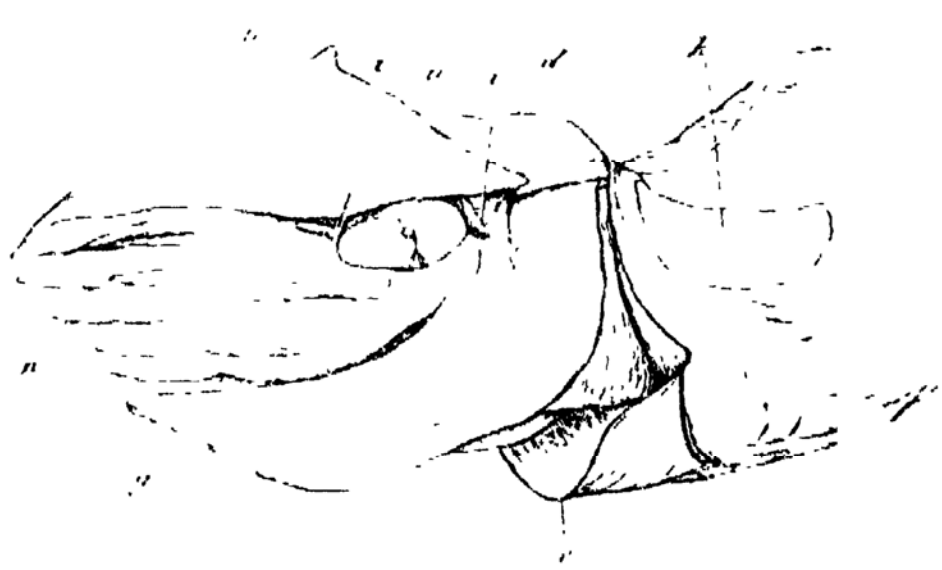
The Siphonopoda are divisible int orders, the names of which (due to Owe scribe the number of gill-plumes presen in fact there are several characters of a importance as those derived from the g which the members of these two or de created from one another.

Order I. **Tetrabranchiata** (Schizosi Tentaculifera).

Characters.—Siphonopodous. Cepha in which the inrolled lateral margins mid-foot are not fused, but form a sipl apparatus (fig. 101). The circumoral of the fore-foot carry numerous sheath tacle-protruders) (fig. 88). There a pairs of ctenidial gills (hence Tetrabranc and two pairs of nephridia, consequent nephridial apertures (fig. 101). The pericardial chamber opens by two indep apertures to the exterior and not in nephridial sacs. There are two o (right and left) in the female and two duct in the male, the left duct i sexes being rudimentary.

A large external shell either coiled or s present, and is not enclosed by reflex the mantle-fold, except such narrow-mouthed sh that of Gomphoceras, which were probably enclosed





ngitudinal section of female Pearly Nautilus (reduced to about half). The shell has been removed and a part of the outer mantle-fold has been cut away in order to show the gill-plumes attached to the roof of the mantle-cavity. On the left side of the head of each are seen the two pairs of tentacles, and on the right side the hood or dorsal portion of the funnel has been removed. The body is supported by the shell and retracted into it by the strong columellar muscle, which has been cut across. The mouth is seen in the floor of the buccal cavity, and the anus and renal papilla on each side of it. The genital papilla is seen in the floor of the mantle-cavity, behind the base of the left gill-plume. The ventral edge of the mantle-fold is seen to be produced into a funnel, which has been cut across. The shell is seen to consist of a series of chambers, the last of which is occupied by the body of the animal, the hinder ones being filled with gas. The suture-line between the septa and the shell-wall is seen on the right side.

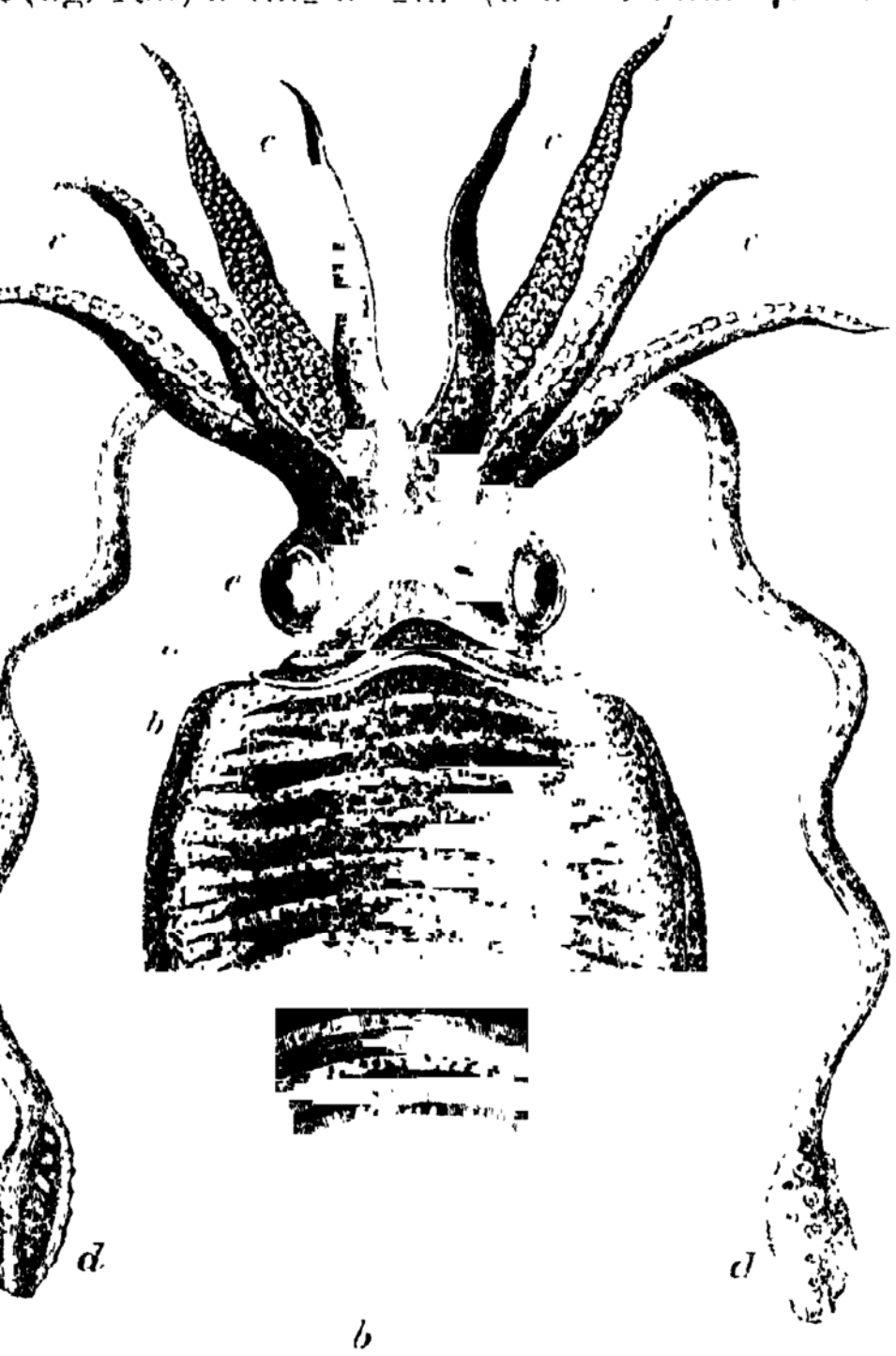
Longitudinal section of the same specimen as that drawn in fig. 90 (reduced to about half). *a*, the conical body-whorl; *b*, the last-formed chamber; *c*, the siphuncle; *d*, the funnel; *e*, the mantle-fold; *f*, the nuchal tentacle; *g*, the eye; *h*, the olfactory organ; *i*, the gill-plumes; *k*, the anus; *l*, the renal papilla; *m*, the genital papilla; *n*, the hood; *o*, the mouth; *p*, the buccal cavity; *q*, the radula; *r*, the odontophore; *s*, the tongue; *t*, the buccal tentacle; *u*, the lip; *v*, the fore-foot; *w*, the mid-foot; *x*, the hind-foot; *y*, the operculum; *z*, the shell-wall; *a*, the septa

... *Nautilida*
... [*Orthoceras*], Breyn.; [*Cyrtoceras*], Goldfuss; [*Gompho*
...], Munster; [*Phragmoceras*], Brod.; [*Gyroceras*], Meyer;
...*oceras*], Barrande; [*Oncoceras*], Hall; [*Lituites*], Breyn
...*chioceras*], Barrande; *Nautilus*, L. (figs. 88, 89, 90, &c.);
...*meana*], Munst.?; [*Nothoceras*], Barrande
2. *Ammonitida*
... [*Bactrites*], Sanderg.; [*Goniatites*], de Haan; [*Rhabdo*
...s], Hauer; [*Clydonites*], Hauer; [*Ceratoceras*], Hauer;
...*ulina*], d'Orb.; [*Ceratites*], de Haan; [*Ammonites*], Lam.;
...*oceras*], d'Orb.; [*Crioceras*], Leveille; [*Hamites*], d'Orb.;
...*nites*], Parkinson; [*Ancyloceras*], d'Orb.; [*Scaphites*],
...mson; [*Ammonites*], Brevn.; [*Turrilites*], Lam.; [*Helio*
...s], d'Orb.; [*Heteroceras*] d'Orb.

3. The names in brackets are those of extinct genera.

2. **Dibranchiata** (= Holosphonia, Acetabulifera)

...*acters*. Siphonopodous Cephalopoda in which the
...d lateral margins of the mid foot are turned over so as to
... complete tubular siphon (fig. 96, *c*). The cotyledons of the fore foot carry suckers disposed upon them
... (as in the Pteropod Pneumodermon) *not* tentacle-
...s. 92, 95, 96). There is a single pair of typical
... (fig. 103) acting as gills (hence Dibranchiata) and



b

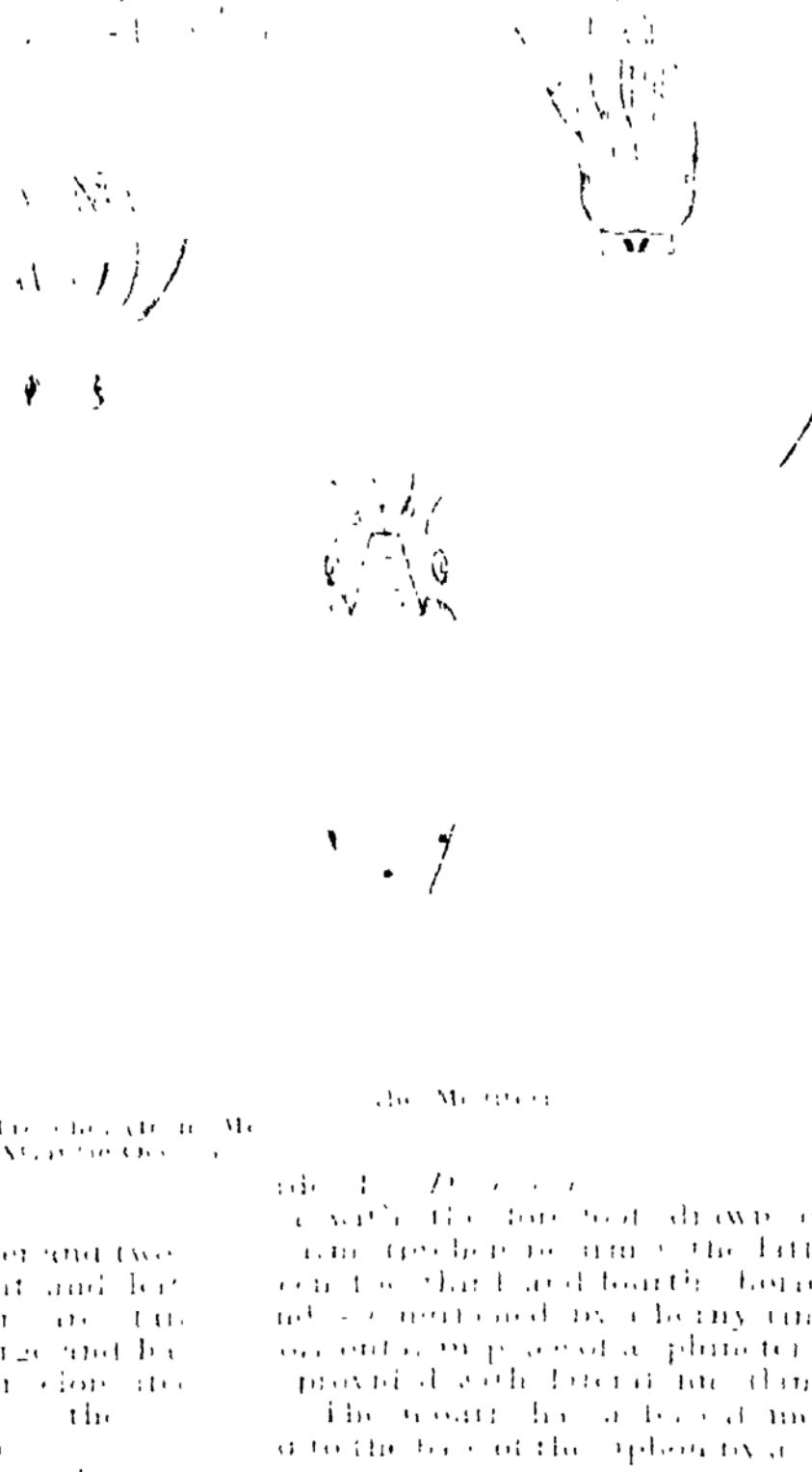
Sepia officinalis, L., half the natural size; *a*, the eight sessile arms, being withdrawn from the pouch in which they are carried during life which is cut away; *b*, the mantle sac; *c*, the right and left ... long prehensile arms; *e*, the eyes.

...e pair of nephridia opening by apertures right and ... the median anus (fig. 103, *r*), and by similar internal ...nto the pericardial chamber, which consequently does ...en directly to the surface as in Nautilus. The ovary ... are sometimes paired right and left (Octopoda), ...mes that of one side only is developed (Decapoda, Ommastrephes). The sperm duct is always single, according to Keferstein, in *Eledone moschata*.

...late-like shell is developed in a closed sac formed by ...antle (figs. 98, 99), except in the Octopoda, which have ...and in Spirula (fig. 100, D) and the extinct Belemnitidæ, which have a small chambered shell resembling that of Nautilus with or without the addition of plate-like ...cylindrical accessory developments (fig. 100, C).

The pair of cephalic eyes are highly developed ... with a refractive lens (fig. 120), cornea, and lid fold; ...vesicle being in the embryo an open sac like that of Nautilus (fig. 119). Osphradia are not present, but cephalic ...tory organs are recognized. One or two pairs of ...salivary glands with long ducts are present. An ... formed as a diverticulum of the rectum and opening ...the anus is present in all Dibranchiata (fig. 103, *l*), ...been detected even in the fossil Belemnitidæ. Branchial hearts are developed on the two branchial afferent ...vessels (figs. 101, *x*, *xx*).

The Dibranchiata are divided into two orders, ...according to the number and character of the arms ...bearing processes of the fore-foot.



...the Mediterranean ...

...Decapoda. Cuttle-fishes. ...

...eight sessile and two ...placed right and left. ...The sessile arms are large and ...The body is elongated ...the ... are developed ... at the head ...

...Octopoda. Typical Dibranchiates. ...

...ide by side. The fore foot drawn ...arms; the latter ...each of the third pair ...ment covered by a horny ...suckers are supported ...provided with a terminal ...The mouth has a beak-like ...to the base of the siphon by a ...cartilage, and contains a pair ...used to tear the food. Salivary ...known. A intestine. The ...for a time present. The ...three pairs of arms, not ... The ovary (*Sepia*). The ...a bell present, which ... enclosed by the ... of the ... to the ...

1. Suborder *Decapoda* (Cuttle-fishes).
Characters. Ten arms, second left tentacular.
Family 1. *Sepiidæ*
Genus. *Sepia* Lam. (figs. 100, D).
Family 2. *Loligidæ*
Genera. [*Loligopsis*], d'Orb. (fig. 100, C); [*Teuthis*], Fabr.; [*Loligo*], Lam.; [*Sepioteuthis*], R. Wagn.; [*Histioteuthis*], Verrill; [*Rossia*], d'Orb.; [*Onychoteuthis*], Huxley.
Family 3. *Sepiadæ*
Genera. *Sepia*, L. (figs. 92, 98, &c.); [*Beloptera*], Voltz; *Belosepia*, Owen.

Section *b* — *Decapoda Chondrophora.*

eter. Internal shell horny.

Sub-section *a* — *Myopsida* (d'Orb.).

th closed cornea, so that the surrounding water does not
lens; mostly frequenters of the coast

Loligidæ.

Loligo, Schneid. (figs. 90, &c.); *Lolaolus*, Steenstrup;
Doryteuthis, Blv.; [*Teuthopsis*], Desl.; [*Leptoteuthis*], Meyer;
Lemmoteuthis] Ag., [*Belotenthis*], Munst.

Sepiolidæ

Sepiola, Schneid.—*Rossia*, Owen

Sub-section *b* — *Octopoda* (d'Orb.)

th open cornea, so that the surrounding water bathes the
surface of the lens, mostly pelagic animals

Cirrhoteuthidæ

Cirrhoteuthis Leach (fig. 91, C)

Lycoteuthidæ

Lycoteuthis, Lemoine (fig. 93, C)

Chiroteuthidæ.

Chiroteuthis, d'Orb. (fig. 93, A).—*Histioteuthis* d'Orb.

Thaumatoteuthidæ

Thaumatoteuthis, Troschel (fig. 91, B)

Octopoteuthidæ

Gonatus, Gray, *Onychoteuthis*, Lichtenstein,
, Lesueur, *Enoploteuthis*, d'Orb., *Leachia*, Lesueur, [*Ornithoteuthis*
Desl., A. Wagn., [*Odontoteuthis*] Munst., *Thysanoteuthis*, Steenstrup,
Histioteuthis d'Orb.

Sub-order 3 — *Octopoda*

Dibranchiata with the four feet drawn out into eight
ly, suckers sessile, devoid of horny rings; eyes small, the

Fig. 90. — Male of *Parasira*
lata, Steenstrup (*Octopus*
Ver.), showing the hecto
arm (*1*, *2*, *3*, *4*, the firs
third, and fourth arm
cesses of the fore foo
third arm of the right s
cotylized; *s*, the apical
hectocotylized arm; *p*
ment which issues fro
when development is
t, the siphon. (From G

Family 3 — *Philonexidæ*

Genera: *Tremoctopus*, Delle Chiaje (*Philonexis*, d'Orb.)
B): *Parasira*, Steenstrup (*Octopus catenulatus*, Fé
female, and *Octopus carena*, Ver., is the male of the on
of this genus according to Steenstrup (fig. 96)); *Argon*
(the shell of this genus is formed only in the femal
expanded ends of the two large "arms" of the fore-foo

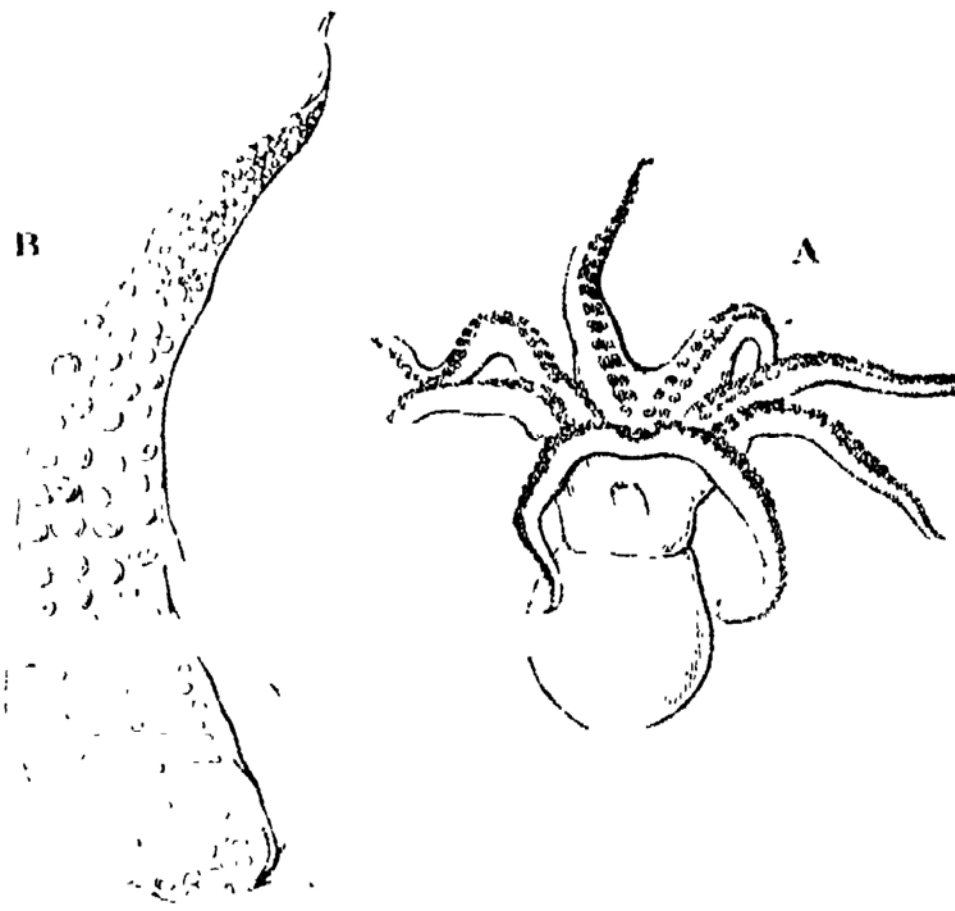


Fig. 95. — A, Male specimen of *Octopus carena*
tocotylized. B, Enlarged vi
Sepia

Further Remarks on the Cephalopoda. In order
a more precise conception of the organization of the C
poda in a concrete form we select the Pearly Naut
further description, and in passing it structure in review we shall take the opportunity of comparing here and there the peculiarities presented by that animal with those obtaining in allied forms. In the last edition of the work the Pearly Nautilus was made the subject of a detailed exposition by Professor Owen, and it has seemed accordingly appropriate that it should be somewhat fully treated on the present occasion also. The figures which illustrate the present description are (excepting fig. 89) original, and prepared from dissections (made under the direction of the writer) of a male and female *Nautilus pompilius*, lately purchased for the Museum of University College, London.

Visceral Hump and Shell.—The visceral hump of Nautilus (if we exclude from consideration the fine, siphuncular pedicle which it trails, as it were, behind it) is very little if at all affected by the coiled form of the shell which it carries, since the animal always slips forward in the shell as it grows, and inhabits a chamber which is practically cylindrical (fig. 89). Were the deserted chambers thrown off of being accumulated behind the inhabited chamb coiled series of air chambers, we should have a more indication in the shell of the extent and form of the a

Amongst Gastropods it is not very unusual to find
imal slipping forward in its shell as growth advances
ving an unoccupied chamber in the apex of the shell.
ay indeed become shut off from the occupied cavity
ansverse septum, and a series of such septa may be
(fig. 42), but in no Gastropod are these apical
ers known to contain a
uring the life of the
in whose shell they
A further peculiarity
Nautilus shell and of
the allied extinct Am-
s, Scaphites, Orthoceras,
d of the living Spirula,
the series of deserted
nbers are traversed by
-like pedicle extending
he centro dorsal area of
eral hump to the small
first formed chamber of
es. No structure com-
to this siphuncular
is known in any other
a. Its closest repre-
ve is found in the so
"contractile cord" of
narkable form Rhabdo-
referred according to
knowledge to the Poly
There appears to be no
but the deserted cham
the Nautilus shell con-
n the healthy living
a gas which serves to
the specific gravity of
ole organism. The gas
to be of the same com-
n as the atmosphere,
larger proportion of
n. With regard to its
we have only conjec-
Each septum shutting
air-containing chamber
ed during a period of
nce, probably after the
active act, when the vis-
ass of the Nautilus may
htly shrunk, and gas is
d from the dorsal inte-
so as to fill up the
previously occupied by
nal. A certain stage
hed in the growth of
nal when no new cham
e formed. The whole
of the loosening of the
in its chamber and of
oping forward when a
otum is formed, as well as the mode in which the
nbers may be used as a hydrostatic apparatus, and
ation to this use, if any, of the siphuncular pedicle,
lved in obscurity, and is the subject of much in
s speculation. In connexion with the secretion of
the animal, besides the parallel cases ranging from
otozoon Arcella to the Physoclistic Fishes, from
ydroid Siphonophora to the insect larva Oestrus,
e the identical phenomenon observed in the lowly
Sepia when recently hatched. Here, in the pores
internal rudimentary shell, gas is observable, which
essarily been liberated by the tissues which secrete

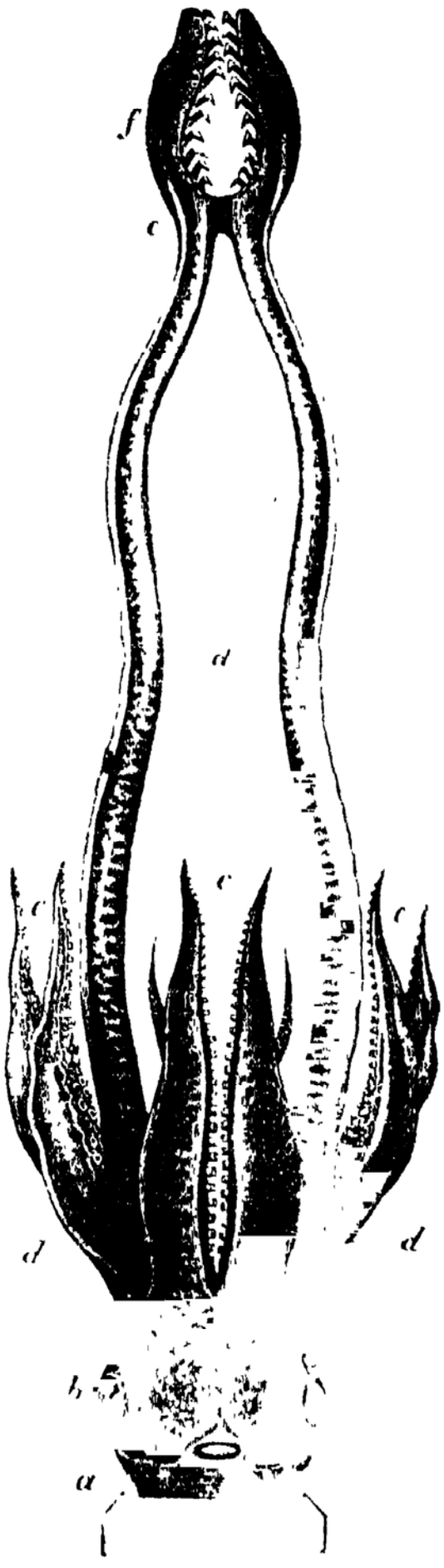


FIG. 97. Head and [illegible] processes of the [illegible] of Octopus [illegible] (from Owen). [illegible] the eight [illegible] pedunculate [illegible] the [illegible] [illegible] of which are provided with [illegible] and with a double row of hooks beyond [illegible]. The [illegible] by contraction of the [illegible] to act in concert.

the shell, and not derived from any external
(Huxley).

The coiled shell of Nautilus, and by analogy that
Ammonites, is peculiar in its relation to the body
animal, inasmuch as the curvature of the coil pro

[illegible]

[illegible] from the centro dorsal area is towards the head on f
instead of away from the head and backwards as
discoid coiled shells such as Planorbis the coil is
absolutely reversed in the two cases. Amongst the
allies of the Nautilus (Tetrabranchiata) we find shells
of a variety of forms,
shapes, open coiled
such as Scaphites,
leading on to perfectly cylindrical
shells with chambers
succeeding each other in a straight
line (Orthoceras),
whence again we
may pass to the
cork screw spire
formed by the shell
of Turrilites.

[illegible]

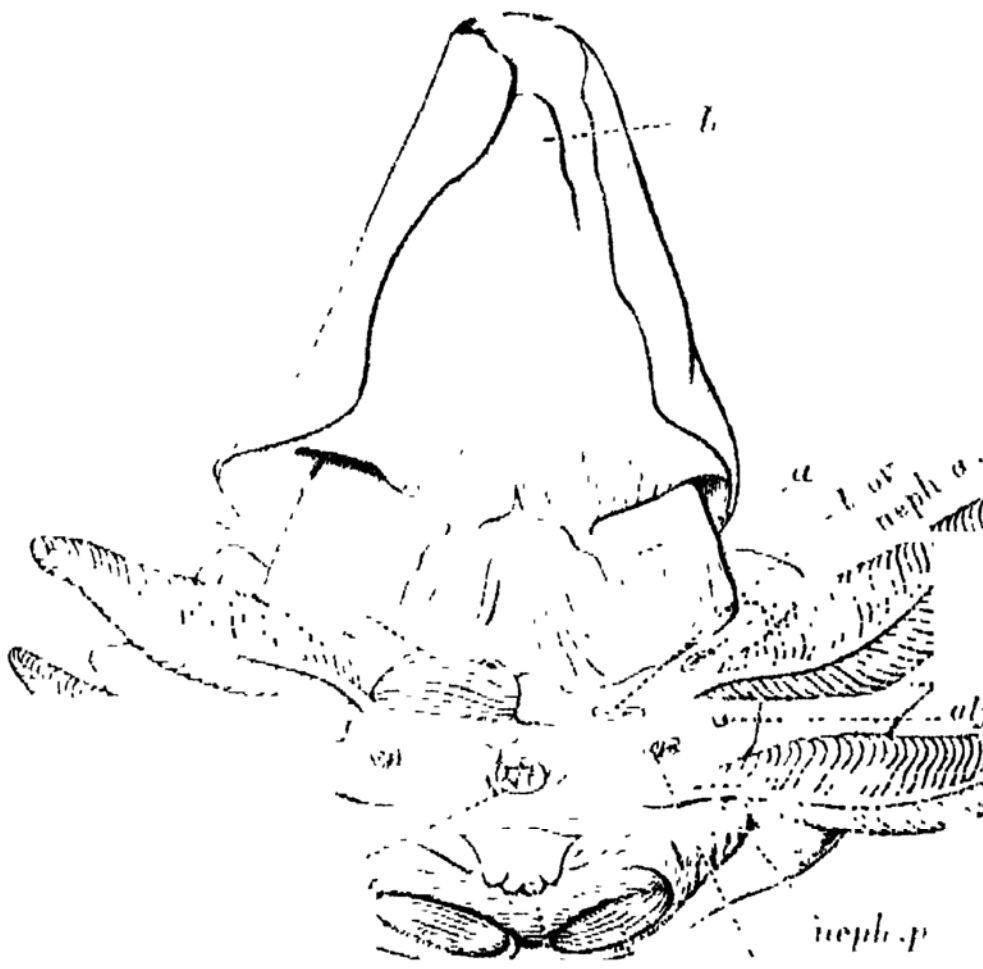
Whilst the Tetrabranchiata [illegible]
we can see in
their remains [illegible]
characterized by
these large chambered shells, which, as in Nautilus
with the exception of some narrow mouthed forms
(Gomphoceras), but very partially covered by
of the mantle (fig. 89, b), the Dibranchiata
an interesting series of gradations in which we
(a) the diminution in relative size of the
shell; (b) its complete investiture by reflected
the mantle (Spirula, fig. 100, D); (c) the

foids of the mantle to form a definitely-closed
(*d*) the secretion by these mantle-folds or walls
shell as of additional laminæ of calcareous shell-
, which invest the original shell and completely
appearance (Spirulirostra, fig. 100, C; Belemnites),
gradual dwindling and total disappearance of the
branchiate shell, and survival alone of the calcare-
deposited by the inner walls of the sac (Sepia,
(*e*) the disappearance of all calcareous sub-
ben the coni or plate which now represents the
of the shell sac, and its persistence as a horny
mandix (Loligo, fig. 99); (*e*) the total disappearance
both shell and consequently of the pen or plate,
ules the rudiment of the shell sac appearing in
larvæ and then evanescing (Octopus). The early
sac at the base of the mantle in which the shell is
in Dibranchiata, has led to an erroneous identifi-
of the sac with the primitive shell sac of the archi-
(fig. 1) or Chiton (fig. 10, A), or Arion (fig. 69
ated of the normally developing Mollusc an embryo
s and 7, *sh*). The late appearance of the shell
Dibranchiata is seen in fig. 124 and 125, it forms
ary outgrowth of the continuous dorsal area of the
having been demonstrated by Lankester (**34**) in
who subsequently showed (**35**) that the same hollow-sac
and disappears without closing up in Argonauta
topus and pointed out the discrepancies of the sac
primitive shell-gland. The shell of the female
nautilus is not formed by the visceral hump but by the
d lobes of the foot, which are in life always closely
d to it.

adhering to the Pteropoda we have shell (the Thecosomata
exceedingly light, and fits close to the animal, no
mantle being formed. It is important to note that
development of the Cephalopoda there is the same tend-
which is exhibited in the Dibranchiate Siphonata
for the mantle-skirt to be reflected over and closely
d to the head (e.g. Cuvolinia, figs. 79 and 80). But
opoda there is no complete formation of a closed
the reflected mantle, no thickening of the enclosed
no disunion of the original shell and substitution
of a laminated plate. The various forms of torm of
the shell of Pteropoda are peculiarity of that

Shell, Hood, Mantle-skirt, and Sub-pallial Chamber. In
arly Nautilus the dorsal visceral hump is completely
d by the free flap of integument known as mantle-
fig. 91, *d, cf*). In the anterodorsal region this flap
ased so as to be reflected a little over the coil of the
which rests on it. In the posteroventral region the
is deepest, forming an extensive sub-pallial chamber,
entrance of which is placed in fig. 91. A view of
oor of the sub-pallial chamber as seen when the
skirt is retroverted and the observer face to face
is indicated by the reference line passing from *c* in
, as shown in fig. 101. With this should be com-
the dorsal view of the sub-pallial chamber of the
female (seen in fig. 103). It should be noted as a
ce between Nautilus and the Dibranchiate that in
rmer the rudimental gland (in the female) lies on
rface of the pallial chamber formed by the dependent
flap (fig. 101 *cf*, 89, F) whilst in the latter it lies
e surface formed by the body-wall, in fact in the
the base of the loose fold forming the mantle skirt com-
in, as a part of what is termed visceral
in the latter.

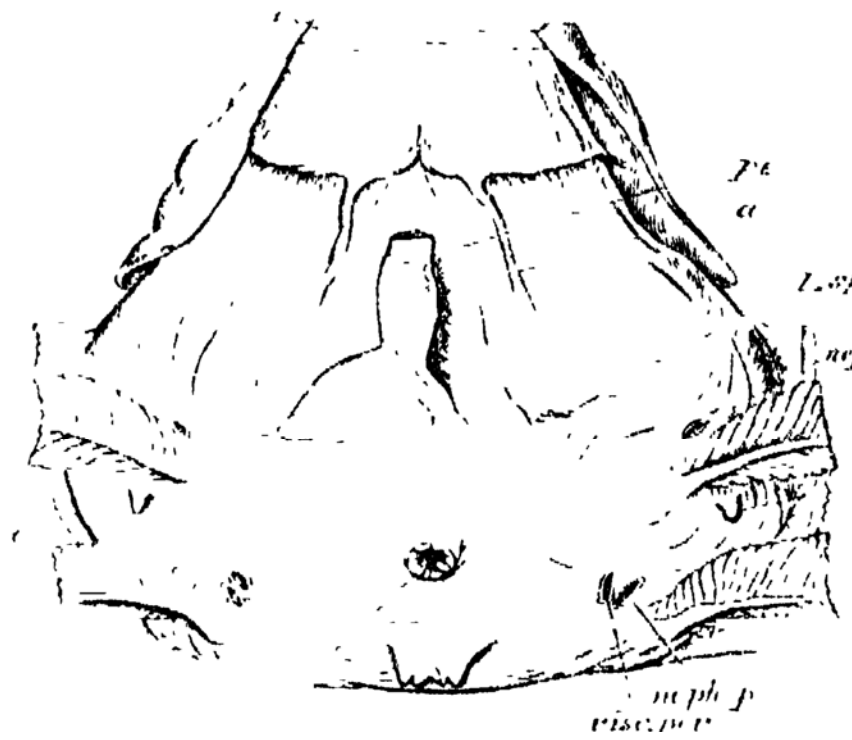
apertures of the two pair of nephridia, of the vis-
ericardial sac, of the genital duct, and of the anus
own in position on the body-wall of the pallial cham-
Nautilus in figs. 101, 102. There are nine apertures



i gin.

[illegible] View of the postero-ventral surface of a male Pearly Nau
mantle-skirt being completely reflected so as to show the mu
sub-pallial chamber (drawn from nature by A. G. Bourne). *c*
hood passing from the mid-foot to the integument, *b* the val
base of the flared hinder end of foot, partially concealed by the inrol
fold of the latter; *c* the mantle-skirt retroverted; *an*, the med
pectinated papilla of unknown significance; *a n*, rudimental gla
[illegible] the left nephridial aperture, aperture of the rudimentary le
(*spermatic duct* of Owen); *neph.a*, aperture of the left anterior ne
neph.p, aperture of the left posterior nephridium; *ves.per.*, left a
the vas deferens; *r*, the left nephridium placed near t
the anterior gill plume. The four gill plumes (ctenidia) are not let

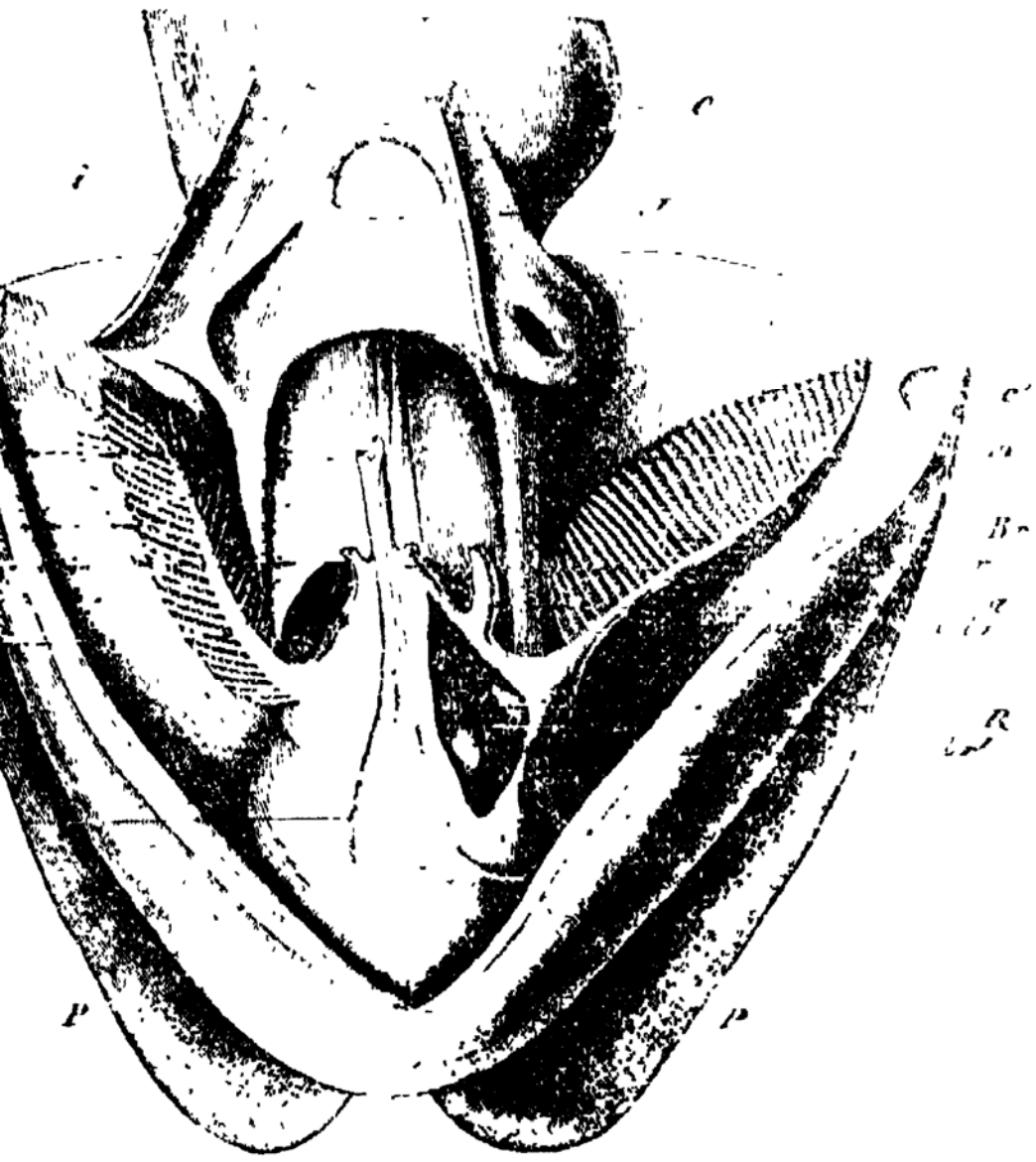
osphradium) between each anterior and posterior gil
(see figs. 101, 102, and explanation). As compar
this in a Dibranchiate, we find (fig. 103) only fou



View of the postero-ventral surface of a male Pearly Nau
mantle-skirt being completely reflected so as to show the mu
sub-pallial chamber and the four ctenidia and the foot cut sho
(drawn from nature by A. G. Bourne). *pe*, penis, being the enlarged te
of the right spermatic duct; *r*, aperture of the rudimentary left
duct (*nephridial sac* of Owen). Other letters as in fig. 101.

tures, viz., the median anus with adjacent orifice
ink-sac, the single pair of nephridial apertures, a
asymmetrical genital aperture (on the left side), ex
female Octopoda and a few others where the
ducts and their apertures are paired. No visce
cardial pores are present on the surface of the
chamber, since in the Dibranchiata the viscero-per

opens by a pore into each nephridium instead of
tly to the surface. A single pair of ctenidia (gill
nes) is present instead of the two pairs in Nautilus.
existence of two pairs of ctenidia and of two pairs
ephridia in Nautilus, placed one behind the other, is
ly remarkable. The interest of this arrangement is in
ion to the general morphology of the Mollusca, for
impossible to view this repetition of organs in a linear
s as anything else than an instance of metamere segmen-
tation, comparable to the segmentation of the ringed
ms and Arthropods. The only other example which
ave of this metamerism in the Mollusca is presented
he Chitons. There we find not two pairs of ctenidia
ly, but sixteen pairs (in some species more) accom-



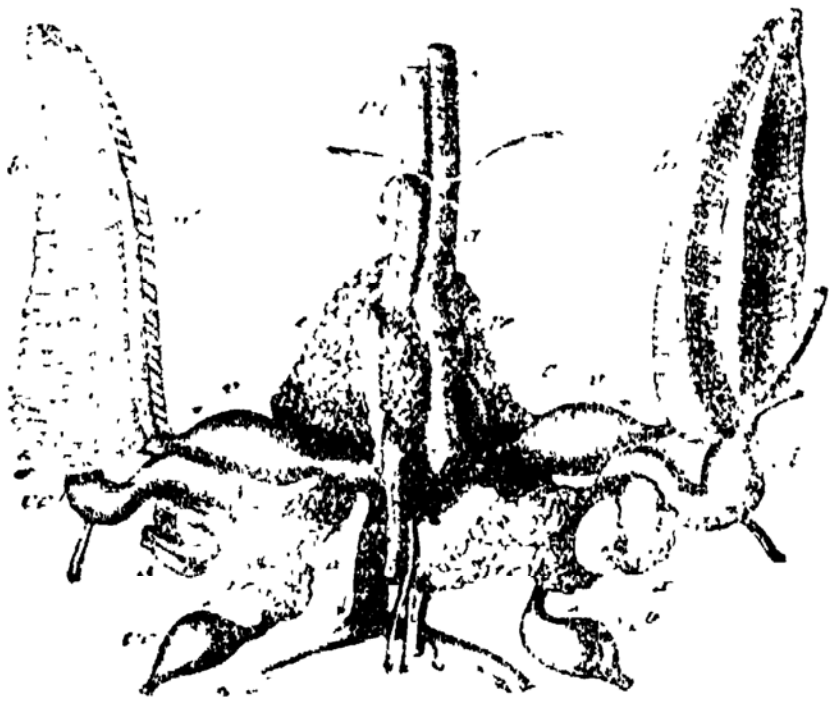
103. View of the ventral surface of
ump longitudinally the head mantle foot and
art. This figure is strictly comparable with fig.
d foot or siphon which has been cut open to
glandular tract of the left nephridium or renal
n (see fig. 108), *P, P*, the lateral lips of the
r of branchiæ (ctenidia), *a*, the anus surrounded
of the ink bag, *c*, cartilaginous socket in the
ld gristle). *l*, fold of the mantle skirt, the hypo-
go-apparatus characteristic of Decapoda, not
pos genital papilla and aperture; *v*, valve of the
ntary hind-foot); *m*, muscular band connected
l foot (siphon) and dorsally with the mantle mus-
sills, carrying the apertures of the nephridia
od vessel, *b, b*, bulbous enlargements of
s. 101, 106), *s*, ink bag. (From Gegenbaur.)

ied by a similar metamerism of the dorsal integument,
ch carries eight shells. In Chiton the nephridia are
affected by the metamerism as they are in Nautilus
s impossible on the present occasion to discuss in the
which their importance demands the significance of
e two instances among Mollusca of incomplete or partial
amerism; but it would be wrong to pass them by with
insisting upon the great importance which the occur
e of these isolated instances of metamere segmentation
group of otherwise unsegmented organisms possess,
the light which they may be made to throw upon the
ure of metamere segmentation in general.

The foot and head of Nautilus are in the adult inex
ably grown together, the eye being the only part belong
primarily to the head which projects from the all
racing foot. The fore-foot or front portion of the foot

in Nautilus has the form of a number of lobes c
tentacles and completely surrounding the mouth (fi
89, 91). The mid foot is a broad median muscular
which exhibits in the most interesting manner a cu
of its margins so as to form an incomplete siphe
101), a condition which is completed and render
nament in the tubular funnel which is the form pre
by the corresponding part of Dibranchiata (fig. 96)
hind foot possibly represented by the valvula fold
-surface of the siphon-like mid foot. In the Pteropo
wing-like swimming lobes (epipodia or pteropodia)
posed to the two halves of the siphon, and are mu
lar sheet of most of the foot. The fore foot pro
h head and eyes, partly mouth, but in Cheiro and Pt
and sides. A hind foot is no
ments often partly present, it is open to doubt
whether the pending portion of the foot in Sp

The lobes of the fore foot of Nautilus and of the
Dibranchiata require further description. It has
subject whether these lobes were probably recog
fish-type, correct and to be encouraged
sufficient reason, [illegible] whether these are truly pa
of the head, i[illegible] great to the present writer to
pose the tentacles at the fore-part of the question are th
portion of the when their development is exa
[illegible] 121, and fully [illegible] 72, shall be set, whereb
is considered th[illegible] was originated by the pedal ca
and, to the ex[illegible] compartment of each Siphonop
Septa and w[illegible] and a Pteropod. Each nucleus
[illegible] as in adult condition of the sy

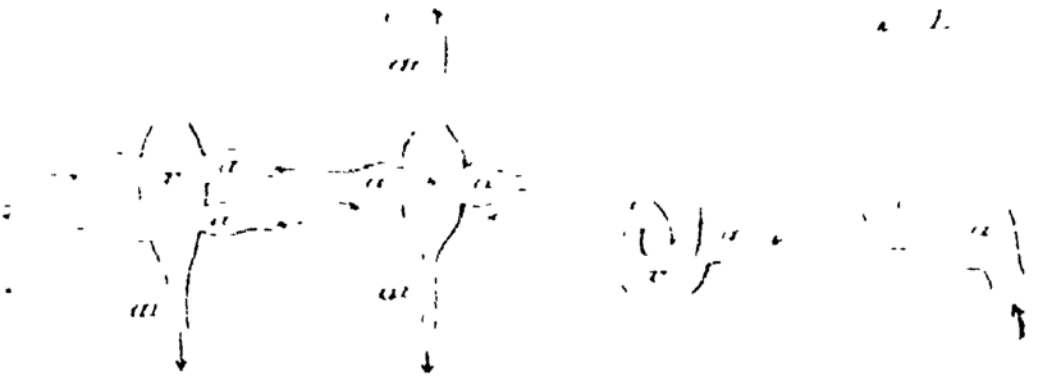


[illegible]
[illegible] nervous
[illegible] ment branch
[illegible] and sense
[illegible] of the pedicle
[illegible] the mou

the
head
the

larval Pteropod [illegible] now [illegible] very that the nucleus
process of that Mollusc [illegible] originally far remov
the head and close in position to the pteropodial
the foot. By differential growth they gradually
and collateral the head, as do the similar nuclei
processes of a pair. In both cases the nuclei bear
eyes are fore foot." The fore foot of Nautilus con
around the buccal cone (fig. 88, *c*), and to pa
appearance with its expanded tentacles similar to th
disc of a sea-anemone (Actinia). No figure has
been published exhibiting this circumoral disc
tentacles in natural position as when the animal is a
swimming, the small figure of Valenciennes being
in detail. All the published figures represent th
appearance of the contracted spirit specimens. M

e, B.Sc., of University College, has prepared from specimens the drawings of this part in the male and Nautilus reproduced in fig. 88, and has restored the o their natural form when expanded. The drawings ry strikingly the difference between male and female. female (lower figure), we observe in the centre of the buccal cone *c* carrying the beak-like pair of hich project from the finely papillate buccal membrane. tentaculiferous lobes of the fore foot are in immediate with this buccal cone, they are the right and left nner lobes, as we propose to call them, and the in nner lobe (*el*), called inferior because it really lies lwards of the mouth. This inner inferior lobe is a double one, representing a right and left inner lobe fused into one. A lamellated organ on its sur robably olfactory in function (*o*), marks the separation constituent halves of this double lobe. Each half a group of fourteen tentacles. The right and the nner lobes (*e*, *e*) each carry twelve tentacles. Ex-



Diagrams to show the relations of the tentacles and lobes of the fore foot in the Mollusca. [After Lankester.]

I. Dorsal view of the fore foot of *Nautilus*, with the tentacles removed from the left side.

II. Dorsal view of the fore foot of a Dibranchiate Cephalopod, with the tentacles removed from the left side.

a, Anterior or dorsal lobe; *b*, lateral lobes; *c*, ventral lobe; *d*, dorsal lobe; *e*, inner lateral lobes; *el*, inner inferior lobe; *f*, outer lateral lobes; *m*, mouth; *o*, olfactory organ; *x*, tentacles of the dorsal lobe; *y*, tentacles of the lateral lobes; *z*, tentacles of the ventral lobe.

to the e three lobe the mu-cular substance of the -emble o me foot is tu ed into a wide ring, which es e pecially thick and large in the dorsal region it i notably modified in form, offering a concavity hich the coil of the hell i received, and furnish protective hood to the retracted ma s of tentacles. part of the e ternal annular lobe of the fore foot is the "hood" (figs. 88, 91, *a*). The median antero ior lin tracer the line nece ity corresponding to ne of conver ence of the two lobe of the fore foot, primitively grea forward on each side of the and finally fu ed together along this line in front of outh. The tentacle carried by the great annular re nineteen on each side, thirty-eight in all. They newhat larger than the tentacle carried on the three lobes. The dorsalmo t pair of tentacles (marked ig. 88) are the only ones which actually belong to art of the disc which forms the great dorsal hood *a*, ood i , in fact, to a large extent formed by the enlarged - of the e two tentacle . In the Ammonite (fossil ranchiata allied to Nautilus) the dorsal surface of ad secreted a helly plate in two piece, known to ete a as Trigonellite and Aptychus. Probably, er, the double plate was carried on the surface of lobed muscular head with the form and sculptur which in Nautilus, it closely a ree. All the ten of the e external di tal ar e t in remarkable tubular s, into which they can be drawn. The sheaths of of these belonging to the external annular lobe are n fig. 91, marked *s*. The sheaths are muscular as the tentacle and are simply tubes from the base ich the solid tentacle grows. The functional signifi of this sheathing arrangement is as obscure as its ological origin. With reference to the latter, it rs highly probable that the tubular sheath represents p of a sucker such as is found on the fore-foot of the Dibranchiata. In any case, it seems to the writer sible to doubt that each tentacle, and its sheath on of the circum-oral disc of Nautilus, corresponds to a on such a lobe of a Dibranchiate. Keferstein follows in strongly opposing this identification, and in reg such tentacle as the equivalent of a whole lobe or ar Decapod or Octopod Dibranch. We find in the de these structures, especially in the facts concerni hectocotylus and spadix, the most conclusive reaso dissenting from Owen's view. We have so far e ated in the female Nautilus ninety tentacles. Fou remain which have a very peculiar position, and lead to the suggestion that the eye itself is a m tentacle. The e remaining tentacles are placed one (before) and one below (behind) each eye, and br the total to ninety four (fig. 91, *e*, *e*). They must sidered as also belonging to the fore foot which th rounds the eye.

In the adult male Nautilus we find the followi portant differences in the tentaculiferous disc as co with the female (see upper drawing in fig. 88) inner inferior lobe is rudimentary, and carries no te It is represented by three groups of lamellæ (*el*), wh not fully expo ed in the drawing. The right and le lobes are subdivided each into two portions. Th shows a larger portion carrying eight tentacles, and detached groups (*y*) of four tentacles, of which thr their sheath- united whilst one stands alone. The tentacle - may be called the "anti spadix." The le lobe shows a imilar larger portion carrying eight te and a curious conical body in front of it correspon the anti spadix. This is the "spadix" of Van der H (36). It carrie - no tentacles, but is terminated by cated lamellæ. These lamellæ appear to represent t tentacles of the anti spadix of the right internal lo are generally regarded as corresponding to that modi of the sucker-bearing arms of male Dibranchiate Ce pods to which the name "hectocotylus" is applied spadix is in fact the hectocotylized portion of th foot of the male Nautilus. The hectocotylized arm of male Dibranchiata is connected with the process o lation, and in the male Nautilus the spadix has pro similar significance, though it is not possible to s how it acts in this relation. It is important to that the modification of the fore foot in the male c pared with the female Nautilus is not confined existence of the spadix. The anti-spadix and the re of the inner inferior lobe are also male peculiarities external annular lobe in the male does not differ fr of the female; it carries nineteen tentacles on eac The four ophthalmic tentacles are also present. In the male Nautilus we find altogether sixty-two te the thirty two additional tentacles of the female being sented by lamelliform structures.

If we now compare the fore-foot of the Dibranchia that of Nautilus, we find in the first place a more arrangement of its lobes, which are either four or fi of tapering processes (called "arms") arranged in around the buccal cone, and a substitution of suck tentacles on the surface of these lobes (figs. 92, 9 The most dorsally placed pair of arms, corresponding two sides of the hood of Nautilus, are in reality th anterior (see fig. 75, (6)), and are termed the first pa the Octopoda there are four pairs of these arms (f 95), in the Decapoda five pairs, of which the fo greatly elongated (figs. 92, 93). In Sepia and othe poda (not all) each of these long arms is withdrawn pouch beside the head, and is only ejected for the of prehension. The figures referred to show some variations in form which these arms may assume.

da they are not unfrequently connected by a web, m an efficient swimming-bell. The suckers are placed ad-oral surface of the arms, and may be in one, four rows, and very numerous. In place of suckers e genera we find on certain arms or parts of the orny hooks; in other cases a hook rises from the of each sucker. The hooks on the long arms of oteuthis are drawn in fig. 97. The fore foot, with aratus of suckers and hooks, is in the Dibranchiata ally a prehensile apparatus, though the whole serie s in the Octopoda serve as swimming organs, and in (*e.g.*, the Common Octopus or Poulp) the sucker surface is used as a crawling organ.

he males of the Dibranchiata one of the arms i r less modified in connexion with the reproductive n, and is called the "hectocotylized arm." This s derived from the condition assumed by the arm se cases in which its modification is carried out to atest extent. These cases are those of the Oc *rgonauta argo* and *Parasira catenulata* (fig. 96) males of these the third arm (on the left side in uta, on the right side in Parasira) is found before eding season to be represented by a globular sac of nent. This sac bursts, and from it a long arm han its neighbours, having a small sac at its extremity asira (fig. 96, *s*), from which subsequently a long t issues. Before copulation the male clasps this th the spermatophores or packets of spermatozoa d from its generative orifice beneath the mantle-skirt, ring coitus the arm becomes detached and is left g to the female by means of its suckers. A new arm ed at the cicatrix before the next breeding season. nale, being much larger than the male, swims away he detached arm lodged beneath her mantle-skirt in a way which is not under stood, the fertilization eggs is effected. Specimens of the female Parasira e detached arm adherent were examined by Cuvier, istook the arm for a parasitic worm and gave to it ne Hectocotylus. Accordingly, the corresponding ed arms of other Siphonopoda are said to be hecto ed. Steenstrup has determined the hectocotylized on of one or other of the arms in a number of male chs as follows:—in all, except the Argonauta and a, the modification of the arm is slight, consisting in l enlargement of part or the whole of the arm, and iteration of some of its suckers, as shown in fig. 95, in Octopus and Eledone the third right arm is otylized; in Rossia the first left arm is hectocotylized ts whole length, and the first right arm also in the only; in Sepiola only the first left arm along its length; in Sepia it is the fourth left arm which is d, and at its base only; in Sepiotenthis, the same at x; in Loligo, the same also at its apex; in Loliolus, ame along its whole length; in Onuma trephes, oteuthis, and Loligopsis no hectocotylized arm has to been observed.

the females of several Dibranchs (Sepia, &c.) the s of spermatozoa or spermatophores received from ale have been observed adhering to the mantle-arms hey are passed in this case by the female to the ova er to fertilize them is unknown.

sculature, Fins, and Cartilaginous Skeleton. Without ng into a detailed account of the musculature of lus, we may point out that the great muscular masses fore-foot and of the mid-foot (siphon) are ultimately ble to a large transverse mass of muscular tissue, nds of which are visible through the integument on ght and left surfaces of the body dorsal of the ap of the mantle-skirt (fig. 89, *l*, *l*, and fig. 91, *l*). muscular areæ have a certain adhesion to the shell, and serve both to hold the animal in its shell and fixed supports for the various movements of the te ferous lobes and the siphon. They are to be ide with the ring-like area of adhesion by which the foot of the Limpet is attached to the shell of that anim fig. 27). In the Dibranchs a similar origin of the m masses of the fore-foot and mid foot from the sides shell—modified, as this is, in position and relations traced.

In Nautilus there are no fin-like expansions of the ment, whereas such occur in the Decapod Dibranch the sides of the visceral hump (figs. 92, 93). As an tion among Octopoda lateral fins occur in Pinnoctop 94, V), and in Cirrhoteuthis (fig. 94, D). In the podous division of the Cephalopoda such fin-like expa of the dorsal integument do not occur, which is to connected with the fact that another region, the mid foot, in Siphonopods [illegible] ted in expanded as a pair of fi

In Nautilus there is a curious plate-like expan integument in the mid dorsal region just behind the lying between that structure and the portion of t skirt which is reflected over the shell. This is sh fig. 90, *h*. If we trace out the margin of the pl find that it becomes continuous on each side wi sides of the siphon or mid foot. In Sepia and other pods (not in Octopoda) a closely similar plate exi exactly corresponding position (see *h* in figs. 110, 111 Sepia a cartilaginous development occurs here imme is below the integument forming the so-called "mucha drawn in fig. 116, D. The morphological signific this mucha lamella, as seen both in Nautilus and in is not obvious. Cartilage having the structure sho fig. 117 occurs in various region of the body of Si poda. In all Glossophorous Mollusca the lung-sac is supported by internal skeletal pieces, having th acter of cartilage, but in the Siphonopodous Cepha such cartilage has a wider range.

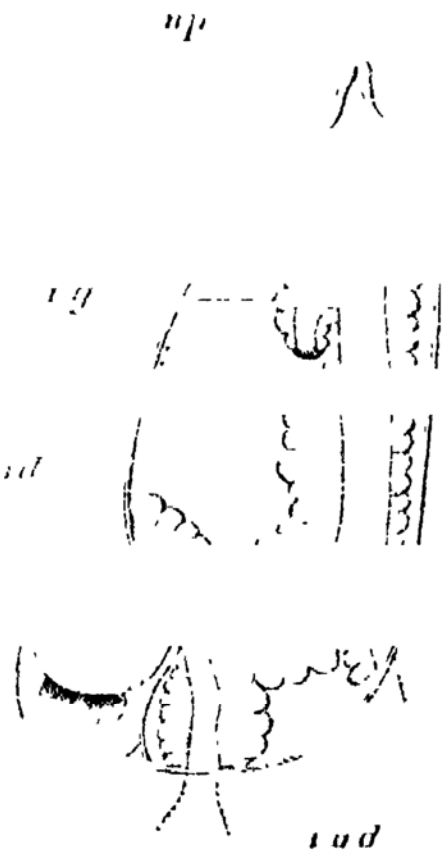
In Nautilus a large H-shaped piece of cartilage s forming the axis of the mid foot or siphon (fig. 1 B). Its hinder part extends up into the head and a the peri-œsophageal nerve-collar (*c*), while the two a ramii extend into the tongue-like siphon. In Sepia Dibranchs generally the cartilage takes a different as shown in fig. 110, C. The processes of this c cannot be identified in any way with those of the pedal cartilage of Nautilus. The lower larger pro the cartilage in Sepia is called the cephalic cartila forms a complete ring round the œsophagus, it com nerves also the gasteropod nerve-collar, so that nerves from the latter have to pass through fora the cartilage. The outer angles of this cartilage on each side so as to form a cup-like receptacle eyes. The two processes projecting right and left fr cartilage in the median line (fig. 110, C) "pro-ophthalmic cartilages;" in front of these, appa seen a piece like an inverted T, which forms a sup the base of the "arms" of the fore foot, and is the "brachial" cartilage. The Decapod Dibranchs have also the [illegible] already mentioned, and are the plate-like "[illegible]" (or [illegible]) described above the anterior end of which rests on and fits into the nuchal cartilage. In Octopoda there is no nuchal ca but two hind-like "dorsal cartilages." In Decapo are also two cartilaginous sockets on the side of the "siphon-lunge cartilages" into which the lobes of the mantle-skirt are loosely fitted. In Sepia and whole base-line of each lateral fin of the mantle (f is a "basi-pterygial cartilage." It is worthy of rema we have, thus developed, in Dibranch Siphonopods

e internal cartilaginous skeleton than is to be found of the lower Vertebrates. There are other instances Klaginous endo-skeleton in groups other than the eata. Thus in some capito-branchiate Chætopods e forms a skeletal support for the gill plumes, whilst Arachnids (Mygale, Scorpio) and in Limulus a large cartilaginous plate the ento-sternite is developed as support for a large series of muscles

Horny Teeth. The buccal cone of Nautilus is ter- by a villous mucous buccal membrane, surround pair of horny jaws. These are very strong and Nautilus, being calcified. Polished beaks of Tetra- ata are known under the name of Rhyncholite- ach the beaks are horny, but more nearly to Nautilus. They resemble in general form those of a the lower beak being the overlapping the upper one ach. The lingual ribbon and buccal apparatus be the case which is typical for Gasteropoda Mollusca. In fig. 107, A is ted a single row of teeth lingual ribbon of Nautilus, g. 107, *b*, C of other Gasteropoda.

Nautilus a long and wide œso- ed œsophagus (*œs*, fig. 105, om the ton- cular bag the apex of the visceral hump into a highly convolute sac enabling the animal to hold 110 c.c. A nearly straight s pass from the pouch- to the stomach, at which it s well-known ink-bag. In other pod these opaque contents (*i*, fig. 106, *a*, and the mu- stomach have a brown- which is very important in the alimentary tract by the cæcum. In all Dib- the cæcum be- near the and may be very spacious, larger than the stomach in ed into a spa-

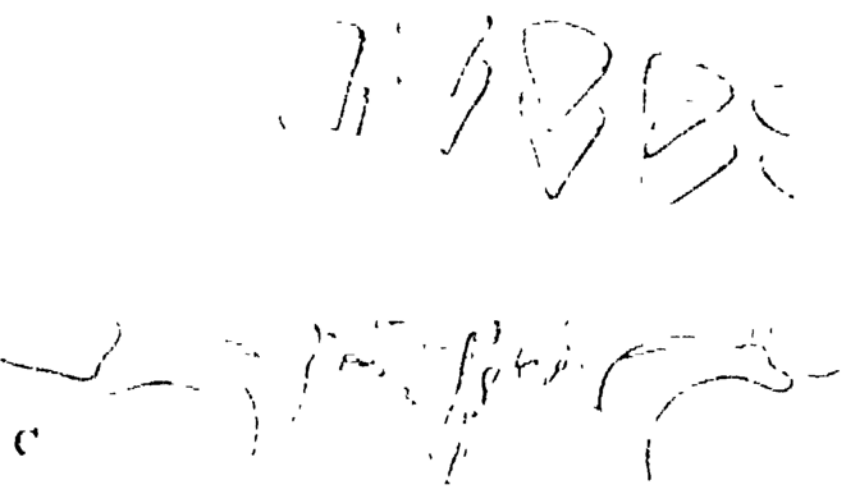
L, liver; *ad*, pan- to



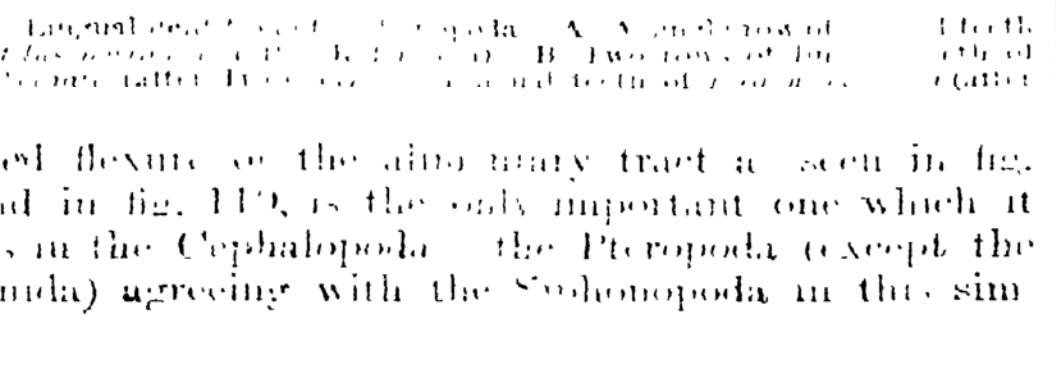
hp, *lg*, *hpd*, *lod*, *b.a*

plicity in consequence of their visceral hump bein twisted. The acini of the large liver of Nautilu compacted into a solid reddish-brown mass by a membrane, as also is the case in the Dibranc The liver has four paired lobes in Nautilus, which by two bile ducts into the alimentary canal at the mencement of the intestine. The bile-ducts unite entering the intestine. In Dibranchiata the two lobes of the liver are placed antero-dorsally (b the shell in Decapoda), and the bile-ducts open in cæcum. Upon the bile-ducts in Dibranchiata are loped yellowish glandular diverticula, which are as "pancreas," though neither physiologically nor m logically is there any ground for considering either called liver or the so-called pancreas as strictly equi to the glands so-denominated in the Vertebrata. In lus the equivalent of the pancreatic diverticula Dibranchiata can be traced upon the relatively shorte duct.

Salivary Glands are not developed in Nautilus u pair of glandular masses lying on the buccal cavity be considered as such. In the Dibranchs, on the co one (Sepia, Loligo) or two pairs of large salivary are present an anterior and a posterior (Octopus, E Onychoteuthis). Each pair of salivary glands h paired duct united to form a single duct, which forward from the gland and opens into the buccal



Lingual teeth of Cephalopoda. A, Portion of one row of teeth of *Sepia officinalis*, viewed from above; B, Two rows of teeth of *Loligo vulgaris*, viewed from above; C, Lateral tooth of *Loligo vulgaris*, viewed from in front.

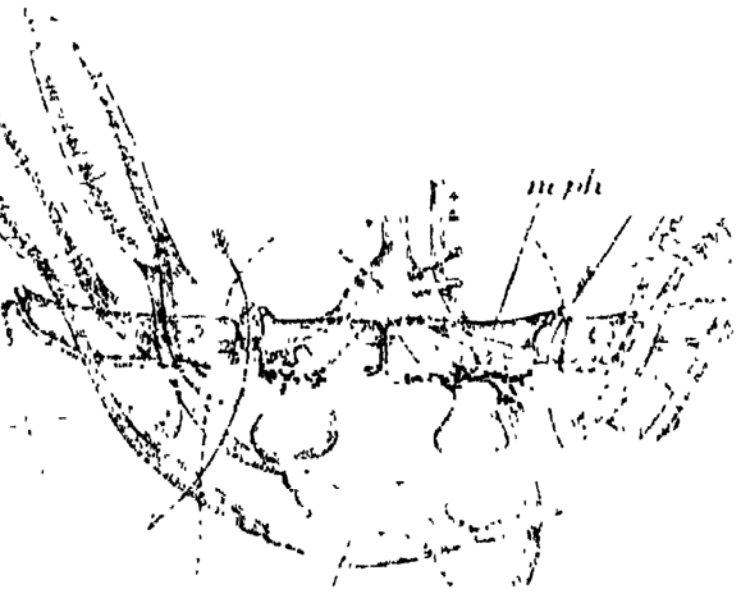


a, Portion of the nephridial sacs, and the veins which run [illegible] (after Vialleton). The nephridial sacs are [illegible] their upper wall removed. *a.c*, vena cava, *v.d c.c*, right de- [illegible] of the same, *v.d.c* left descending branch of the same, *v.* [illegible] the [illegible] *v.m* mesenteric vein, *v.g*, genital vein, *v.a* abdominal vein; *c.p.d*, left abdominal vein; *c.p.d*, right pallial ve- [illegible] left pallial vein, *c* brachial heart, *c*, appendage of the same; *c* [illegible] of the branchial heart, *c.g*, external aperture of the right nephridu [illegible] *c.p* pericardial sac or nephridium in connection with the visceral pericardial sac, the course of which below th [illegible] is indicated by dotted lines; *n*, the similar orifice of the l [illegible] renal outgrowth; *v.k*, visceral pericardial sac (dotted

owl flexure or the ali- mary tract as seen in fig. d in fig. 110, is the only important one which it s in the Cephalopoda the Pteropoda (except the nida) agreeing with the Siphonopoda in this sim

near the radula. The anterior pair of glands when be in the head near the buccal mass, the posterior much further back beneath the liver, at the sides ophagus. It is the posterior pair which alone a sent in Sepia and Loligo. The ink bag is to be con as an appendage of the rectum. It is not develo Nautilus, nor in the Pteropoda; in all Dibranchiata (the fossil Belemnites) it is present (fig. 106, *a*; fig. and has been observed to develop as a diverticulum rectum, with spirally plaited walls which very early a black pigment. The spiral plaitings of the walls di

ive size as the volume of the sac increases. Its
rface acquires a metallic iridescence similar to that
integuments of many fishes. The opening of the
is in the adult sometimes distinct from but near to



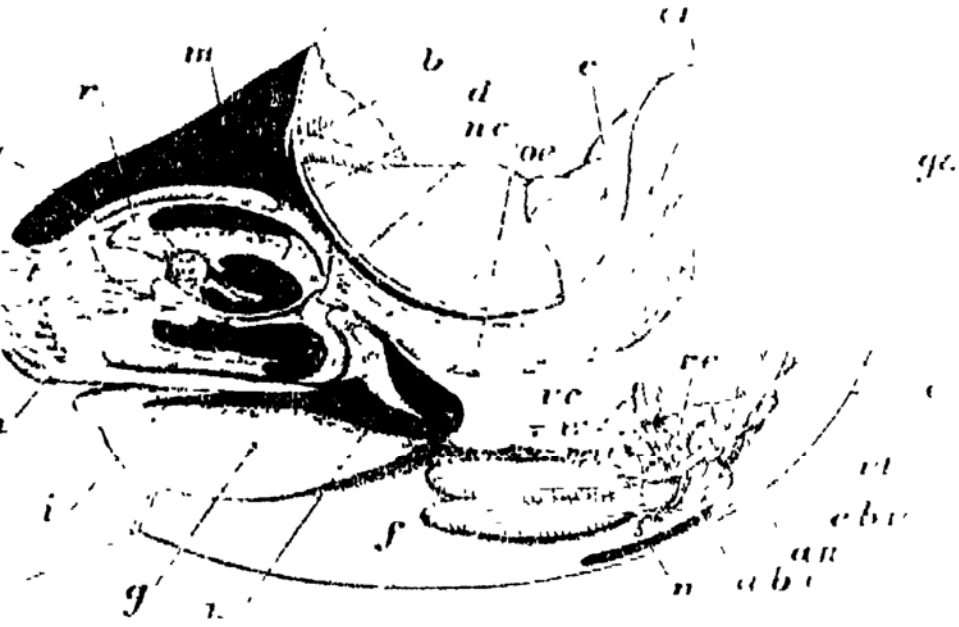
reid

dial sac, and the fo
) *ccgl*, *cvb*, and th
e two of the oppo
dent aperture, *ct*
backward extension
ht aperture of the
to outer wall
ar bodies of the li
a large) body of the
nt vessel into the
le of the heart, *ao*

us (Sepia); in other cases it opens into the
e anus. The ink-bag of Dibranchiate Siphono
y to be identified with the adherent (compa
of some Gastropoda.

om, Blood-vascular System, and Excretory Or

us and the other Siphonopoda conform to



. Diagram representing a vertical approximately median section of *Nautilus pompilius* (from a drawing by W. H. Flower). Parts which are quite black are the columns of blood-corpuscles. *m*, the mantle-mass; *a*, the shell; *b*, the nuchal plate identical with the ge of Sepia (see fig. 90, *b*); *c*, the integument covering the *d*, the mantle-flap or skirt in the dorsal region where it re of the shell; *e*, the inferior margin of the mantle-skirt in the shell represented by the dotted line; *f*, the palial chamber the four gills; *g*, the ventrally cut median portion of the mad), *h*, the capito-pedal cartilage (see fig. 110); *i*, the valve of *l*, the siphuncular pedicle (cut short); *n*, the hood or dorsal f the annular lobe of the foot; *r*, tentacles of the anterior l acles of the inner inferior lobe, *q*, buccal membrane; *s*, upper *s*, lower jaw or beak; *t*, lingual ribbon; *v*, the viscero-pericardial ve collar; *w*, œsophagus; *re*, crop; *ar*, gizzard; *ct*, mid-line *an*, mesenterial gland; *nept*, aperture of a nephridial sac; *e* lar masses on the walls of the afferent branchial vein (see fig. afferent branchial vessel; *ebr*, efferent branchial vessel; *ct*, vent heart.

l Molluscan characters in regard to these organs. the general body-cavity or cœlom forms a lacunar

ge |

pr
chamber (fig. 109, *vcp*). In Nautilus the viscero-per
sac open to the exterior directly by a pair of aperture
placed close to the right and on close to the left p
nephridial aperture (fig. 101, *ne*, *ne'*). The direct
of the pericardial sac to the exterior is an exception
occurs in all other Mollusca. In all other Molluscs
pericardial sac open into the nephridia and thro
or the anterior nephridium to the exterior. In Nautilu
two openings, from the viscero-pericardial sac to
nephridia. Therefore the external pore of the visc
cardial sac may possibly be regarded as a lateral
viscero-pericardial orifice from the actual modified po
sac to a position along side of its orifice. Parall
of such shifting are seen in the various positions
orifice of the ink-bag in Dibranchiata and in the
of the genital ducts of Mollusca, which in some fo
(*e.g.*, Spondylus) open into the nephridia, whilst
cases they open close by the side of the nephridia
surface of the body. The viscero-pericardial sac

-hs is very large also, and extends into the dorsal
It varies in shape -that is to say, in the extensions
rg ri ht and left between the various viscera in
i genera, but in the Decapods is largest. In an ex-
of this chamber is placed the ovary of Sepia, whilst
ricle of the heart and the branchial hearts and their
ces also lie in it. It is probable that water is
nto this chamber through the nephridia, since sand
r foreign matters are found in it. In all it opens
pair of nephridial sacs by an orifice on the wall of
ot far from the external orifice (fig. 108, *y*, *y'*).
oes not seem any room for doubting that each orifice
ond to the reno-pericardial orifice which we have
the Gastropoda, and half find accord in the Lamelli-
a. The single tube like nephridium and the peri-
n of the Pteropoda also communicate by an aperture.
irculatory organs, blood vessels, and blood of Nauti
ot differ greatly from those of Gastropoda. The
e of the heart is a four cornered body, receiving a
branchial efferent vessel (auricle) at each corner
y). It gives off a cephalic aorta anteriorly, and
r abdominal aorta posteriorly. The diagram, fig.
ves to show how this simple form of heart is related
orsal vessel of a worm or of an Arthropod, and how
mple flexure of the ventricle (D) and a sub-sequent
ion of one auricle, following on the suppression of
nchia, one may obtain the form of heart characte-
of the Ani-pleurous Gastropoda (excepting the
nchia). The flexed condition of the heart is seen
pus and is to some extent approached by Nautilus,
hat we do not perceive that perfect parallelism
hown in the figure (D). The most remarkable
presented by the heart of Nautilus is the possession
n stead of two auricles, a feature which is simply
to the metamerism of the branchiae. By the left
he heart of Nautilus, attached to it by a membrane,
ging loosely in the visceropericardial chamber, is
storm sac of Owen. This has recently been shown
e rudimentary left oviduct or sperm duct, as the
y be (Lankester and Bourne, **37**), the functional
ac and its duct being attached by a membrane
pposite side of the heart.

ephalic and abdominal aortæ of Nautilus appear,
ning to the antero-root and postero-root trunks of the
respectively, to open into sinus-like spaces surround-
viscera, muscular masses, &c. These spaces are
, but confined and shallow. Capillaries are stated
in the integument. In the Dibranchs the arterial
is very much more complete: it appears in some
end in irregular lacunæ or sinuses, in other cases
capillaries which lead on into veins. An investiga-
the capillaries in the light of modern histological
ds is much needed. From the sinuses and capil-
veins take origin, collecting into a large median
ior vena cava), which in the Dibranchs as well as in
has a ventral (pre-to-ventral) position, and runs
to the long axis of the animal. In Nautilus this
arises off at the level of the gills four branchial
ent veins (fig. 109, *avv*), which pass into the four
thent arteries. In the Dibranch at a similar posi-
vena cava gives off a right and a left branchial
ent vein (fig. 108, *v.a.v.c*, *v.a.v.c'*), each of which,
ng the wall of the corresponding nephridial sac and
g additional factors (fig. 108, *a.a*, *e.p.d*, *v.a.d*, *a.b.v*),
at the base of the corresponding branchial plume,
there a pulsating sac—the branchial heart (fig. 104,
fig. 108, *c.h*). Attached to each branchial heart is a
glandular body, which may possibly be related to
ger masses (*axc* in fig. 109) which depend into the
pericardial cavity from the branchial advehent veins
of Nautilus. From the dilated branchial heart the
chial advehent vessel proceeds, running up the ad-
face of the gill-plume (*ai*, *ai'*, fig. 104). From each
plume the blood passes by the branchial efferent ve
(*v'*, fig. 104) to the heart, the two auricles being for
by the dilatation of these vessels (*v*, *v* in fig. 104).

The blood of Siphonopoda contains the usual amœboi
puscles, and a diffused colouring matter—the hæmocy
of Fredericque—which has been found also in the blo
Helix, and in that of the Arthropods Homarus and Lim
It is colourless in the oxidized, blue in the deoxidized s
and contains copper as a chemical constituent.

The nephridial sacs and renal glandular tissue are cl
connected with the branchial advehent vessels in Nau
and in the other Siphonopoda. The arrangement is
as to render the typical relations and form of a nephri
difficult to trace. In accordance with the metameris
Nautilus already noticed, there are two pairs of neph
Each nephridium assumes the form of a sac opening
pore to the exterior. As is usual in nephridia, a glan
and a non-glandular portion are distinguished in each
these portions, however, are not successive parts of a tu
happens in other cases, but they are localized areæ of the
of the sac. The glandular renal tissue is, in fact, con
to a tract extending along that part of the sac's wall w
immediately invests the great branchial advehent
The vein in this region gives off directly from its w
complete herbage of little vessels, which branch and
stomose with one another, and are clothed by the glan
epithelium of the nephridial sac. The secretion is acc
lated in the sac and passed by its aperture to the exte
Probably the nitrogenous excretory product is very ra
discharged; in Nautilus a pink coloured powder is f
accumulated in the nephridial sacs, consisting of cal
phosphate. The presence of this phosphatic calculus by no means proves that such was the sole excretion of the renal glandular tissue. In Nautilus a glandular growth like that rising from the wall of the branchial vessel into its corresponding nephridial sac, but larger in size, depends from each branchial advehent vessel into the visceropericardial sac, probably identical with the "appendage" of the branchial hearts of Dibranchs.

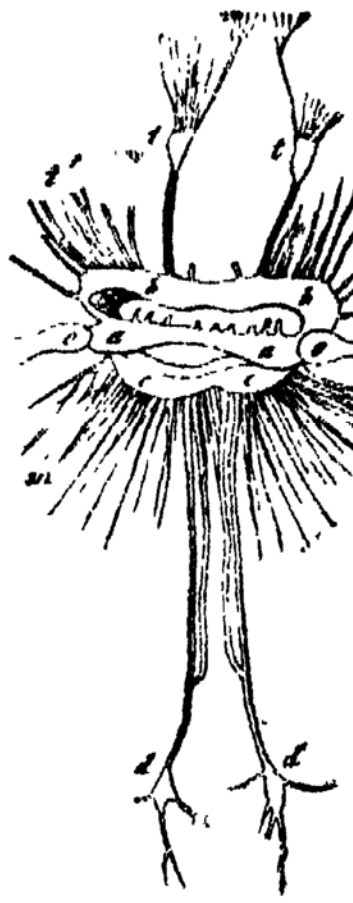


FIG. 112.—Nervous syst
Nautilus pompilius (fr
genbaur, after Owen).
ganglion-like enlargem
nerves passing from th
ganglion to the inner s
tentacles; *t'*, nerves to t
tacles of the outer or
lobe; *b*, pedal ganglio
a, cerebral ganglion-p
pleuro-visceral gan
band (fused pleural and
ral ganglion pairs); *d*,
ganglion placed on the
of the large visceral ner
before it gives off its br
and its osphradial bra
m, nerves from the
ganglion to the mantle

The chief difference, other than that of number between the nephridia of the Dibranchs and those of Nautilus, is the absence of the accessory growths depending into the viscero-pericardial space just mentioned, and, of more importance, the presence in the former of a pore leading from the nephridial sac into the viscero-pericardial sac (*a*, *a'* in fig. 108). The external orifices of the nephridia are also more prominent in Dibranchs than in Nautilus, being raised on papillæ (*ap* in fig. 108; *x* in fig. 103). In Sepia, according to Vigelius (**38**), the two nephridia give off each a divertículum dorsalwards, which unites with its fellows and forms a great median renal chamber, lying between the ventral portions of the nephridia the viscero-pericardial chamber. In Loligo the f

the two nephridia to form one sac is still more obvious, ce the ventral portions are united. In Octopus the ohridia are quite separate.

Tegumental pores have not been described in Nautilus, t exist in Dibranchiata, and have been (probably oneously, but further investigation is needed) supposed introduce water into the vascular system. A pair of

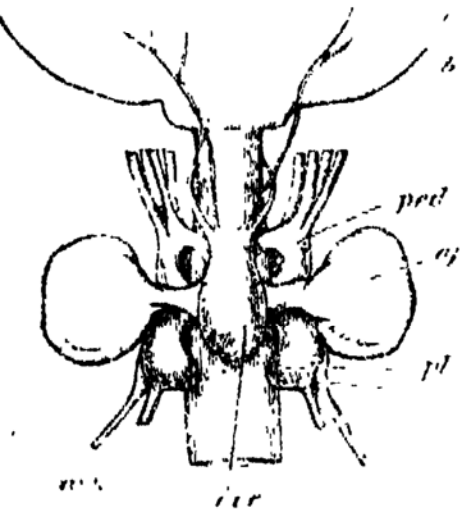


Fig. 113.

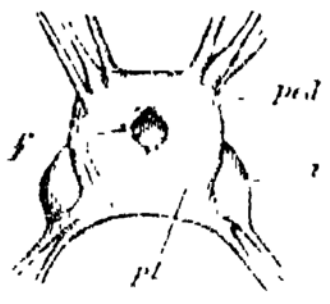


Fig. 111.

s. 113, 111. Nerve centres of O topo
orsal aspect, in fig. 111 one from the v
ped, pedal ganglion; *opt*, optic gan
anglion; *vis*, visceral ganglion; *o*
ass formed by pedal, pleural, and v
lood-vessel.

gh pores leading into sub-tegumental spaces or coelom Le area, the nature of which is imperfectly known, exist the back of the head in Philonexis, Tremoctopus, and gonauta. At the base of the arms and mouth tour such res are found in Histioteuthis and Ommastrephes -ix Sepia, Loligo, Onychoteuthis. Lastly, a pair of such res are found in the ecapoda at the base the long arms, lead- g into an extensive b-tegumental pouch each side of the head to which the long ms can be, and usually e, withdrawn. In pia, Sepiola, and Ros the whole arm is iled up in these sacs; Loligo only a part it is so; in Histio nthis, Ommastrephes, d Onychoteuthis, the es are quite small d do not admit the ms.

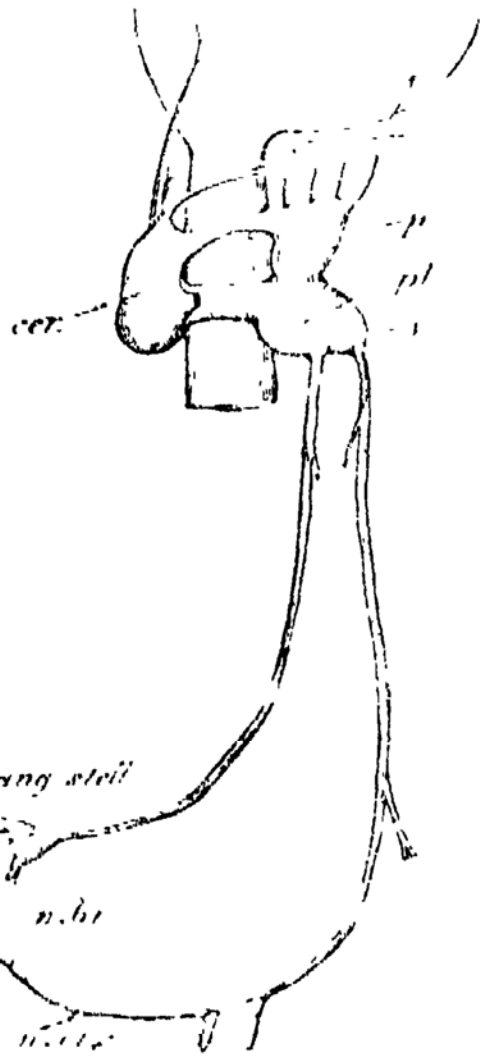
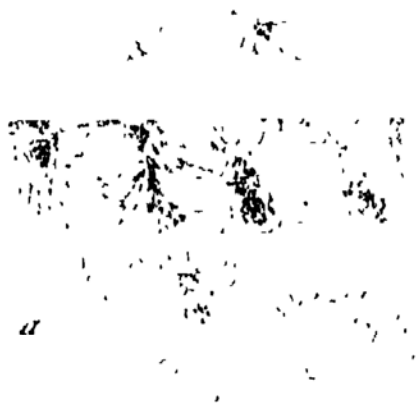


Fig. 112. Lateral view of the nerve centre and nerves of the right side of *ctr* (from a drawing by A. G. Bourne). *bc*, buccal ganglion; *cer*, cerebral ganglion; *ped*, pedal ganglion; *pl*, pleural and visceral region of the pleuro-visceral ganglion; *gang. stell*, the right stellate ganglion of the mantle connected by a nerve to the pleural portion; *n.visc*, the right visceral nerve; *n.olf*, its (probably) olfactory branch; *n.br*, its branchial branches.

Nervous System.—autilus, like the other ephalopoda (*e.g.*, Pneu- odermon, fig. 87; ctopus, fig. 113), ex bits a great concentra on of the typical Mol- scan ganglia, as shown fig. 112. The gan ia take on a band-like rm, and are but little fferentiated from their mmissures and con- ectives, an archaic ondition reminding us of Chiton. The special optic out rowth of the cerebral ganglion, the optic ganglion (fig. 12, *o*), is characteristic of the big-eyed Siphonopoda. he cerebral ganglion-pair (*a*) lying above the œsophagus is connected with two sub-œsophageal ganglion ps band-like form. The anterior of these is the peda and supplies the fore-foot with nerves *c'*, *c*, as al mid-foot (siphon). The hinder band is the viscer pleural pair fused (compare fig. 112 with fig. 8 especially with the typical Enthyneurous nervous s of Limnæus, fig. 22); from its pleural portion nerve to the mantle, from its visceral portion nerves branchiæ and genital ganglion (*d* in fig. 112), a immediate connexion with the latter is a nerve osphradium or olfactory papilla. No buccal ganglia been observed in Nautilus, nor has an enteric nervous been described in this animal, though both attain a development in the Dibranchiata. The figures (11 115) representing the nerve centres of Octopus, se exhibit the disposition of these parts in the Dibran The ganglia are more distinctly swollen than in Na In Octopus an intra-buccal ganglion pair are prese responding to the buccal ganglion pair of Gastropoda Decapoda a supra-buccal ganglion pair connecte these are also developed. In lieu of the numerou ating pallial nerves of Nautilus, we have in the D chiata on each side (right and left) a large erve passing from the pleural portion of the visceral ganglion to the mantle, where it enlar form the stellate ganglion. From each stellate ga nerves radiate to supply the powerful muscles mantle-skirt. The nerves from the visceral portion pleuro-visceral ganglion have the same course as in Na but no osphradial papilla is present. An enteric system is richly developed in the Dibranchiata, con with the somatic nervous centres through the ganglia, as in the Arthropoda through the stomato ganglia, and anastomosing with deep branches of t ceral nerves of the viscero-pleural ganglion pair been especially described by Hancock (39) in strephes. Upon the stomach it forms a single lar readily-detected gastric ganglion. It is questionable how far this and the "coeliac ganglion" formed in Decapoda by branches of the visceral nerves which pany the vena cava are to be considered as the equi of the "abdominal ganglion," which in a typical Ga nervous system lies in the middle of the visceral ner or commissure, having the right and left visceral on either side of it, separated by a greater or less of visceral nerve cord (see figs. 20, 21, 22). There little doubt that the enteric nervous system is more developed in the Dibranchiata than in other Mollus that it effects a fusion with the typical "visceral more extensive than obtains even in Gastropoda, such a fusion no doubt must also be admitted.

Special Sense Organs.—Nautilus possesses a osphradial papilla (fig. 101, *olf*) corresponding in and innervation to Spengel's organ placed at the bas ctenidia (branchiæ) in all classes of Mollusca. Thi has not been detected in other Siphonopoda. In pods it is well developed as a single ciliated pit, a the ctenidia are in that group aborted (fig. 87, Nautilus possesses other olfactory organs in the of the head. Just below the eye is a small tr process (not seen in our figures), having the struct shortened and highly modified tentacle and sheat Valenciennes, who is followed by Keferstein, this is a an olfactory organ. The large nerve which runs organ originates from the point of junction of th with the optic ganglion. The lamelliform organ i inner inferior tentacular lobe of Nautilus is poss olfactory in function. In Dibranchs behind the pit or open canal supplied by a nerve corresponding origin to the olfactory nerve of Nautilus above me

y the ... of tacte reside in certain processes
the ne ... d Nautilus and other Siphonopoda.



... of Nautilus were
... ch [illegible] at the ... e
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... ge ... eloteon
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... own by Lan-
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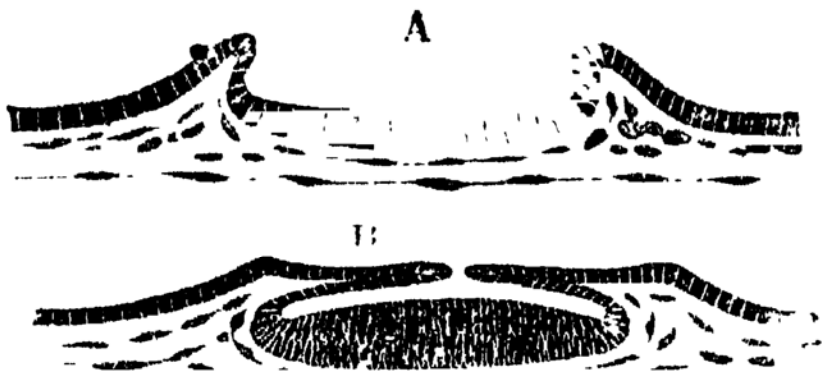
... l, ... (... a), which gradually ... the ...
... tion with the exterior becomes narrowed to a
... al which is ... by a lens at one end of the ... and
... has ... external opening obliterated. A ... cle
... only ... found in all Dibranchiata.
... e of Nautilus is among the most interesting ... the
... t remarkable animal. No other animal which
... the bulk and general elaboration of organization
... reach an eye as ... that of Nautilus. When looked
... the ... e no metallic lustre, no transparent

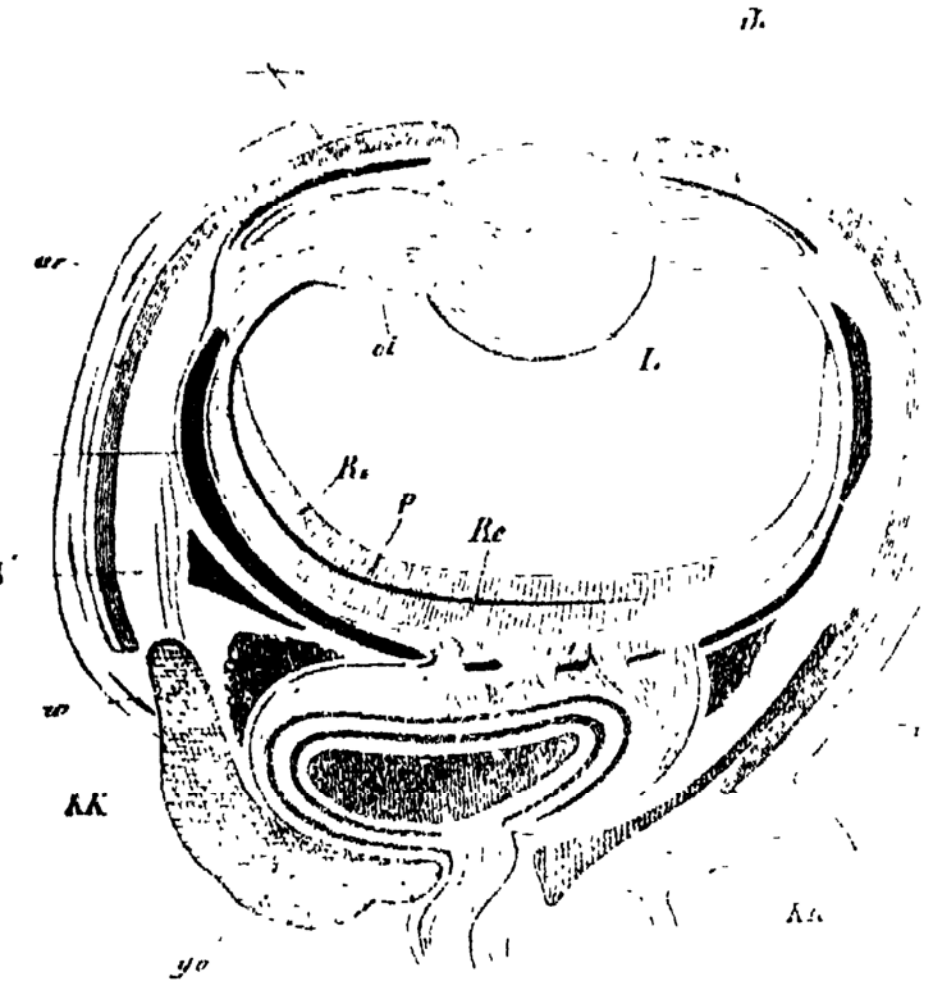
... ... of the ... l of the drum, half an inch
... ... ter looks like that of the surrounding
... ... t ... to the middle of the drum membrane is
... to ... a ...). Owen very naturally thought
... ...

s forms as a structureless growth, projecting inwards from front wall of this vesicle (fig. 123, B, *l*). The integument und the primitive optic vesicle which has sunk below



119.—Diagrams of sections showing the early stage e of Loligo when it is, like the permanent eye of N of Patella open sac. A First appearance of the eye as a n growth of the ring-like wall to form a sac, the Loligo. (From Lankester.)

surface now rises up and forms firstly in front of the axi the eye the iridian folds (*cf* in B, fig. 123, *cf* in fig. 120 in fig. 118), and then secondly an outer circular fold ws up like a wall and completely closes over the iridian ds and the axis of the primitive vesicle (fig. 120, *C*). s covering is transparent, and is the cornea. In the anic Decapoda the cornea does not completely close leaves a central aperture traversed by the optic nerv ese forms are termed Oligopsidæ by d'Orbigny (42), whil Decapoda with closed cornea are termed Myopsidæ the Octopoda the cornea is closed, and there is ever ther fold thrown over the eye. The iris surrounding cornea presents a free circular margin, and can be drawn r the surface of the cornea by a sphincter muscle. It is acts as an adjustable diaphragm, exactly similar an



120.—Horizontal section of the eye of Sepia (Myop cephalic artilages (see fig. 116); *C*, cornea (cuticle), *l*, lens, body, ternal layer of the retina; *Re*, external layer of the re between these; *o*, optic nerve; *go*, optic ganglion; *M* and *A*, cartilage of the iris; *w*, white body; *ce*, accessory aute chamber. (From Hensen, after Hensen.)

ovement to the iris of Vertebrates. Sepia and allied Deca ds have a horizontal lower eyelid, that is to say, only e-half of the sphincter like fold of integument is movable he exact history of the later growth of the lens in the branchs' eye is not clear. As seen in fig. 120, it appears ter attaining a certain size, to push through the front ll of the primitive optic vesicle at the point correspond g to its centre of closure, and to project a little into the terior chamber formed by the cornea. The wall of the primitive optic vesicle adjacent to the embedded l now becomes modified, forming a so-called "ciliary in which muscular tissue is present, serving to regul focus of the lens (*cf* in fig. 120). Bobretzky (43) from Lankester, whose view is above given, in ass distinct origin to the protruding anterior segment lens (*l*¹ in fig. 118). The optic ganglion, as well other large ganglia of the Dibranchiata, originate mesoblast of the embryo. The connexion between t of the retina and the nerve fibres proceeding from th ganglion must therefore be a secondary one.

Chromatophores.—In Nautilus these remarkable ture, which we mention here as being intimately ated with the nervous system appear to be absent Dibranchiata they play an important part in the ec enabling them to compete in comparison with the sl of the contents of the mid-body, to elude the observa either prey or foe. They consist of large vesicula (true nucleated cells converted into vesicles), arran a layer immediately below the epidermis. Each c tophore cell has processes to ten muscular bands a to the walls, radiating from it on all sides. The cont of the cell itself causes the chromatophore cell to out or return to its spherical resting state by i elasticity. In the physiological state, after such a c mechanical stimulus, which is usually protected by it- nuclei it covers an area of 3 mm. The sp of the chromatophore cells is intensely coloured w of the following colours—scarlet, yellow, blue, b which are usually of the greatest purity and brilliance action of the chromatophores may be watched most in young Loligos, either under the microscope or w naked eye. The chromatophores are suddenly ex and more slowly retracted with rapidly recurring nation. All the blue, or all the red, or all the may be expanded and the other colours left qu Thus the animal can assume any particular hu changeful appearance in a most striking way with extra rapidity. There is a distinct adaptation of the assumed in the case of Sepia and other to the co the surrounding rock and bottom.

Gonads and Genital Ducts.—In Nautilus it has been shown by Lankester and Bourne (37) that the duct of both eyes are joined right and left the l large rudimentary and tentacle-like appendage described by Owen as adhering by membranous ment to the ventricle of the heart, and known by stem to communicate by a pore with the exterior the Cephalopoda agree with other Mollusca in bilaterally symmetrical genital duct to the ca not archaic members of the class. The ovary gonad) on the testis-pouch consists in Nautilu the Dibranchiata in a cut-off cavity walled off fr other viscera, near its ventro-dorsal region. This is formed by the coalescence of peritoneal wall, th enclosed is originally part of the coelom, and i and Dibranchiata, in the adult part of the visceral chamber. In Octopus and its allies the genital chamber communicates by a right and a left canal with the exterior at the end of a prominent cone of peritoneum ovary or testis is set at the growth from the inner wall chamber, which it only partly fills. In Nautilus t genital duct, which is functional, is supplied conti to the pore on the postero-dorsal part of the ou walls of the capsule in which lie the ovary testis, as the case may be. The gonad itself ap represents a single median or bilateral organ.

The true morphological nature of the genital duc Cephalopoda and of other Mollusca is a subject which speculation and inquiry. In all the cases in whi

ontinuous with the tunic of the gonad itself occur – Nematoid worms, in Arthropoda, and in Teleostean he sides. Mollusca there is an absence of definite lge as to the mode of development of the duct. s, however, from such facts as have been ascer- that the gonad lies at first freely in the cœlom, t the duct develops in connexion with the genital ad attaches itself to the embryonic gonad, or to the which grows around it. The question then arises e nature of the pore. In other groups of animals that the pore, and tunnel or tube connected with which the genital products are conveyed to the , is a modified nephridium (usually a pair, one nd one left). Is it possible that this is also the here the duct very early becomes united to the and even gives rise to the appearance of a tubular testis? Probably this is the case in Teleostean see Huxley's observations on the oviducts of the 4) but it seems to be a tenable position that in other including the Mollusca, the genital pore is a simple in the body wall leading into the body cavity ont, such as we find on the dorsal surface of the orm, which has become specialized for the extrusion genital products. Possibly, as in Nemertine and ood worms, the condition preceding the development definite genital pores was one in which a temporary of the body wall occurred at the breeding season, is temporary aperture has gradually become perma The absence of genital pores in Patella, and some branchs which make use of the nephridia for the on of their genital products, suggests that the very Mollusca or their forefathers were devoid of genital nd pore. In no Mollusca, however, is the nephrid ed in the same way as a genital duct as it is in the oda, the Cephalopoda, and the Vertebrata; for the outh of the nephridium in Mollusca leads into the dial space, and it is not through this space and thus that the genital products of any Mollusca enter phridium (except perhaps in Neomenia), although y this month that the genital products enter the dium in the former classes above named. Hence angement in Patella, &c., is to be looked upon as a development from the simpler condition when the a brought forth by rupture of schizocœlic, trochoïds, , and not as derived from the common arrangement otation of a nephridium to the genital efferent func nephridial.[1]

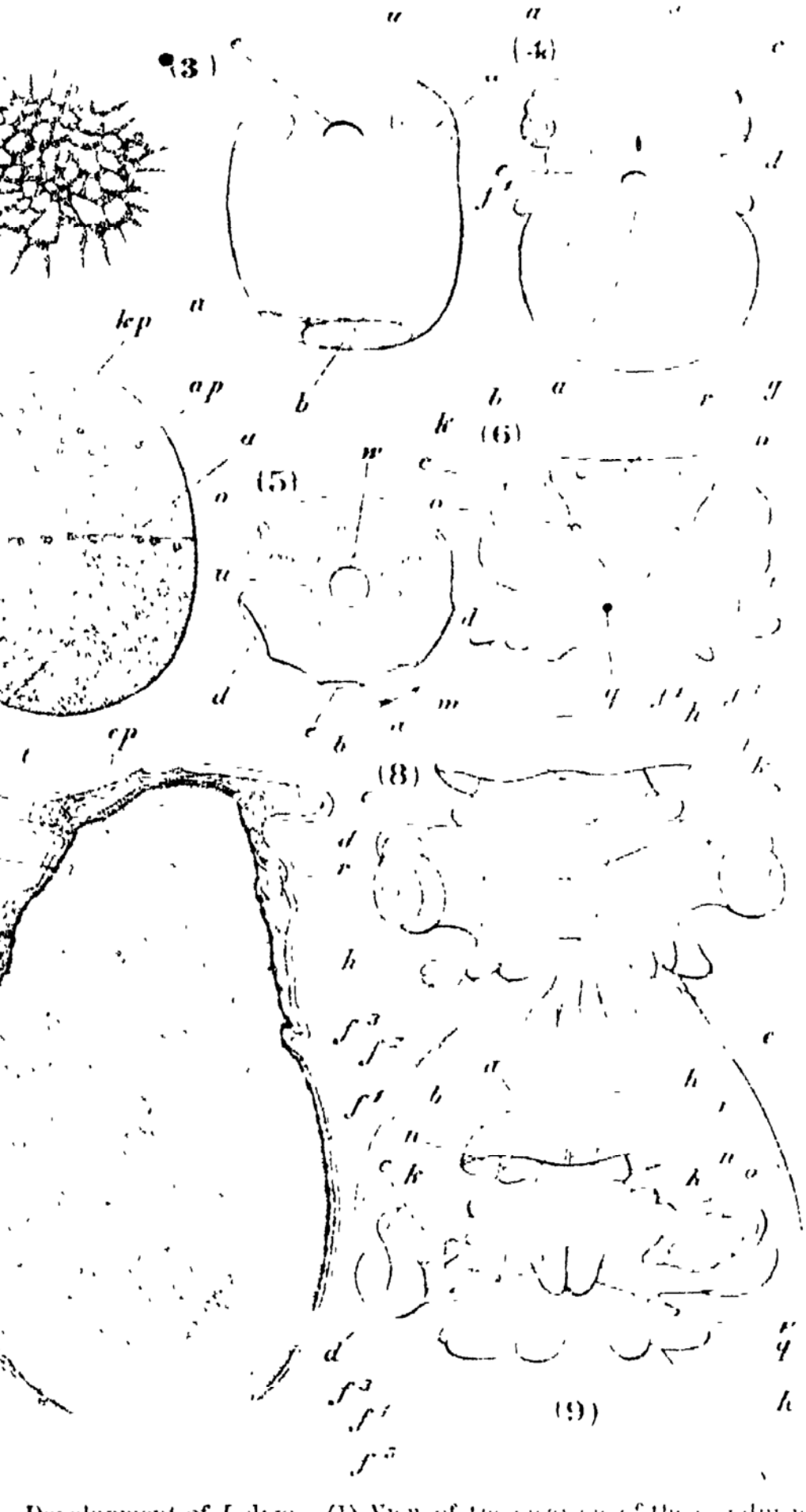
unctional oviduct of Nautilus forms an albuminif gland as a diverticulum, which appears to corres a dilatation in the male duct, which succeeds the ell, and is called the "accessory gland." The male s a second dilatation (Needham's sac), and then is ed in the form of a large papilla. In Dibranchs, e ducts are but little more elaborated. They are externally. In female Octopoda, in Omma-trephes, and in the Octopod (*Eledone moschata*) the genital are paired, opening right and left of the anus. But other Dibranchs a male genital duct only is deve viz., that of the left side, and leads from the genital ere it embraces the gonad to a symmetrically placed In the male Dibranchs the genital duct is coiled rovided with a series of glandular dilatations and

[1] Intermediate arrangements lead over to this nephridial future, either ome of Polychæta (in Eunicidæ, genus Eunice, divisible into Ne- e and Ichnoteæ), the testis or the nephridium serving as a the latter a portal vein appears to be being developed. In each of ver groups the pore may be (1) devoid of a duct, (2) provided t which is unattached to the gonad and opens into the body- 3) provided with a duct which fuses with the gonad. The ducts of Ichnoteæ forms may be called Ichnogonaducts, as dis- ed from the Nephrogonaducts of nephridial forms.

receptacles. These are connected with the formati he spermatophores. In the Siphonopoda the sper fluid does not flow as a liquid from the genital po the spermatozoa are made up into little packets extrusion. In other Mollusca (Pulmonata) and in annuals (Chætopoda) this formation of "sperm-ro known, but in the Siphonopoda it attains its h development. Exceedingly complicated structures cylindrical form (sometimes an inch in length) are in the male genital duct by a secretion which embe cements together the spermatozoa. They are form Nautilus as well as in Dibranchs, the actual manner in their complicated structure is produced being not cap pictured. Accessory glands not forming part of the o but furnishing the material for enclosing the eggs in an envelope, are found as paired structures, opening sou behind the anus in Nautilus (101, *g.n.*) and in t branchs. They are known as the nidamental gland the female Sepia they are particularly large and pro and are accompanied by a second smaller pair.

Reproduction and Development. The details of congress and of the actual fertilization of the egg are unknown in Nautilus, and imperfectly in the Dib and the Pteropoda. Allusion has already been m the subject in connexion with the heterocotylized arm mature eggs of Nautilus are unknown, as well as the ance which they present when deposited. In the Dib the eggs are always very large; in some cases the a of food-yelk infused into the original egg cell is so g to give it the size of a large pea. This results mode of development which is only known outsi class among the Vertebrata, it is discoblastic. The plasm of the fertilized egg cell segregates to one the egg, and there undergoes cell division, resulting formation of a disc of cleavage cells (fig. 121, (1)) bling the cicatricula of the hen's egg, which subse spreads over and invests the whole egg (fig. 121, (2) details of this process we must refer the reader t works (**45, 46**); but it may here be noted that in addi the layer of cleavage cells, which consists of more th stratum of cells in the future embryonic area as c to the yelk-sac area, additional cells are formed mass of residual yelk apparently by an independent of segregation, each cell having a separate origin, they are termed "autoplasts." The autoplasts eve form a layer of fusiform cells (fig. 121, (7), *h*; fig. and fig. 123, *ps*), the "yelk-membrane" which ever rests upon and encloses the residual yelk. The c cells form a single layer on the yelk-sac area and two on the embryonic area, an outer layer one cell deep (f *ep*), and an inner the middle layer of the three is often thick and many cells deep (fig. 122, *m*). T great difficulty here in identifying the layers with th typical layers of other animal embryos, except in to the outermost, which corresponds with the epib Vertebrates in many respects. The middle layer, he gives rise to the nerve ganglia as well as to the m cœlom, and skeleto-trophic tissues, and to the mid of the alimentary canal with its hepatic diverticu liver (see fig. 121, (7) and explanation, where the c the mid gut as a vesicle *x* is seen). It is clearly, th something more than the mesoblast of the Ver giving rise, as it does, to important organs formed epiblast and hypoblast in other animals. Lastly, th membrane, though corresponding to the Vertebrat blast in position and structure, furnishes no part alimentary tract, but disappears when the yelk pletely absorbed. In fact, the developmental phe in Sepia, Loligo, and Octopus are profoundly pertu the excessive proportion of food-yelk. Balfour ha

the chick the orifice of closure of the overspreading
arm does not represent the whole of the blastopore,



- Development of Loligo. (1) View of the cleavage of the egg, showing
st formation of embryonic cells. (2) Lateral view of the egg at a little
age. *a*, limit to which the layer of cleavage cells has spread over the
portion of the egg (shaded) as yet uncovered by cleavage cells; *cp*, the
asts; *kp*, cleavage pole where first cells were formed. (3) Later stage,
nt *a* now extended so as to leave but little of the egg surface (*y*) uncov
The eyes (*d*), mouth (*e*), and mantle sac (*c*) have appeared. (4) Later
anterior surface, the embryo is becoming tipped off from the yolk
. (5) View of an embryo similar to (3) from the cleavage-pole or
dorsal area. (6) Later stage, posterior surface. (7) Vertical mes
dorso-ventral and antero-posterior plane of symmetry of the embryo
(4). (8) View of the anterior face of an older embryo. (9) View of the
or face of an embryo of the same age as (8). Letters as in (3) to
ions of the mantle; *b*, mantle-skirt; *c*, superficial invagination to form
e "white body"; *d*, the eye; *e*, the mouth; *f*, *f*¹, *f*², *f*³, the lobes of the
ses of the fore foot; *g*, rhythmically contractile area of the yolk sac
nsist of a hernia-like protrusion of the median portion of the fore foot
. 72-7); *h*, dotted line showing internal area occupied by yolk (food
al of the egg); *k*, first rudiment of the mid foot (paired ridges which
to form the siphon or funnel); *l*, sac of the radula or lingual ribbon
mach; *n*, rudiments of the gills (paired elevations); *o*, the otocyst
invaginations of the surface of the mid foot; *p*, the optic ganglion
distal portion of the ridges which form the siphon or mid foot; *l*, basal
sal portion of the same structure; *s*, the vesicle-like rudiment of the
formed independently of the parts connected with the mouth; *t*, *mes*
ithout invagination; *u*, rudiment of the salivary gland; *v*, in (5), the
ne at an earlier stage open (see fig. 120), now closed up; *w*, the open
ne formed by an uprising ring-like growth of the centro-dorsal area
), the mantle-skirt commencing to be raised up round the area of the
ac. In (7) *mes* points to the middle cell layer of the embryo, *ep* to the
layer, and *h* to the deep layer of fusiform cells which separates every
the embryo from the yelk or food-material lying within it. (Original.)

ut this is in part to be sought in the widely-separated
ive streak. The present writer has little doubt that

a structure corresponding to the primitive streak
chick, and lying near the klastic pole, will be fo
Sepia and Loligo, and the strange vesicular origin
mid gut will be traced to and explained by it.

Leaving this difficult question of the cell-layers
embryo, we would draw the reader's attention to the
of sketches representing the semi-transparent embr
Loligo, drawn in fig. 121. When the cleavage cells
nearly enclosed the yelk, the upper or embryonic
shows the rudiments of the centro-dorsal mantle
pen ac, the mouth the paired optic pits, and the

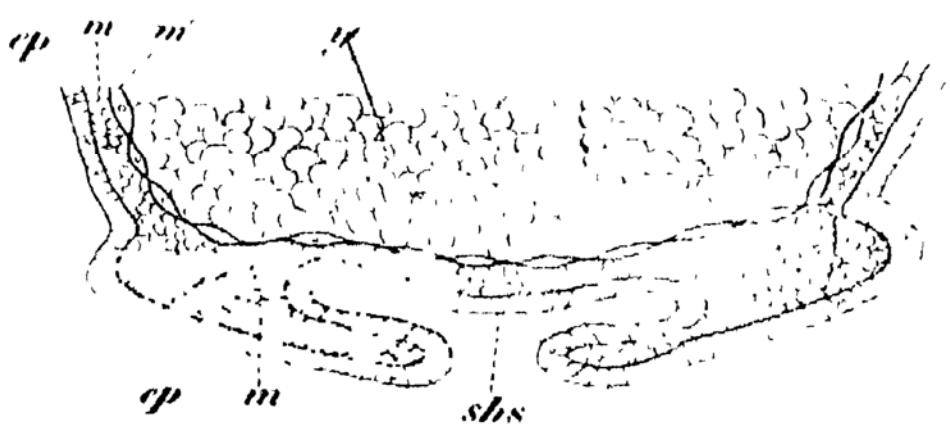
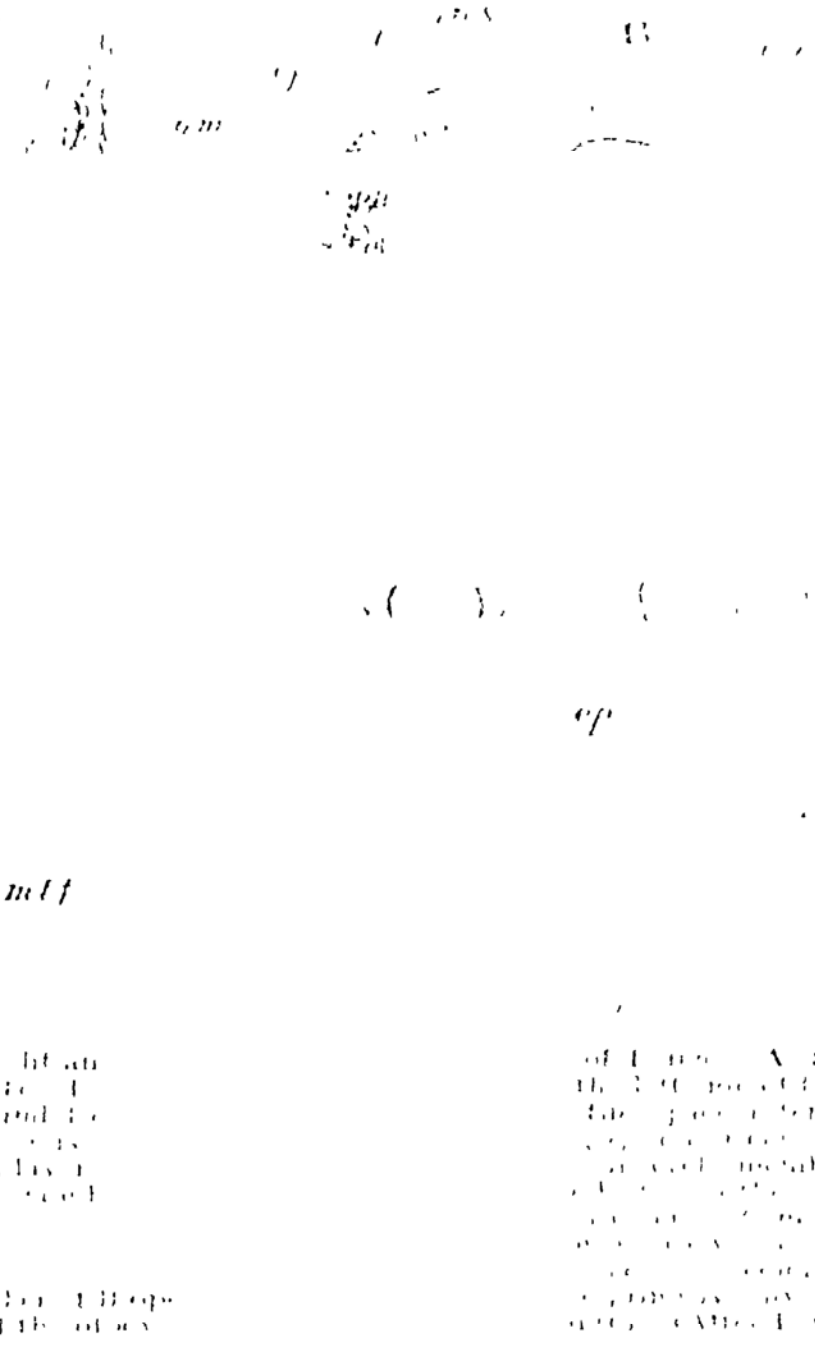


Fig. 122. Section through the full-grown shell-gland occupying the centr
area of an embryo of Loligo, the position of which is indicated in
(7) and (8) on the preceding page. *ep*, simple cells forming
layer of the general surface; *sbs*, the secreted veil or test enclosed
m, the full-grown test sac. (Original.)

otic pits (fig. 121, (3), (5)). The eye-pits close
119), the orifice of the mantle-sac narrows, and its
becomes raised and freely produced as mantle
at the same time an hour-glass-like pinching in
whole embryo commences, separating the embryo
from the so-called yelk-sac (fig. 121, (4)). Now
"waist" of constriction, part by part, ten lobes ar
121, (8)) the arms of the fore foot. It now b
obvious that the yelk-sac is but the median surface
fore foot bulged out moderately by food-yelk, just
hind region of the foot is in the embryo-stage (see fig
and explanation). Just as in the chick, this dilate
holding foot is rhythmically contractile, and p
steadily over the area *g* in fig. 121, (4). At this
nal long-sac especially, the mouth of the young Ceph
is in no way surrounded by the fore-foot, but lie
above its nascent lobe (*e* in fig. 121). Subsequ
sink, as it were, between the right and left most
pair of the arms, which grow toward one anoth
base above it, and leave no trace of their original
and relative. Fig. 121, (6) gives a view of the
dorsal surface of an embryo, in which the importa
appearance of the formation of the funnel or siphon
union of two pieces (*ep*), which grow up each side pe
one right and one left, like the sides of the
Nautilus or the swimming lobes of a Pteropod, and
quently come together, as *s*¹ will in (9), where th
letter *s* indicates the same part. The explanation
121 and 123 are given very full, and here, therefo
shall only allude to two additional points. A curio
of tissue of unknown significance occurs in the
Dibranchs, known as the white body (*w* in fig. 1
strongly marked invagination just above the orbit i
prominent feature in the embryo of Loligo, Sepi
Octopus, and appears to give rise to this so-calle
body. This invaginated portion of the outer cell
seen in fig. 121, (8) and (9), lettered *c*, in fig. 123
B, it is lettered *wb*.

Lastly, in fig. 123, A, the origin of the optic
ganglion *ng* from the cells of the middle layer sh
especially noticed. In some other Mollusca the
ganglia have been definitely traced to the outer ce

in some Gastropods, according to Bobretzky, they te, as here shown, for Loligo.
egg-coverings of the Dibranchiate are very complete. nuta and Octopus deposit each egg in a firm oval lum and transparent, which has a long stalk by m Octopus) the egg is fixed in company with two hundred others to some foreign object Sepia each egg in a thick envelope of many layers ing india rubber Loligo encloses many rows of a copious tough jelly, and affixes a dozen or twenty g strings to one spot. Sepia and Loligo deposit g- when laid. The female Octopus most jealously



them building a nest o
nuta carries hers with her

ne and mediterranean
pecial brood-holding

of biting, rasping, or prehensile organs. The ani sessile, or endowed with very feeble locomotive p The Lipocephala comprise but one class, the L branchia, also known as Elatobranchia and Conchife

Class LAMELLIBRANCHIA.

Characters.—Lipocephala in which the archaic ERAL SYMMETRY of the Mollusca is usually fully ret and raised to a dominant feature of the organization lateral compression of the body and the development shell as two bilaterally symmetrical plates or valves ng each one side of the animal. The FOOT is comm imple cylindrical or ploughshare-shaped organ, use boring in sand and mud, and more rarely presents a ng disc similar to that of Gastropoda; in some forn aborted. The paired CTENIDIA are very greatly dev ht and left of the elongated body, and form the prominent organ of the group. Their function is not respiratory but nutritive, since it is by the cu produced by their ciliated surface that food partic brought to the feebly developed mouth and buccal

The Lamellibranchia present as a whole a som uniform structure, so that, although they are very num it is not possible to divide them into well-marked sub- or sections, and orders. The chief points in whic vary are (1) in the structure of the ctenidia or bra plates, (2) in the presence of one or of two chief m the fibres of which run across the animal's body fro valve of the shell to the other (adductors); (3) in the g or less elaboration of the posterior portion of the m but so as to form a pair of tubes, by one of which i introduced into the sub pallial chamber, whilst other it is expelled; (4) in the perfect or deficient syn of the two valves of the shell and the connected soft as compared with one another; (5) in the develop the foot as a disc like crawling organ (Area, Nucula, N culus, Trigonia, Lepton, Galeomma), as a simple p like or tongue-shaped organ (Unionacea, &c.), as a re- saltatory organ (Cardium, &c.), as a long burrowing dra (Solenacea, &c.), or its partial (Mytilacea) or eve plete abortion (Ostracea).

The essential Molluscan organs are, with these tion, uniformly well developed. The MANTLE SK always long, and hides the rest of the animal from vi dependent margins meeting in the middle line belo ventral surface when the animal is retracted; it is were, cut in the median line before and behind s form two flaps, a right and a left; on these the rig the left calcareous valves of the shell are borne respec connected by an uncalcified part of the shell call ligament In many embryo Lamellibranchs a centr PRIMITIVE SHELL GLAND or follicle has been detecte 8 and 151). The MOUTH lies in the median line ant the ANUS in the median line posteriorly.

Both CTENIDIA right and left are invariably prese axis of each taking origin from the side of the body the schematic archi Mollusc (see fig. 1 and fig. 13 pair of NEPHRIDIA opening right and left, rather far f on the sides of the body, are always present. Each by its internal extremity into the pericardium. A GENITAL APERTURES, connected by genital ducts wi paired gonads, are found right and left near the nep pores, except in a few cases where the genital duc that of the nephridium (Spondylus). The sexes are but not always, distinct. No accessory glands or cop organs are ever present in Lamellibranchs. The e often act as brood-pouches.

A dorsal contractile HEART, with symmetrical rig left auricles (fig. 113, A) receiving aerated blood fr ctenidia and mantle-skirt, is present, being unequa

development of the Pteropoda, so far as known, no point of contact with that of the Siphonopoda than with that of the Gastropoda, owing to the fact the mouth does not acquire a process of food-yolk. Con ly, we find typical trochosphere and veliger larvae the Lamellibranchia (fig. 8, C, and fig. 8 D), whilst the Ihering has made known very table to the Gymnosomata, and with ordered (fig. 8 D). The former set of demonstrations for all the view which ... some zoologists, viz., that the velar ... the same thing as the ptero lobes of ... and foot of Pteropoda. The latter are of imp... ing, showing that, as in embryo opoda so ... Pteropoda the tucker bearing f the foot ... tructures, and only e the head and ... round the mouth as the result of bryonic growth

BRANCH B. *LIPOCEPHALA.*

Characters.—Mollusca with the head region undeveloped Shelly eyes are present, the buccal cavity is devoid

veloped only in those few forms which are inequivalve. The typical PERICARDIUM is well developed. It appears, as in other Mollusca, not to be a blood-space although developed from the cœlom, and it communicates with the exterior by the pair of nephridia. As in Cephalopoda (and possibly other Mollusca) water can be introduced through the nephridia into this space. The ALIMENTARY CANAL keeps very nearly to the median vertical plane whilst exhibiting a number of flexures and loopings in this plane. A pair of large glandular outgrowths, the so-called "liver" or great digestive gland, exists as in other Molluscs. A pair of pedal OTOCYSTS, and a pair of OSPHRADIA at the base of the gills, appear to be always present. A typical NERVOUS SYSTEM is present (fig. 144), consisting of a cerebro-pleuro visceral ganglion pair, united by connectives to a pedal ganglion-pair and an osphradial ganglion pair (parieto splanchnic).

A special cæcum connected with the pharynx is sometimes found, containing a tough flexible cylinder of transparent cartilaginous appearance and unknown significance, called the "crystalline style" (Mactra), which probably represents the radular sac of Glossophora. In many Lamellibranchs a gland is found on the hinder surface of the foot in the mid line, which secretes a substance which sets into the form of threads: the so-called "by-sus" by means of which the animal can fix itself. Sometimes the gland is found in the young and not in the adult (Anodon Unio, Cyclas). In some Lamellibranchs (Pecten, Spondylus, Ostrea, Solenomya, Tellina, Pectunculus, Galeommata, &c.), although cephalic eyes are always absent, special eyes are developed on the free margin of the mantle-lobe, apparently by the modification of tentacles which are commonly found there (fig. 145). The existence of pores in the foot and elsewhere in Lamellibranchs by which liquid can pass into and out of the vascular system although asserted as in the case of other Mollusca, appears to be improbable. It has yet to be shown by satisfactory microscopic sections that the supposed pores are anything but epidermal glands.

The Lamellibranchia live chiefly in the sea, some in fresh waters. A very few have the power of swimming by opening and shutting the valves of the shell (Pecten, Lima), most can slowly crawl or rapidly burrow; others are when adult, permanently fixed to stones or rocks either by the shell or the byssus. In development some Lamellibranchia pass through a free-swimming trochosphere stage with preoral ciliated band; other fresh water forms which carry the young in brood pouches formed by the ctenidia have suppressed this larval phase.

The following classification and enumeration of genera are based primarily upon the characters of the adductor muscles. The Heteromya and Monomya must be conceived of as derived from forms resembling such Gastroconchon-Isomya as Nucula and Trigonia, which undoubtedly are the nearest living representatives of the ancestral Lamellibranchia, and bring us nearest to the other branch of the Mollusca, the Glossophora.

Order 1.- Isomya.

Character. Anterior and posterior adductor muscles of approximately equal size.

Sub-order 1. - *Integropallia.*

Characters. — Marginal attachment of the mantle to the shell not inflected to form a sinus; siphons not developed in some, present in most.

Family 1. — *Arcacea.*

Genera: *Arca*, L. (fig. 132); *Cucullæa*, Lam.; *Pectunculus*, Lam.; *Limopsis*, Sassi; *Nucula*, Lam. (fig. 131); *Isocardia*, Munster; *Leda*, Schu.; *Yoldia*, Moll.; *Solenella*, Sowerby, &c.

Family 2. — *Trigoniacea.*

Genera: *Trigonia*, Brug.; *Axinus*, Sow.; *Lyrodesma*, Conrad.

Family 3. — *Unionacea.*

Genera: *Unio*, Retz.; *Castalia*, Lam.; *Anodon*, Cuv. &c.); *Iridina*, Lam.; *Mycetopus*, d'Orb., &c.

Family 4.- *Lucinacea*

Genera: *Lucina*, Brug.; *Cardis*, Cuv.; *Diplodonta* *Kellia*, Turton; *Montacuta*, Turton; *Lepton*, Turton *omma*, Turton; *Astarte*, Sow.; *Crassatella*, Lam.; Ag.; *Cardita*, Brug., &c.

Family 5. *Cyprinacea*

Genera: *Tridacna*, De C.; *Chama*, L.; *Diceras*, Lk.; *Lucinodon*, Lam.; *Hippopodium* Sow.; *Cardi* *Corbicula* Mke.; *Cyrena*, Lk. *ata*, Brug. (fig. 14 S:1351); *Cyprina*, Lam., &c.

Order 2. *Sesamyaria*

[illegible] d attachment of the mantle to th [illegible] nus into which the pallial siphons [illegible] were present, and large

Family 6. *Ver* [illegible]

Genera: *Cy* [illegible] *ina*, Lam., *Dip* Mcd. *Cardi* [illegible] Lk., *Sca* [illegible], Mcd., *L* [illegible] *Lucinopsis* Lam. *Pon* [illegible] L., *Dosi* L. *Asa* [illegible] *Crassa* Bronn *Mesod* [illegible] *Isocardia* Cuv. *Lucina* Lam.

Family 7. *Mac* [illegible]

Genera: *M* [illegible], Sby. *Cha* [illegible], Bro. *Pec* [illegible] *Thracia* Le [illegible], *Cl* [illegible], Sow., *Lyonsia* Sow. Brug. *Ma* [illegible] *Pholadomya* Des. *Periploma* A [illegible] Lam. [illegible] Mcd. &c. [illegible] *Mya* L.

Family 8. *Myi* [illegible]

Genera: *Ma* [illegible] *Lutraria* Lam., *Lyonsia* Lam. *Pholas* L. *Pandora* Brug. *Teredo* L., &c.

Order 2. Heteromya.

[illegible] adductor muscles unequal [illegible]

Family 1. *Mu* [illegible] Lam.

Genera: *Mu* [illegible] *Lithodomus* Cu., &c.

Family 2. *Ar* [illegible]

Genera: *Arca* [illegible] Mcke.

Family 3. *Pectinacea*

Genera: *Pecten* [illegible] *Spondylus* [illegible] *Lima* [illegible] Desh., &c.

Family 4. *Ostracea*

Genera: *Ostrea* [illegible] *Gryphæa* [illegible] *Exogyra* [illegible] *Alectryonia* [illegible] *Hyotis* [illegible] *Placunanomia* [illegible] *Anomia* [illegible] *Placuna* [illegible] *Perna* [illegible] *Crenatula* [illegible] *Aviculopecten* [illegible] *Pterinea* [illegible] *Pteria* [illegible] *Meleagrina* [illegible] *Avicula* [illegible] *Malleus* [illegible] *Vulsella* [illegible] *Inoceramus* [illegible] *Monotis* [illegible] *Aucella* [illegible] *Gervillia* [illegible] *Perna* [illegible] *Crenatula* [illegible] *Bakewellia* [illegible] *Isognomon* [illegible] *Hippochæta* [illegible] *Dimyodon* [illegible] *Trigonodus* [illegible] *Myophoria* [illegible] *Myalina* [illegible] *Modiola* [illegible] *Mytilus* [illegible] *Lithophagus* [illegible] *Dreissena* [illegible] *Congeria* [illegible] *Brachydontes* [illegible] *Crenella* [illegible] *Modiolaria* [illegible] *Volsella* [illegible] *Septifer* [illegible] *Arcomytilus* [illegible] *Perumytilus* [illegible] *Hormomya* [illegible] *Aulacomya* [illegible] *Choromytilus* [illegible] *Mytilimeria* [illegible] *Crenomytilus* [illegible] *Grammatodon* [illegible] *Solenomya* [illegible] *Petricola* [illegible] *Lithophaga* [illegible] *Saxicava* [illegible] *Gastrochæna* [illegible] *Clavagella* [illegible] *Aspergillum* [illegible] *Fistulana* [illegible] *Teredina* [illegible] *Teredo* [illegible] *Xylotrya* [illegible] *Bankia* [illegible] *Martesia* [illegible] *Pholas* [illegible] *Jouannetia* [illegible] *Barnea* [illegible] *Pholadidea* [illegible] *Xylophaga* [illegible] *Turnus* [illegible] *Platyodon* [illegible] *Cochlodesma* [illegible] *Thracia* [illegible] *Myochama* [illegible] *Anatina* [illegible] *Periploma* [illegible] *Lyonsia* [illegible] *Poromya* [illegible] *Cuspidaria* [illegible] *Neæra* [illegible] *Verticordia* [illegible] *Halonympha* [illegible] *Pandora* [illegible] *Clidiophora* [illegible] *Myadora* [illegible] *Lutraria* [illegible] *Mya* [illegible] *Corbula* [illegible] *Sphenia* [illegible] *Hiatella* [illegible] *Panopæa* [illegible] *Glycimeris* [illegible] *Saxicavella* [illegible] *Myochlamys* [illegible] *Myopsis* [illegible] *Myodora* [illegible] *Myonera* [illegible] *Myopholas* [illegible] *Myoforceps* [illegible] *Myoconcha* [illegible] *Myacites* [illegible] *Myalina* [illegible] *Myoplusia* [illegible] *Myoplus* [illegible] *Myoschiza* [illegible] *Myoscapha* [illegible] *Myoscalpellum* [illegible] *Myoscalprum* [illegible] *Myoscalpellus* [illegible] *Myoscalprus* [illegible] *Myoscalpellum* [illegible] *Myoscalprum* [illegible] *Myoscalpellus* [illegible] *Myoscalprus* [illegible]

Order 3. Monomya.

[illegible] Mono

[illegible] never developed [illegible]

Family 1. *A* [illegible]

Genera: *Ano* [illegible] *Anodonta* Cuv. *Symphynota* Lea. *Margaritana* Schum. *Unio* Retz. *Hyria* Lam. *Mycetopus* d'Orb. *Iridina* Lam. *Castalia* Lam. *Diplodon* Spix. *Glabaris* Lea. *Hyriopsis* Lea. *Obovaria* Lea. *Lampsilis* Rafinesque. *Proptera* Rafinesque. *Quadrula* Rafinesque. *Plagiola* Rafinesque. *Symphynota* Lea. *Alasmodonta* Say. *Anodontoides* Simpson. *Strophitus* Say. *Arcidens* Lea. *Pleurobema* Rafinesque. *Elliptio* Rafinesque. *Unio* Retz. *Margaritana* Schum. *Hyria* Lam. *Mycetopus* d'Orb. *Iridina* Lam. *Castalia* Lam. *Diplodon* Spix. *Glabaris* Lea. *Hyriopsis* Lea. *Obovaria* Lea. *Lampsilis* Rafinesque. *Proptera* Rafinesque. *Quadrula* Rafinesque. *Plagiola* Rafinesque. *Symphynota* Lea. *Alasmodonta* Say. *Anodontoides* Simpson. *Strophitus* Say. *Arcidens* Lea. *Pleurobema* Rafinesque. *Elliptio* Rafinesque.

Family 2. *Unio* [illegible]

Genera: *Unio* [illegible] *Margaritana* Schum. *Hyria* Lam. *Mycetopus* d'Orb. *Iridina* Lam. *Castalia* Lam. *Diplodon* Spix. *Glabaris* Lea. *Hyriopsis* Lea. *Obovaria* Lea. *Lampsilis* Rafinesque. *Proptera* Rafinesque. *Quadrula* Rafinesque. *Plagiola* Rafinesque. *Symphynota* Lea. *Alasmodonta* Say. *Anodontoides* Simpson. *Strophitus* Say. *Arcidens* Lea. *Pleurobema* Rafinesque. *Elliptio* Rafinesque.

Further R [illegible]

branchiæ are t [illegible] ed

of Mollu [illegible]

suppose that, [illegible] arch Mo

phyletic forms [illegible] he bivalv

the elaborate [illegible] her direc

Lamellibranch [illegible] he large

monaxial cepl [illegible] ome in

mantle-lobes w [illegible] opened

animal, re [illegible] ne of character-

the [illegible] ly pared

[illegible] ve development of the other [illegible]

[illegible] ed Lamellibranchia to be

as the radula [illegible] the radular sac of Glo

ancestral [illegible] ne, there is no indication wha

the ancestor [illegible] d Lamellibranchia had acquir

-centrive of [illegible] neal apparatus, so highly de

Glossophora [illegible] ne diverging from the stoc

that is to [illegible] e common ancestor of the

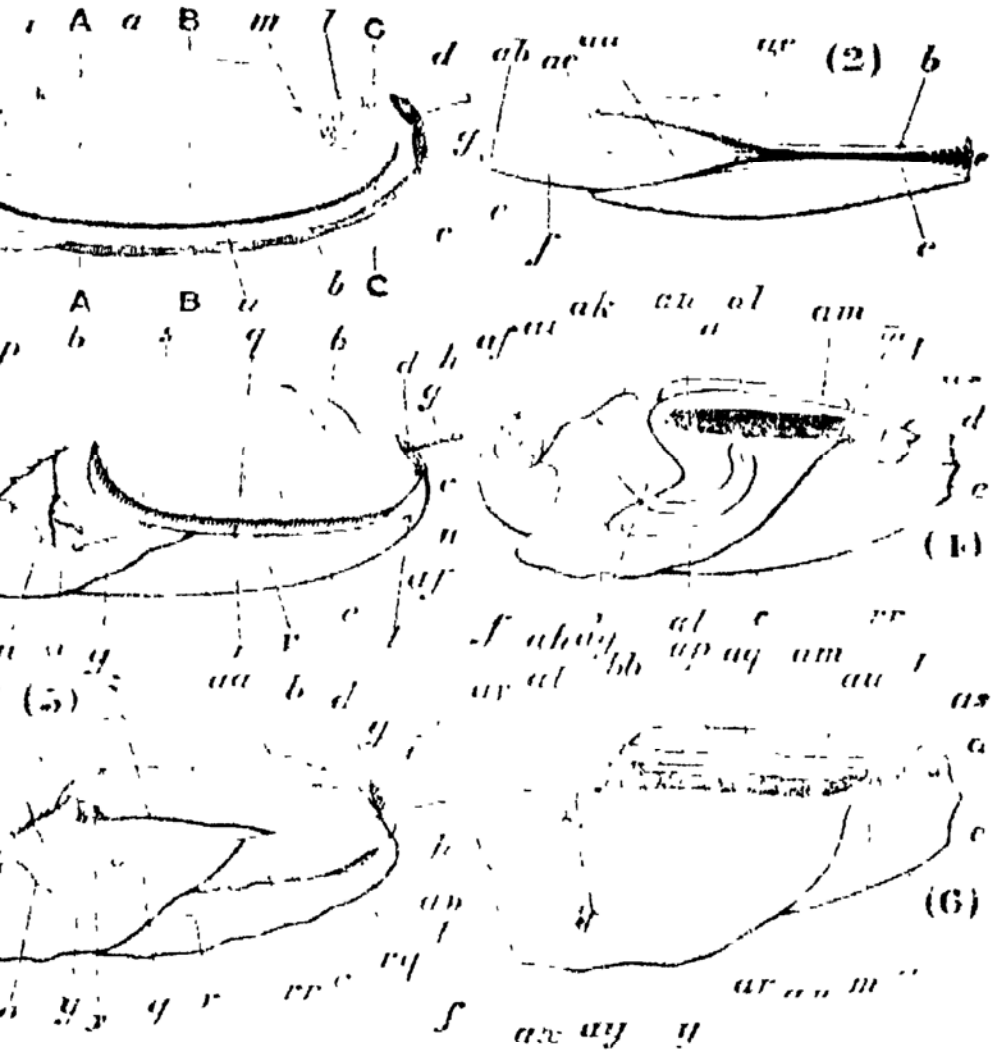
branches of [illegible] ncs presented the distinctive

of neither bra [illegible] They had not an aborted cephal

and they had not a lingual ribbon.

As an example of the organization of a Lamel we shall review the structure of the Common Pon (*Anodonta cygnea*), comparing its structure with

amellibranchia. The Swan Mussel has superficially
etly developed bilateral symmetry. The left side of
nal is seen as when removed from its shell in fig.
The valves of the shell have been removed by
r their adhesions to the muscular areæ *h*, *i*, *k*, *l*, *m*, *n*.



and so to form a more or less completely closed bag
the Scaphopoda (Dentalium). In this way the
d, *e* of the hinder part of the mantle skirt of Anodon
the Siphonate forms converted into two, separate hol
edges of the mantle being elsewhere fused together
this hinder margin. Further than this, the part
mantle skirt bounding the two holes is frequently dra
so as to form a pair of tubes which project from the she
130, 141). In such Lamellibranchs as the oysters, sc
and many others which have the edges of the mant
quite free, there are numerous tentacles upon those
In Anodon these pallial tentacles are confined to a sma
surrounding the interior siphonal notch (fig. 124, (3

The centro-dorsal point *a* of the animal of An
(fig. 124, (1)) is called the umbonal area; the great a
muscular surface *h* is that of the anterior adductor
the posterior similar surface *i* is that of the po
adductor muscle; the long line of attachment *u*
simple "pallial muscle," a thickened ridge which
to run parallel to the margin of the mantle-skirt
Lamellibranch. In some of the Siphonate Isomya,
are hence termed "Sinupallia," the pallial muscle
simple but deeply incurved at the posterior region s
allow of the large pallial siphons being retracted wit
shell or expanded at will (fig. 127, and figs. 140, 1

It is the approximate equality in the size of the anterior and posterior adductor muscles which has led to the name Isomya for the group to which Anodon belongs. The hinder adductor muscle may be considered as representing morphologically the transverse fibres of the root of the foot of Nautilus by which it adheres to its shell (fig. 91, *k*), the annular muscular area of Patella (fig. 27, *c*), and the columella muscle of the Gastropods generally. It is always large in Lamellibranchs, but the anterior adductor may be very small (Heteromya), or absent altogether (Monomya). The anterior adductor muscle is in front of the mouth and alimentary tract alto and must be regarded as a special and peculia lopment of the median anterior part of the man

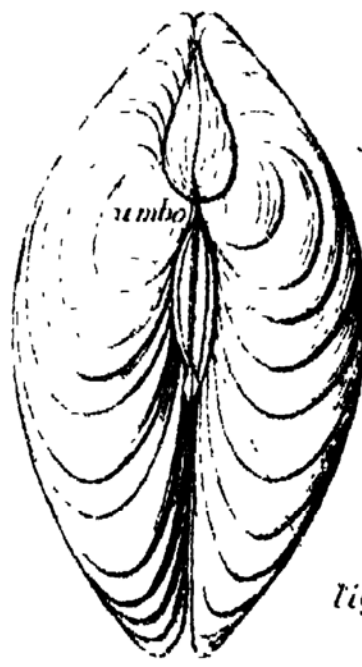


FIG. 125. View of the t of the shell of Cythe the Sinupalliate Isom the dorsal aspect.

FIG. 126. Right valve of the same shell from the outer face

e edge of the left half of the mantle-skirt *b* is repre
s a little contracted in order to show the exactly simi
edge of the right half of the mantle-skirt *c*. These
e not attached to, although they touch, one another;
p (right or left) can be freely thrown back in the way
has been carried out in fig. 124, (3) for that of the
. This is not always the case with Lamellibranchs;
s in the group a tendency for the corresponding
f the mantle-skirt to fuse together by concrescence,

in Heteromya and Isomya. Amongst those L
branchs which have only a posterior adductor (Mor
it is remarkable that the oyster has been fou
Huxley) to possess, when the young shells and
first develop, a well-marked anterior adductor as w
posterior one. Accordingly there is ground for sup

ne Monomya have been developed from Isomya-
ncestors, and have lost by atrophy their anterior
or. The single adductor muscle of the Monomya
rated by a
ace of fibre
vo portions,
therof these
regarded as
y represent
e anterior
or of the
Lamellis. One of
portions is
gamentous,
rves to keep
shells con-
attached to
other, whilst
e fleshy por-

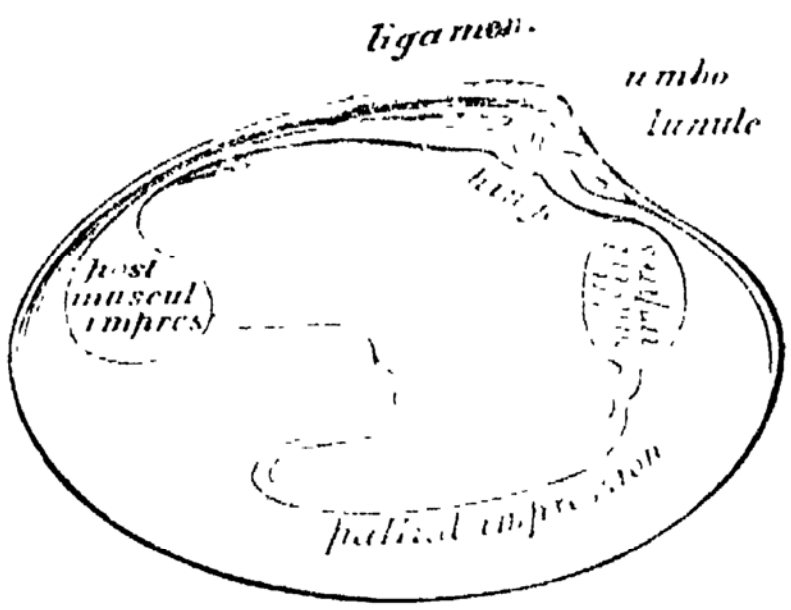


Fig. 127. Left valve of the same shell from the inner face. (Figs. 125, 126, 127, from Owen.)

rves to close the shell rapidly when it has been gaping
emoving the valves of the shell from an Anodon it
sary not only to cut through the muscular attach
of the body wall to the shell but to sever also a
elastic ligament, or spring resembling india rubber,
the two shells about the umbonal area. The bell
don does not present these parts in the most strongly
l condition, and accordingly our figure (figs. 125,
27) represent the valves of the Simpechinate
ea. The corresponding parts are removed
n. Referring to the figures (125, 126) for
on of terms applicable to the parts of the valv and
rkings on its inner surface - corresponding to the
ar area which we have already noted on the surface
mmal's body - we must specially note here the post
that denticulated thickening of the dorsal margin
valve which is called the hinge (fig. 127). By this
ne valve is closely fitted to the other. Below this
ach shell becomes concave, above it each shell rises a
form the umbo, and it is into this ridge like upgrowth
valve that the elastic ligament or spring is fixed (the
As shown in the diagram (fig.
representing a transverse sec
the two valves of a Lamelli
the two shells form a double
f which the toothed hinged is
erum. The adductor muscles
in the concavity of the shells
n the long arms of the lever
echanical advantage; their con
keeps the shells shut, and
es the ligament or spring *h*
other hand, the ligament *h*
on the short arm formed by
bonal ridge of the shells; when-
e adductors relax, the elastic
ce of the ligament contracts,
e shells gape. It is on this
that the valves of a dead La-
anch always gape; the elastic
t is no longer counteracted by
rt of the adductors. The state
re of the valves of the shell is
refore, one of rest; when it is
that is, when there is no
ar effort—the valves of a Lamellibranch are slightly
, and are closed by the action of the adductors when
nal is disturbed. The ligament is simple in Anodon,
y Lamellibranchs it is separated into two layers, an
nd an inner (thicker and denser). That the condition

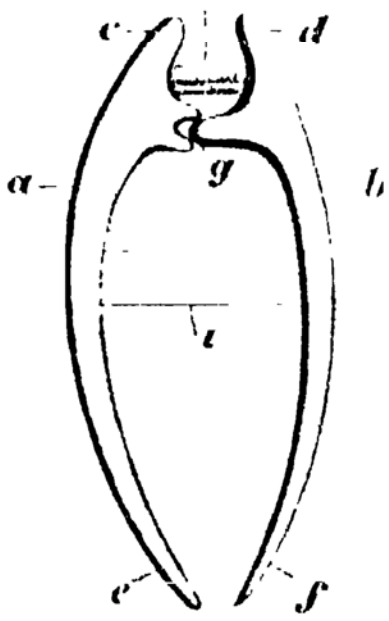


Fig. 128. Diagrammatic section of a Lamellibranch shell, figure
a, *b* the right and left valves of the shell; *c*, *d*, the umbones or short arms of the lever; *e*, *f*, the long arms of the lever; *g* the hinge; *h* the ligament; *i*, the adductor muscle.

of gaping of the shell valves is essential to the life
Lamellibranch appears from the fact that food to
it, water to aerate its blood, and spermatozoa to
its eggs, are all introduced into this gaping cham
currents of water, which are set going by the
developed etenidia. The current of water enters i
sub-pallial space at the spot marked *e* in fig. 12
and, after passing as far forward as the mouth *m* in f
(5), takes an outward course and leaves the sub
space by the upper notch *d*. These notches are
in Anodon as the afferent and efferent siphonal
respectively, and correspond to the long tube like
inferior and efferent superior "siphons" formed
mantle in many other Lamellibranchs (fig. 130).

Whilst the valves of the shell are equal in Ano
and in many Lamellibranch (Ostrea, Chama, Corbu
one valve larger, and the other smaller and sometim
whilst the larger shell may be fixed to rock or to
(Ostrea, &c.). A further variation consists in the d
ment of additional shelly plates upon the dorsal
tween the two large valves (Pholadidae). In *Pholas*
we find a pair of umbonal plates, a dorsal umbonal pl
a dorsal plate. It is to be remembered that the whol
cuticular hard product produced on the dorsal surfa
on the mantle flaps is to be regarded as the shell
which a median band like area, the ligament usually
unsclerified, so as to result in the production of two
united by the cuticle ligament. But the shelly su
does not always in boring forms adhere to this for
its first growth. In *Xylophaga* the whole of the
mantle area secretes a continuous
tube, although in the young conditi
valves were present. These are se
129) set in the firm substance of th
tubular shell, which has even replac
ligament, so that the tube is comple
To redo a similar tube is formed as the
elongate (boring in wood), the original
valves not adhering to it but remaining
able and provided with a special m
apparatus in place of a ligament.

Let us now examine the organs w
beneath the mantle-skirt of Anodon,
bathed by the current of water wh

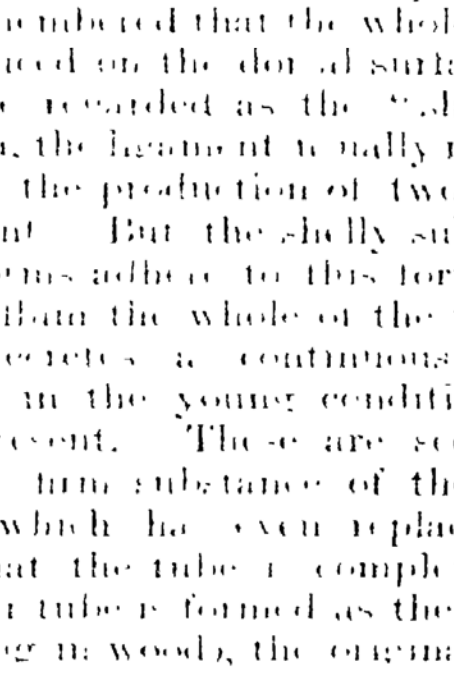
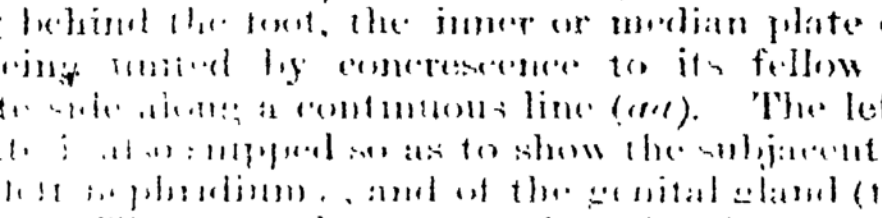


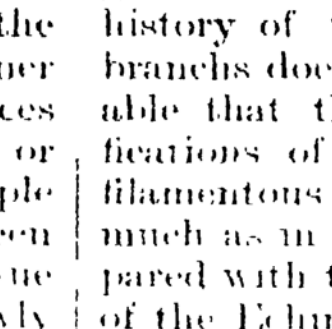
Fig. 129.

Fig. [illegible] Shell of *Teredo navalis* from (from Owen).
Fig. [illegible] Shell of *Teredo gibbosa* to show the original valv
embedded in a continuous calcification of the tube (from Owen).

culates through it. This can be done by letting
throwing back the left half of the mantle skirt a
presented in fig. 124, (3). We thus expose the
like foot (*f*), the two left labial tentacles, and t
left gill plates or left etenidium. In fig. 124, (5),
the labial tentacles *n* is also thrown back so as t

outh *w*, and the two left gill-plates are reflected
o show the gill-plates of the right side (*ox*, *oq*) pro-
behind the foot, the inner or median plate of each
eing united by coalescence to its fellow of the
te side along a continuous line (*aa*). The left inner
t is cut away so as to show the subjacent orifices
ht re-phridium , and of the genital gland (testis or
g. The foot that is exposed in Anodon is a simple
ue like organ. It can be protruded between
the m (fig. 124, *f*) to issue
he shell, and by its action the Anodon can slowly
or burrow in soft mud or sand. It has been sup
that water is taken into the blood-vessels of the
through pore in the foot, and to pits of oppo i-
i. views still maintained (Carl Bock, **47**). In fig.
the letters *ab*, *ec*, *ad*, point to three pit like depres-
supposed by Grobben to be pore leading into the
y tem. According to Carriere (**48**) the e pits are
but accessories of the tubes, in one case
the entrance to ramified glands. Other Lamelli
may have a larger foot relatively than has Anodon.
has a sole like surface. In Area too and many
it carries a by-sus-forming gland and a by-sus
ing gland. In the Cockle, in Cardium and in
ia, it is capable of a sudden stroke which
mal to jump when out of the water, in th





to a height of four In Myti ent alte
l to little more tha
t the e gland In

Labial tentacle of Ar (Fig. 3)
ghly vascular
ce richly
l with nerves *h*
anterior ten

g

f

to

Area (fig. 133)
the Cockle
other Lamelli
all Lamelli
; they do not
except in
sometime
out to
like dimen
Their appear
nd position suggest that they are in some way
morphologically to the gill-plates, the anterior
entacle being a continuation of the outer gill-plate,
and the posterior a continuation of the inner gill-
There is no embryological evidence to support this
gested connexion, and, as will appear immediately
history of the gill-plates in various forms of La
branchs does not directly favour it. Yet it is very
able that the labial tentacles and gill plates are
fications of a double horseshoe-shaped area of ci
filamentous processes which existed in ancestral Mo
much as in Phoronis and the Polyzoa, and is to be
pared with the continuous prae- and post-oral ciliated
of the Echinid larva Pluteus and of Tornaria (**49**).

The gill plates have a structure very different from
of the labial tentacles, and one which in Anodon is
larly complicated as compared with the condition pres
by these organs in some other Lamellibranchs, and
what must have been their original condition in the
tors of the whole series of living Lamellibranchia.
phenomenon of "coalescence" which we have alread
to note as showing itself so importantly in regard t
free edges of the mantle-skirt and the formation o
siphons, is what, above all things, has complicate
structure of the Lamellibranch ctenidium. Our p
knowledge of the interesting series of modifications th
which the Lamellibranch gill-plates have developed to
complex final form is due to R. Holman Peck
of Mytilus (**51**). The Molluscan ctenidium is
cally, as shown in fig. 2, a plume like
ture, consisting of a vascular axis, on
side of which is set a row of numero
demibranch or filamentous processes,
processes are hollow, and receive the v
blood from, and return it again aerated
the hollow axis, in which an afferent a
efferent blood-vessel may be differen
In the genus Nucula (fig. 134), one o
Arcacea, we have an example of a La
branch retaining this plume like form o
other Arcacea (*e.g.*, Area and Pectunculus) the l
cesses which are set on the axis of the ctenidium a
cuelle, but are slightly flattened, very long tubes o
ow filaments. These fila
ments are so fine and are
set so closely together
that they appear to form
a continuous membrane
until examined with a
lens. The microscope
how that the neighbour-
ing filaments are held to-
gether by patches of cilia,
called 'ciliated junc-
tions,' which interlock
with one another just as
two brushes may be made
to do. In fig. 133, A a
portion of four filaments
of a ctenidium of the Sea
Mussel (Mytilus) is repre-
sented, having precisely
the same structure as
those of Area. The fila
ments of the gill (ctenid-
dium) of Mytilus and
Area thus form two
closely set rows which
depend from the axis of
the gill like two parallel
plates. Further, their structure is profoundly modifi
the curious condition of the free ends of the depe
filaments. These are actually reflected at a sharp an

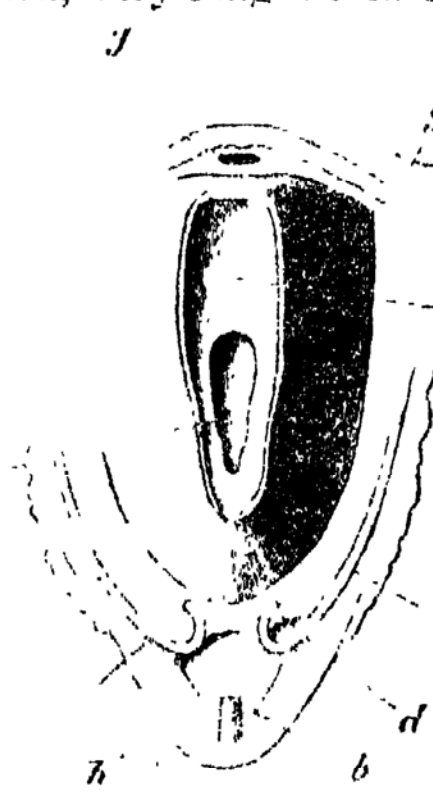
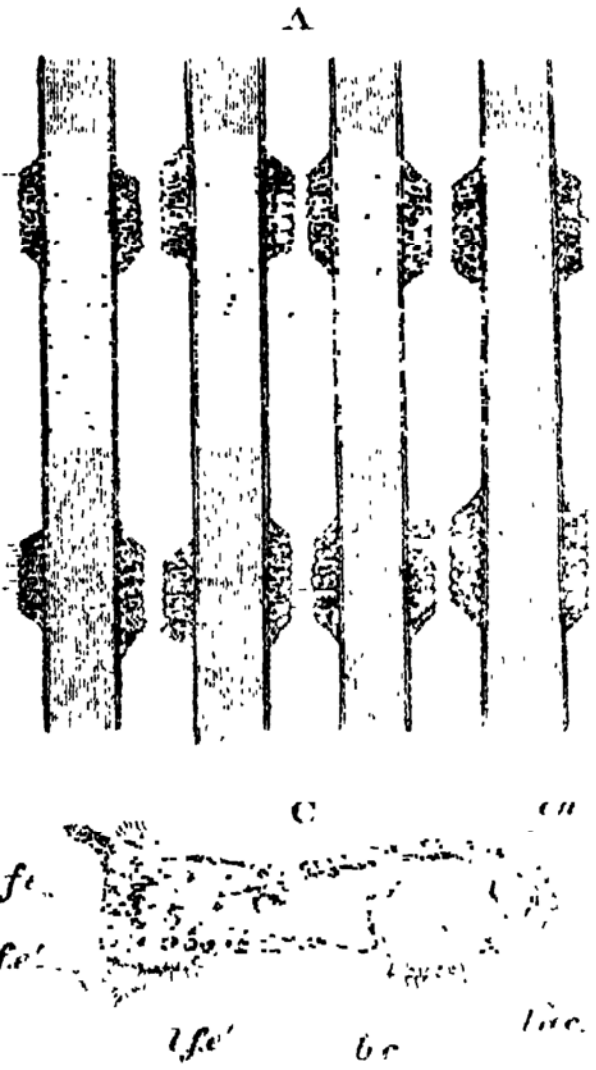


FIG. 132.—View from the ventral (po
pect of the animal of *Area Noae*, the
lap and gill-filaments having been c
a, mouth; *b*, anus; *c*, free spirally
extremity of the gill axis or ctenid
of the right side; *d*, do of the le
e, *f*, anterior portions of these axe
by coalescence to the wall of th
g, anterior adductor muscle; *h*, p
adductor, *i*, anterior labial tent
posterior labial tentacle; *l*, base li
foot; *m*, sole of the foot, *n*, e
(Original.)

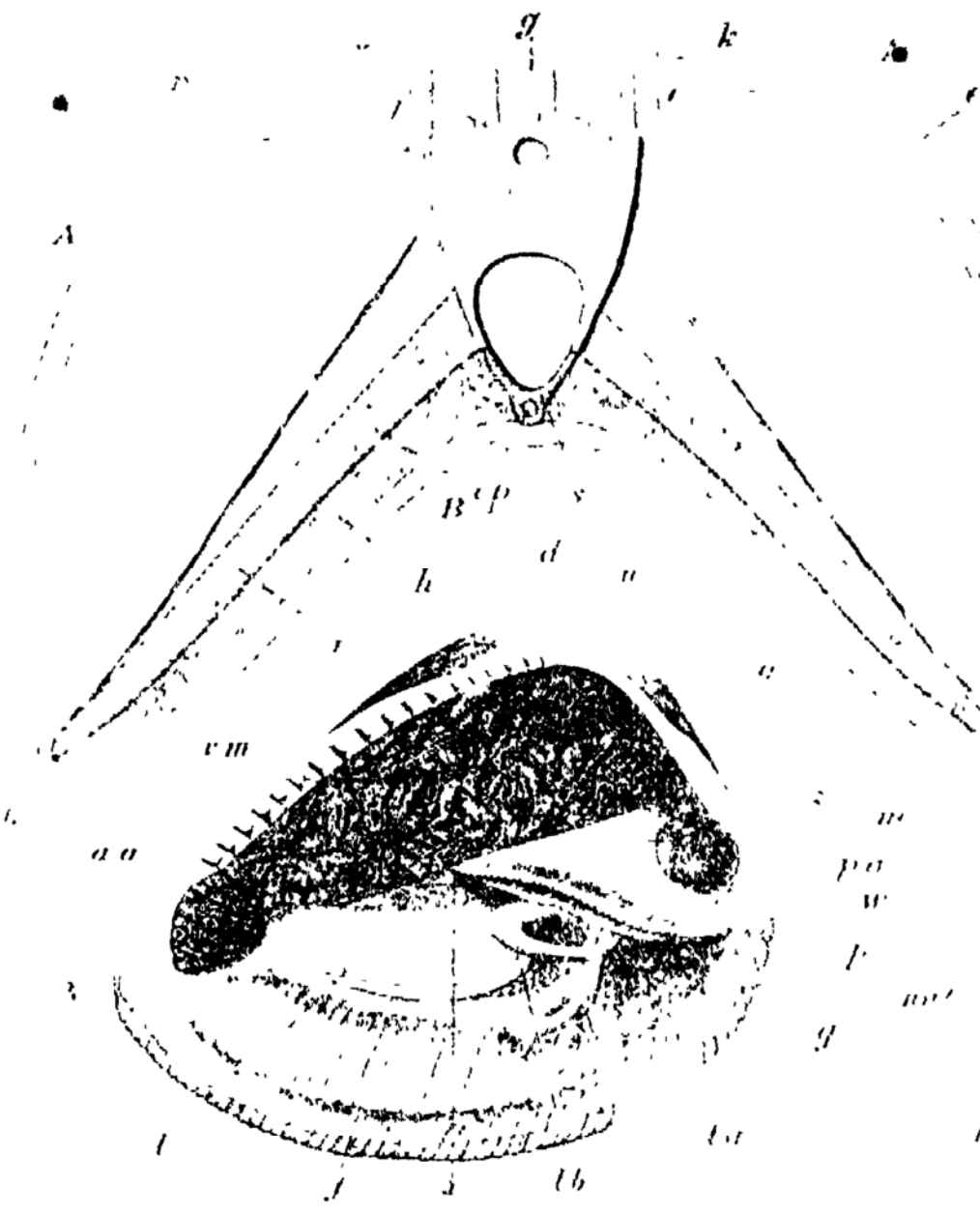
l on themselves in fact - and thus form an additional filaments (see fig. 133, B). Consequently, each primiament has a descending and an ascending ramus, and of each row forming a simple plate, the plate is consisting of a descending and an ascending lamella. axis of the etenidium lies by the side of the body, very frequently connate with the body, as so often s in Gastropods also, we find it convenient to speak two plate like structures formed on each etenidial the outer and the inner gill-plate; each of these is



.—Filaments of the etenidium of *Mytilu*
rt of four filaments seen from the outer fac
ons e.j. B. Diagram of the posterior face
escending ramus and ascending ramus of
, the ciliated junctions, *d l*, inter-lamel
n of a filament taken so as to cut both the
amellar junction. *fc.*, frontal epithelium
to-frontal epithelial cells with long cilia
filament; *lac.*, blood lacuna traversed by
cells; *bc.*, blood-corpuscle.

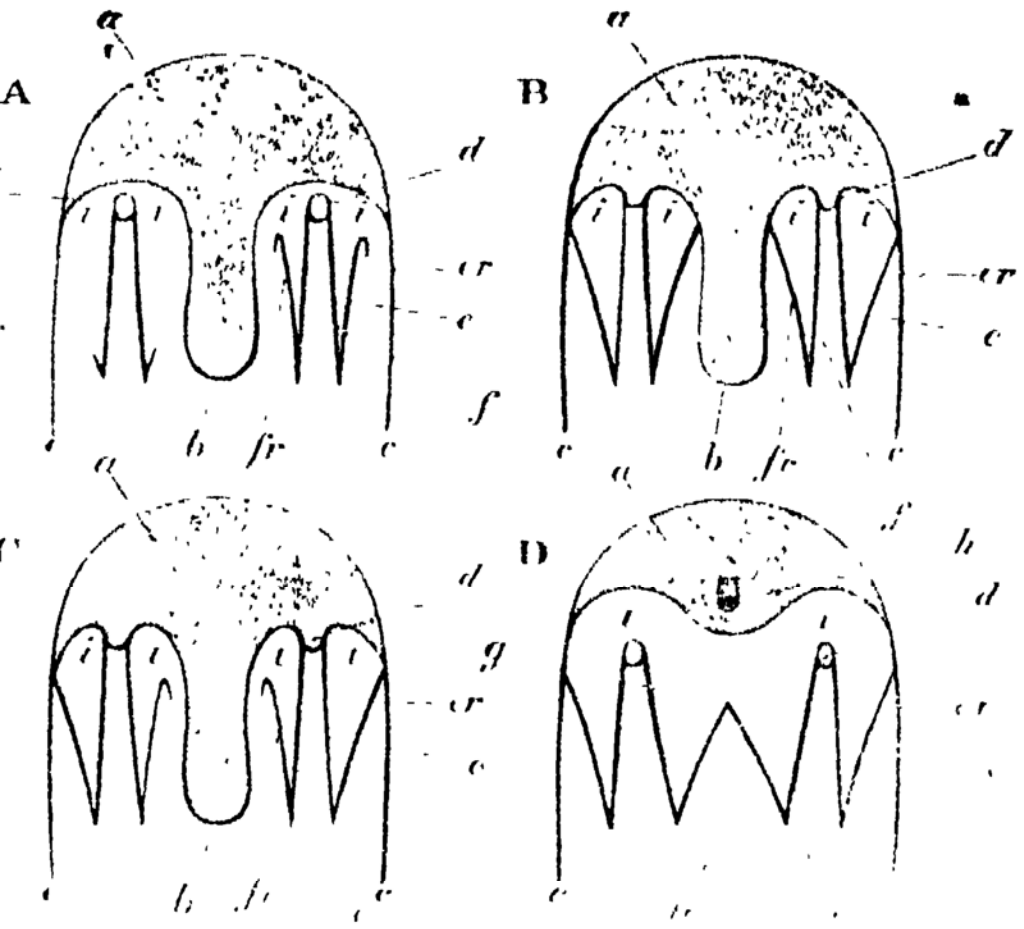
sed of two lamellæ, an outer (el) and an
l in the case of the outer gill pl and an abaxial and
er (the reflected) in the case of the inner gill plate.
s the condition seen in Arca and Mytilus, the so
plates dividing upon the slightest touch into their
tuent filaments, which are but loosely conjoined by
"ciliated junctions." Complications follow upon
n other forms. Even in Mytilus and Arca a con
n is here and there formed between the ascending
escending rami of a filament by hollow extendible
owths called "interlamellar junctions" (*ilj.* in B, fig.
Nevertheless the filament is a complete tube formed
tonous substance and clothed externally by ciliated
elium, internally by endothelium and lacunar tissue
n of connective tissue"—as shown in fig. 133, C
let us suppose, as happens in the genus Dreissena
us not far removed from Mytilus that the ciliated
ilamentar junctions (fig. 136) give place to solid
ament inter-filamentar junctions, so that the filament
onverted, as it were, into a trellis work. Then let us
so that the inter lamellar junctions which we have
ly noted in Mytilus become very numerous, large,
rregular; by them the two trellis works of filaments
be united so as to leave only a sponge-like set
aces between them. Within the trabeculæ of the
e-work blood circulates, and between the trabeculæ
vater passes, having entered by the apertures left

in the trellis-work formed by the united gill fila
(fig. 138, A, B). The larger the intra lamellar s



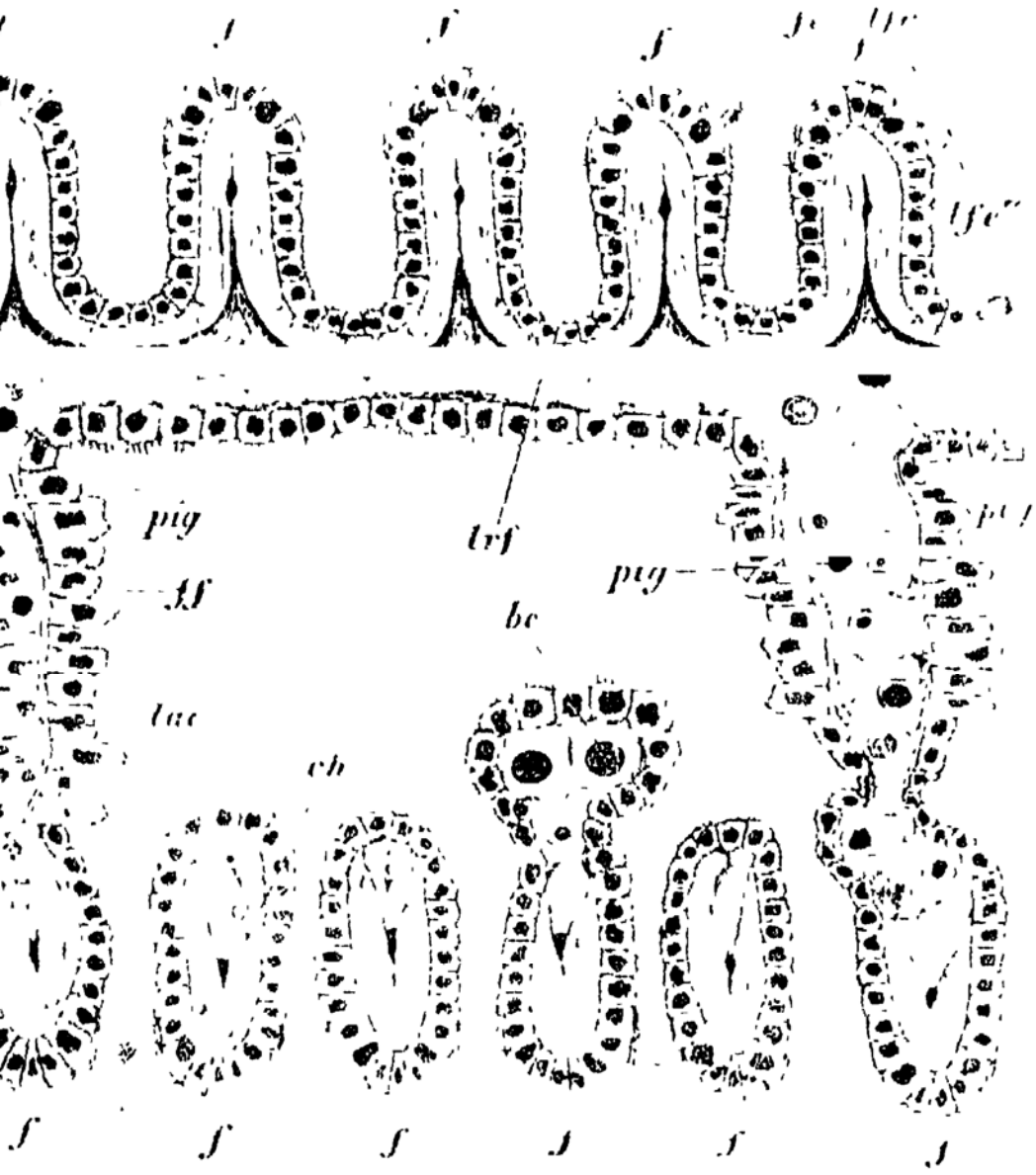
growth becomes the more do the original ... lose the character of blood-holding tube and ... become denser as the roots for the ... portions the porous growth. The ... seen both ... section of Dreissena gill (fig. 136) and in the ... fig. 137, A, B, C). In the drawing of Dreis... individual filament ... are cut across more ... the base of an inter-filamentar junction, in the ... lower part of the figure at a point where they are free ... chitinous substance is observed to be ... as compared with what it is in fig. 133, C ... to obliterate altogether the lumen of the ... And in Anodon (fig. 137, C) this obliteration ... Anodon, besides being thickened, the chitinous sub... the filament develops a specially dense ... each side of each filament. Although the ... etenidium is thus highly complicated in Anodon, ... more so in some of the Siphonate genera of Lamellib... The filaments take on a secondary grouping, the ... the lamellæ being thrown into a series of half cy... ridges, each consisting of ten or twenty filaments, a...

uch greater strength and thickness than the others may laced between each pair of groups. In Anodon, as in



...ion, by comparison of the gill-plate in the Lamellibranchs, the Pteropods, the Heteropods, and the Gasteropods. A bow-shaped section with the adductor, by comparison of Carinaria (Pecten or Anodon), Pterotrachea (Cardium or Anodon), and Aplysia (Anodon), the pedal ganglia, the foot, the mantle flap, the axis of the ctenidium, the sub-branchial cavity, the reflected lamella, the gill-plate, the lamellae of the gill-plate, the gill-filaments, the afferent vessel, the efferent vessel, the supra-branchial chamber, the sub-pallial chamber, the osphradium, the auricle, the ventricle, the rectum, the anus, the kidney, the pericardium, the nephridial opening, the genital opening, the pallial nerve, the visceral nerve, the pedal nerve, the supra-branchial ganglion, the sub-pallial ganglion, the osphradial ganglion, the visceral ganglion, the pedal ganglion, the cerebral ganglion, the labial ganglion, the buccal ganglion, the oesophagus, the stomach, the intestine, the liver, the salivary gland, the radula, the odontophore, the cartilage, the muscle, the nerve, the blood-vessel, the connective tissue, the epithelium, the cuticle, the ciliated epithelium, the gland-cell, the mucous gland, the sub-epithelial gland, the sub-epithelial connective tissue, the sub-epithelial blood-space, the sub-epithelial nerve-plexus, the sub-epithelial ganglion-cell, the sub-epithelial fibre, the sub-epithelial muscle-fibre, the sub-epithelial connective tissue-cell, the sub-epithelial blood-corpuscle, the sub-epithelial pigment-cell, the sub-epithelial gland-cell, the sub-epithelial ciliated cell, the sub-epithelial non-ciliated cell, the sub-epithelial supporting-cell, the sub-epithelial basal-cell, the sub-epithelial boundary-membrane, the sub-epithelial perivisceral space, the sub-epithelial perivascular space, the sub-epithelial perineural space, the sub-epithelial perilymphatic space, the sub-epithelial perihaemal space, the sub-epithelial perigastric space, the sub-epithelial perihepatic space, the sub-epithelial perirenal space, the sub-epithelial pericardial space, the sub-epithelial perigonadial space, the sub-epithelial perianal space, the sub-epithelial perioral space, the sub-epithelial perilabial space, the sub-epithelial perimantle space, the sub-epithelial perifoot space, the sub-epithelial perigill space, the sub-epithelial perictenidial space, the sub-epithelial perisupra-branchial space, the sub-epithelial perisub-branchial space, the sub-epithelial perisub-pallial space, the sub-epithelial perisupra-pallial space, the sub-epithelial perisupra-visceral space, the sub-epithelial perisub-visceral space, the sub-epithelial perisupra-pedal space, the sub-epithelial perisub-pedal space, the sub-epithelial perisupra-cerebral space, the sub-epithelial perisub-cerebral space, the sub-epithelial perisupra-labial space, the sub-epithelial perisub-labial space, the sub-epithelial perisupra-buccal space, the sub-epithelial perisub-buccal space, the sub-epithelial perisupra-oesophageal space, the sub-epithelial perisub-oesophageal space, the sub-epithelial perisupra-stomach space, the sub-epithelial perisub-stomach space, the sub-epithelial perisupra-intestine space, the sub-epithelial perisub-intestine space, the sub-epithelial perisupra-liver space, the sub-epithelial perisub-liver space, the sub-epithelial perisupra-salivary-gland space, the sub-epithelial perisub-salivary-gland space, the sub-epithelial perisupra-radula space, the sub-epithelial perisub-radula space, the sub-epithelial perisupra-odontophore space, the sub-epithelial perisub-odontophore space, the sub-epithelial perisupra-cartilage space, the sub-epithelial perisub-cartilage space, the sub-epithelial perisupra-muscle space, the sub-epithelial perisub-muscle space, the sub-epithelial perisupra-nerve space, the sub-epithelial perisub-nerve space, the sub-epithelial perisupra-blood-vessel space, the sub-epithelial perisub-blood-vessel space, the sub-epithelial perisupra-connective-tissue space, the sub-epithelial perisub-connective-tissue space, the sub-epithelial perisupra-epithelium space, the sub-epithelial perisub-epithelium space, the sub-epithelial perisupra-cuticle space, the sub-epithelial perisub-cuticle space, the sub-epithelial perisupra-ciliated-cell space, the sub-epithelial perisub-ciliated-cell space, the sub-epithelial perisupra-non-ciliated-cell space, the sub-epithelial perisub-non-ciliated-cell space, the sub-epithelial perisupra-supporting-cell space, the sub-epithelial perisub-supporting-cell space, the sub-epithelial perisupra-basal-cell space, the sub-epithelial perisub-basal-cell space, the sub-epithelial perisupra-boundary-membrane space, the sub-epithelial perisub-boundary-membrane space, the sub-epithelial perisupra-perivisceral space, the sub-epithelial perisub-perivisceral space, the sub-epithelial perisupra-perivascular space, the sub-epithelial perisub-perivascular space, the sub-epithelial perisupra-perineural space, the sub-epithelial perisub-perineural space, the sub-epithelial perisupra-perilymphatic space, the sub-epithelial perisub-perilymphatic space, the sub-epithelial perisupra-perihaemal space, the sub-epithelial perisub-perihaemal space, the sub-epithelial perisupra-perigastric space, the sub-epithelial perisub-perigastric space, the sub-epithelial perisupra-perihepatic space, the sub-epithelial perisub-perihepatic space, the sub-epithelial perisupra-perirenal space, the sub-epithelial perisub-perirenal space, the sub-epithelial perisupra-pericardial space, the sub-epithelial perisub-pericardial space, the sub-epithelial perisupra-perigonadial space, the sub-epithelial perisub-perigonadial space, the sub-epithelial perisupra-perianal space, the sub-epithelial perisub-perianal space, the sub-epithelial perisupra-perioral space, the sub-epithelial perisub-perioral space, the sub-epithelial perisupra-perilabial space, the sub-epithelial perisub-perilabial space, the sub-epithelial perisupra-perimantle space, the sub-epithelial perisub-perimantle space, the sub-epithelial perisupra-perifoot space, the sub-epithelial perisub-perifoot space, the sub-epithelial perisupra-perigill space, the sub-epithelial perisub-perigill space, the sub-epithelial perictenidial space, the sub-epithelial perisupra-perictenidial space, the sub-epithelial perisub-perictenidial space.

y other Lamellibranchs, the ova and hatched embryos arried for a time in the ctenidia or gill apparatus, and in particular case the space between the two lamellae

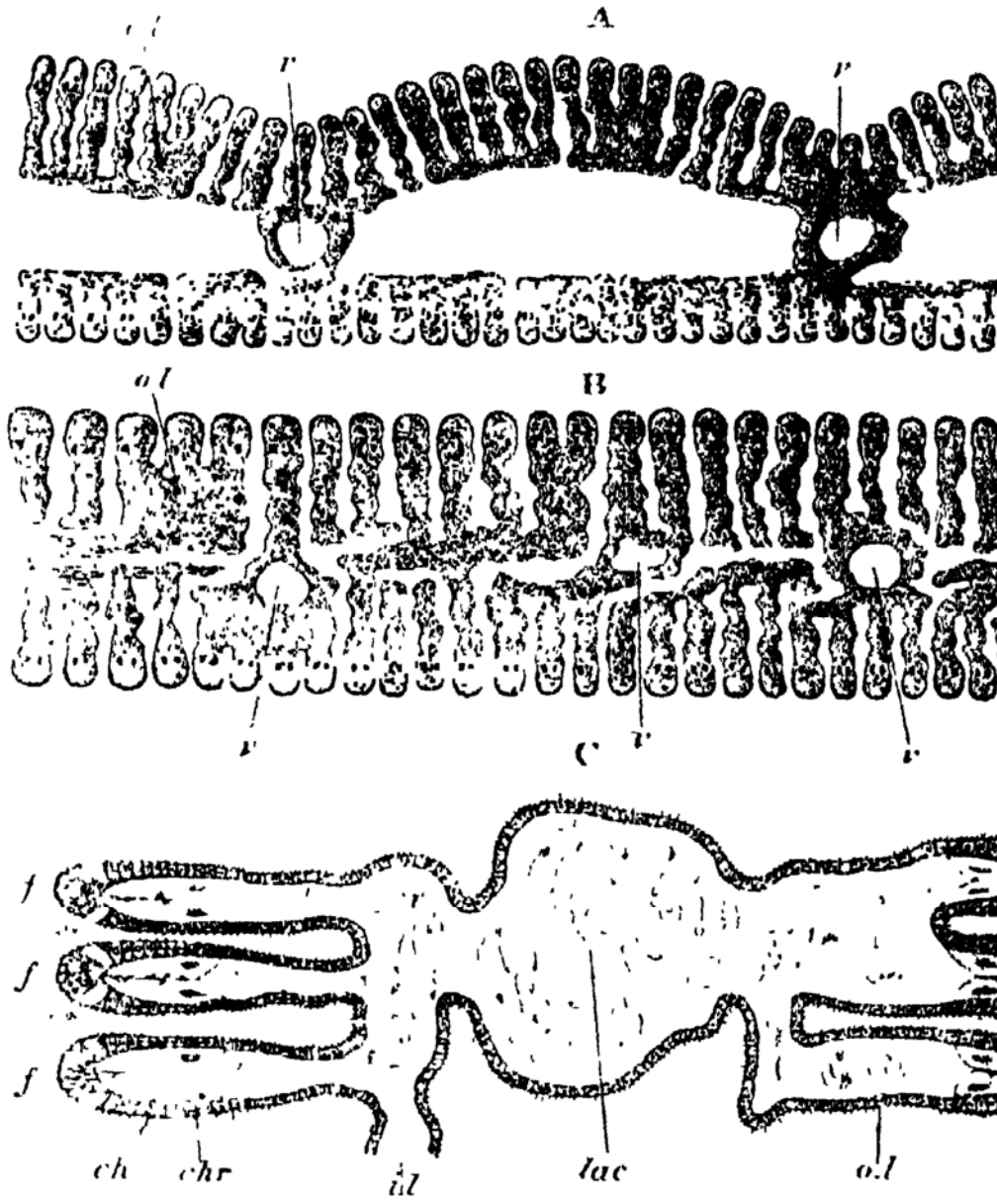


...Transverse section of the outer gill-plate of *Dacrydium polymorphum* (after Hoffman Peck). *f*, constituent gill-filament; *pf*, fibrous sub-epithelial tissue; *ch*, chitinous substance of the filament; *trf*, cells related to the chitinous substance; *bc*, buccal tissue; *pig*, pigment cells; *bc*, blood-corpuscle; *fr*, frontal epithelium; *fr*, *fr*, two rows of latero-frontal cilia-cells with long cilia; *lol*, lobose, probably muscular, substance of the gill-filament gland-cells.

he outer gill plate is that which serves to receive the (fig. 137, A). The young are nourished by a substance

formed by the cells which cover the spongy inter-l outgrowths.

There are certain other points in the modification typical ctenidium which must be noted in order to stand the ctenidium of Anodon. The axis of each ium, right and left, starts from a point well forwar the labial tentacles, but it is at first only a ridge, an not project as a free cylindrical axis until the back

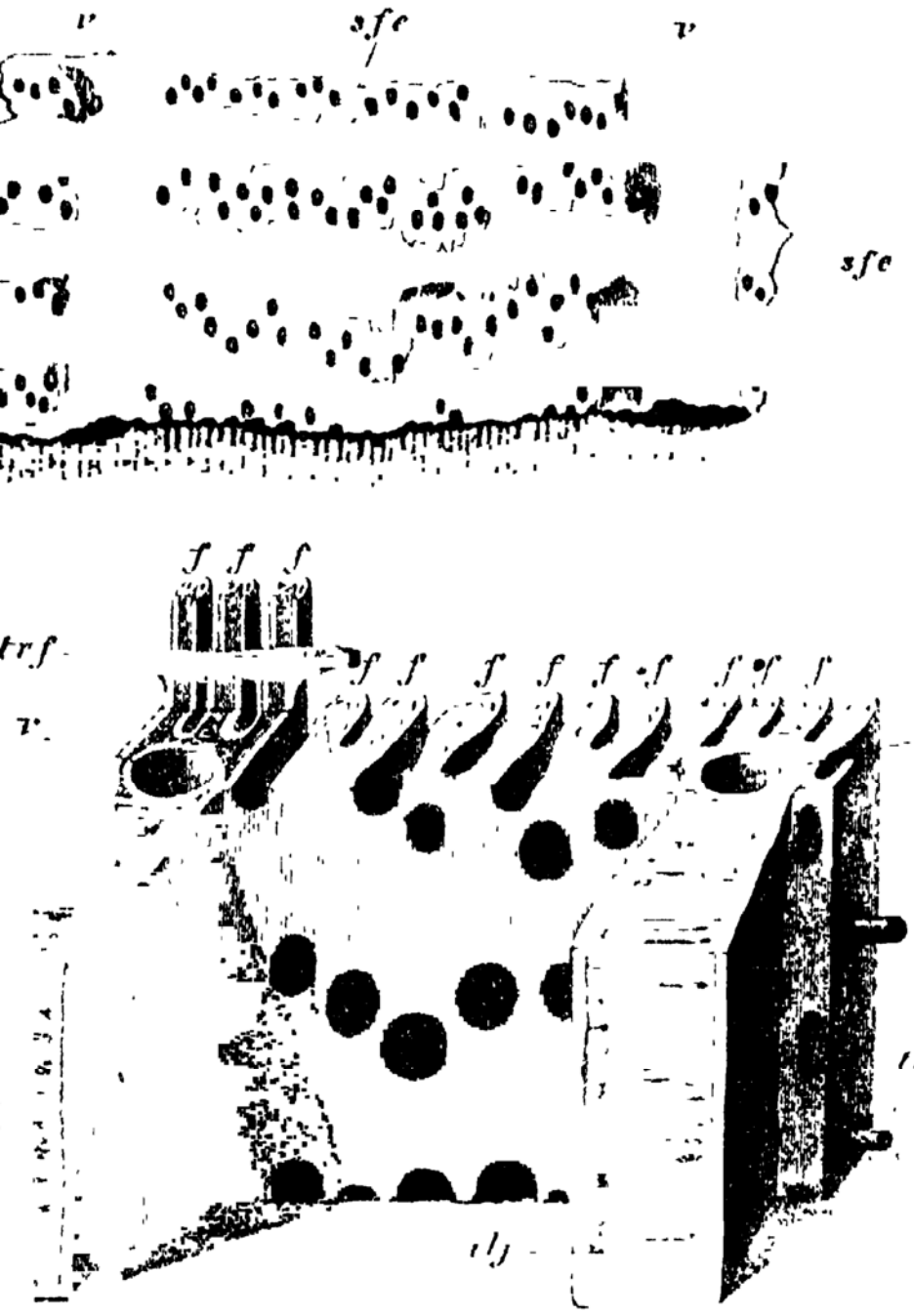


...Transverse section of gill-plates of Anodon (after Peck). A, inner gill-plate. B, outer gill-plate. C, A portion of B more highly m *o.l*, outer lamella; *i.l*, inner lamella; *v*, blood-vessel; *f*, constit ment; *fr*, frontal tissue; *ch*, chitinous substance of the filam chitinous rod enclosed in the softer substance *ch*.

the foot is reached. This is difficult to see at all i don, but if the mantle-skirt be entirely cleared awa if the dependent lamellae which spring from the et axis be carefully cropped away so as to leave the axi intact, we obtain the form shown in fig. 131, where *b* are respectively the left and the right ctenidial ax jecting freely beyond the body. In Area this can with far less trouble, for the filaments are more ea moved than are the consolidated lamellae formed filaments of Anodon, and in Area the free axes ctenidia are large and firm in texture (fig. 132, *c*, *d*

If we were to make a vertical section across th axis of a Lamellibranch which had the axis of its cte free from its origin onwards, we should find such re as are shown in the diagram fig. 135, A. The gill is seen lying in the sub-pallial chamber between t *b* and the mantle *c*. From it depend the gill-filam lamellae formed by united filaments—drawn as bla *f*. On the left side these lamellae are represented ing only a small reflected growth, on the right si reflected ramus or lamella is complete (*fr* and *cr*) actual condition in Anodon at the region where t commence anteriorly is shown in fig. 135, B. The the ctenidium is seen to be adherent to, or fused crescence with, the body-wall, and moreover on ea the outer lamella of the outer gill-plate is fused mantle, whilst the inner lamella of the inner gill- fused to the foot. If we pass a little backwards a another section nearer the hinder margin of the f

arrangement shown diagrammatically in fig. 135, more correctly in fig. 142. In this region the inner of the inner gill-plates are no longer affixed to the Passing still further back behind the foot, we find



—Gill-lamellæ of Anodon (after Peck). A, Piece of an inner gill-plate torn from the connective tissue also partly cut away round the s, their transverse junctions *tr*, and the "window *gl*, internal surface of the lamella; *x*, *y*, *z* in the outer lamella of the outer gill plate and surface (after Peck). *f*, constituent filaments, *tr* nsverse inter-filamentar junctions; *z* n. The series of oval holes on the h open between the filaments re the transverse inter-filamentar junctio

t of the outer mellæ, the sub to expose the B in the latter ace of a block from the inter ribbon, *tr* one of set, *z* outer lamellar lobe; *x* and *y* the water-w separated here on

lon the condition shown in the section D, fig. 135. es *i* are now free; the outer lamella of the outer es (*x*) still adhere by coneresceuce to the mantle hilst the inner lamellæ of the inner gill plates meet nother and by coneres- at *g*. In eral view of inal with l mantle- and gill the line of rence of the lamellæ of nner gill- is readily it is marked *aa* in fig. 124, (5). In the same the free part of the inner lamella of the inner e resting on the foot is marked , whilst the l part the most anterior- - has been snipped issors so as to show the genital and nephridial es *x* and *y*. The coneresceuce, then, of the ge of the reflected lamellæ of the gill plates of is very extensive. It is important, because such rescence is by no means universal, and does not or example, in Mytilus or in Area; further, because

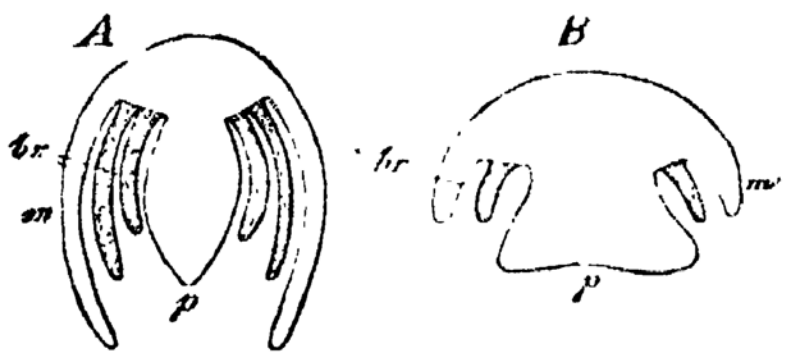


FIG. 139. Transverse sections of *A*, a Lamellibranch, and *B*, an Isopleurous Gastropod (Chiton). They show the relations of *p*, the foot; *br*, the branchiæ; and *m*, the mantle. (From Gegenbaur.)

when its occurrence is once appreciated, the reduc the gill-plates of Anodon to the plume-type of the s etenidium presents no difficulty; and, lastly, it has ance in reference to its physio logical significance. The me- chanical result of the coales- cence of the outer lamellæ to the mantle flap, and of the inner lamellæ to one another as shown in section D, fig. 135, is that the sub-pallial space is divided into two paces by a horizontal sep tum. The upper space (*x*) communicates with the outer world by the excurrent or su perior siphonal notch of the mantle (fig. 124, *d*), the lower pace communicates by the lower siphonal notch (*e* in fig. 124). The only comm tion between the two spaces, excepting through the work of the gill plate, is by the slit *c* in fig. 124, by the non-coalescence of a part of the inner lamella inner gill plate with the foot. A probe (*z*) t nto through this slit-like passage, and it can be seen to pa the excurrent siphonal notch. It through this p or indirectly through the pores of the gill plates, t water introduced into the lower sub-pallial space m on its way to the excurrent siphonal notch. subdivision of the pallial chamber, and direction

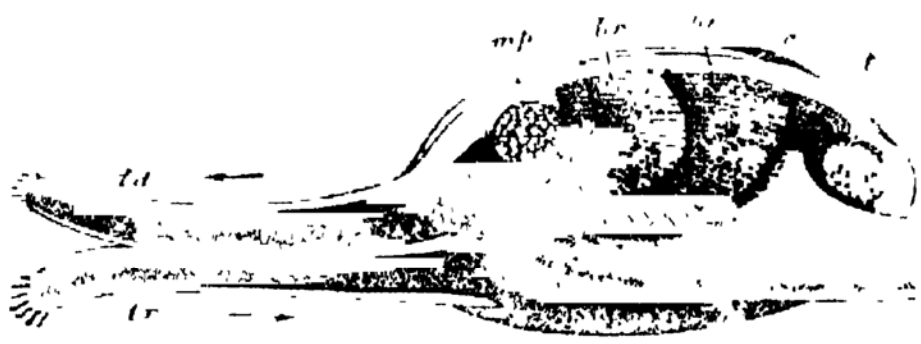


FIG. 141.—The same animal as fig. 140, with the foot and siphons Letters as in fig. 140. (From the Challenger.)

currents set up within it do not exist in a num Lamellibranchs which have the gill lamellæ compar

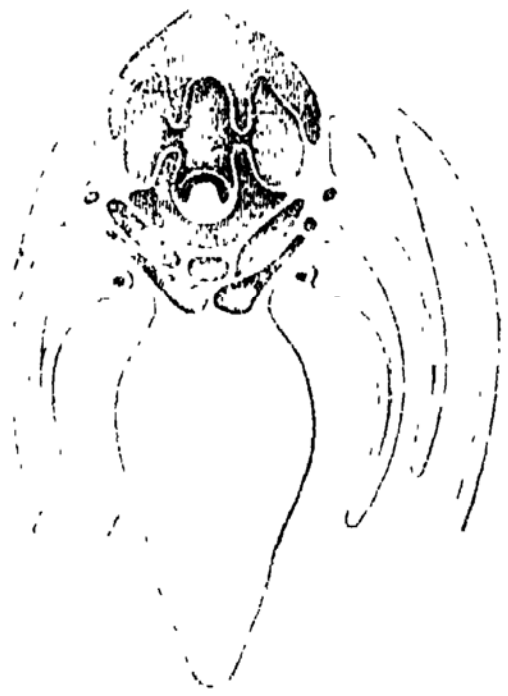
free (Mytilus, Area, Trigonia, &c.), and it is in these that there is least modification by coalescence of t mary filamentous elements of the lamellæ. Proba gill-structure of Lamellibranchs will ultimately some classificatory characters of value when the been thoroughly investigated throughout the class.

The alimentary canal of Anodon is shown in fig. 1 The mouth is placed between the anterior adduct the foot; the anus opens on a median papilla ov the posterior adductor, and discharges into the s pallial chamber along which the excurrent stream The coil of the intestine in Anodon is similar to other Lamellibranchs, but the crystalline style diverticulum are not present here. The rectum t the pericardium, and has the ventricle of the heart w as it were around it. This is not an unusual arran in Lamellibranchs, and a similar disposition occurs Gastropoda (Haliotis). A pair of ducts (*rr*) lead t last enlargement of the alimentary tract called s into a pair of large digestive glands, the so-called the branches of which are closely packed in this (*gl*). The food of the Anodon, as of other Lamellib consists of microscopic animal and vegetable org which are brought to the mouth by the stream wh into the sub-pallial chamber at the lower siphona (*c* in fig. 124). Probably a straining of water fro

s is effected by the lattice-work of the ctenidia or
es.

heart of Anodon consists of a median ventricle em-
the rectum (fig. 143, *A*), and giving off an anterior
osterior artery, and of two auricles which open into
rice by orifices protected by valves.

blood is colourless, and has colourless amœboid
, floating in it. In two Lamellibranchs, *Solen*
ilis (Lankester, 31) and *Area Noæ*, the blood is crimson,
to the presence of corpuscles impregnated with
obin (Lankester, 31). In Anodon the blood is
by the ventricle through the arteries into vessel
, which soon become irregular lacunæ surround
viscera but in part (*viz.* the labial tentacles and
the gut) very free vessels with endothelial cell
re found. The blood makes its way by large
s a venous sinus which lies in the middle line be
heart, bearing the paired renal organs (nephridia)
between it and that organ. Hence it pas-
the vessels of the glandular walls of the nephridia
nd left into the gill lamellæ, whence it returns
many openings into the widely dilated auri
dial more pr
s been given to
s of the transm
ries, veins, and
es in Anodon
facts warrant
se of the blood
an only become
ously introduced
it, large amount
Distinct afferent
re-channel an
di terminated in
lamellæ in pale
Lancer (52) ha
on the subject,
it is highly prob
at the re-some
irculation in the
n the filament
all of Mytilus the
cavity is divided
more or less complete
septum, but two



Vertical section through the Ano

pericardium which is clothed with a pecu
clothelium *cl*, fig. 143). Veins are said by Keber
to open anteriorly into it, but this appears to
error. It does not contain blood or communicate
with the blood system, this relation of the peri
we have noted already in Gastropod and Cephalo
A good case for the examination of the question a
the blood enters the pericardium of Lamellibranchs,
the foot, or by the renal organs when the
ods
nch
ns made by Pe
no real
although
are

pair of nephridia or Anodon called in Lamelli
the organs of Bojanus, lie below the membranous
the pericardium, and open into it by two well
apertures (*e* and *f* in fig. 143). Each nephridium,
ing bent upon itself as shown in fig. 143, C, D,
the exterior by a pore placed at the point marked
121, (5), (6)). It is no doubt possible, as in the

Gastropoda and Cephalopoda, for water to enter from the
exterior by the nephridia into the pericardium, but that
if ever does so is as yet not proved. What is certain
from the set of the ciliary currents is that liquid generally

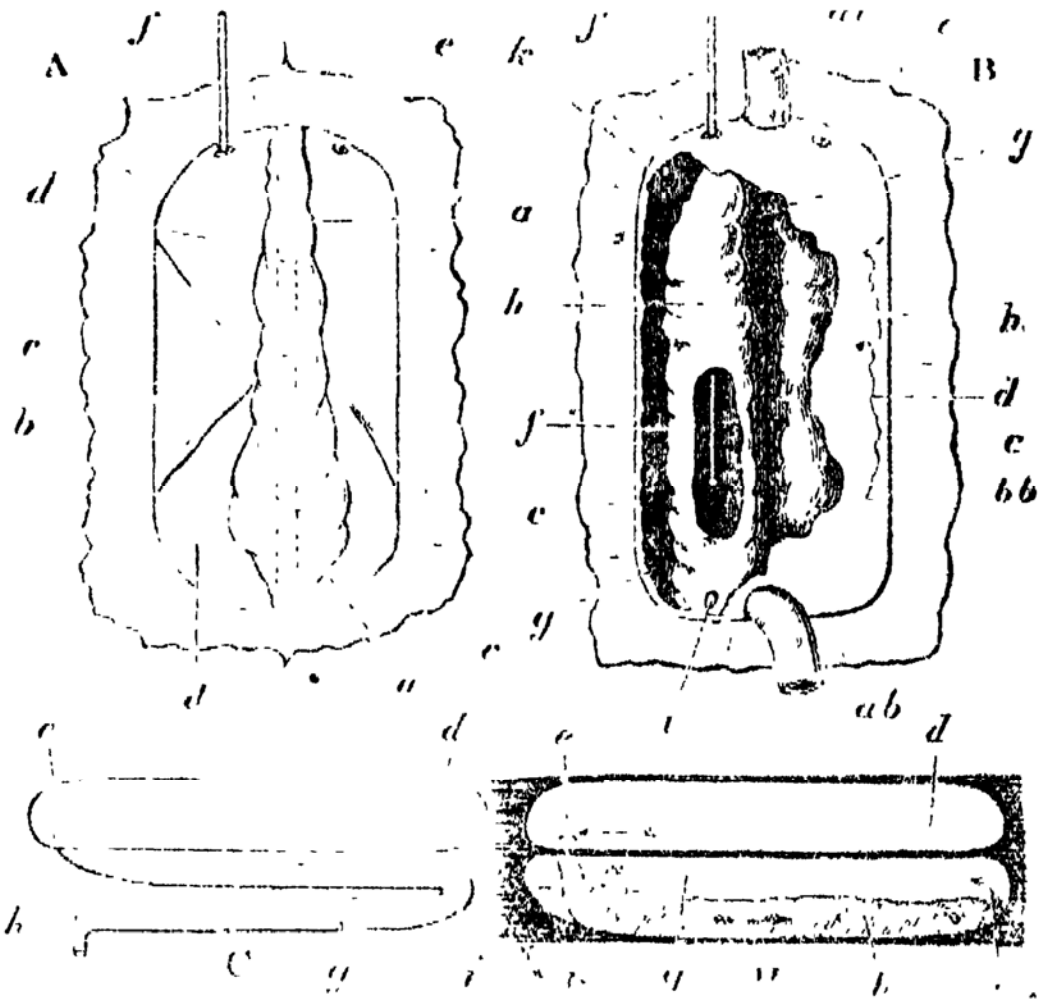


FIG. 143.—Diagrams showing the relations of pericardium and nephridia in a Lamellibranch such as Anodon. A, Pericardium opened dorsally so as to expose the heart and the floor of the pericardial chamber *d*. B, Heart removed, floor of the pericardium cut away on the left side so as to expose the non-glandular sac of the nephridium, exposing the glandular sac *b* which has also cut away so as to show the probe *i*. C, Ideal pericardium and nephridium viewed dorsally. D, Lateral view showing the actual relations of the glandular and non-glandular sacs of the nephridium. The arrows indicate the course of fluid from the pericardium outwards. *a*, ventricle of the heart; *a'*, auricle; *b*, cut remnant of the auricle; *c*, dorsal wall of the pericardium cut and reflected; *e*, reno-pericardial orifice; *f*, probe introduced into the left reno-pericardial orifice; *g*, non-glandular sac of the left nephridium; *h*, glandular sac of the left nephridium; *k*, pore leading from the nephridium into the non-glandular sac of the left nephridium; *k'*, pore leading from the non-glandular sac to the exterior; *ac*, anterior, *ab*, posterior extremities of the intestine and ventricle.

pass out of the pericardium by the nephridia. One half of each nephridium is of a dark green colour and glandular (*h* in fig. 143). This opens into the reflected portion which overlies it as shown in the diagram fig. 143, D, *i*; the latter has non-glandular walls, and opens by the pore *k* to the exterior. The nephridia may be more ramified in other Lamellibranchs than they are in Anodon. In some they are difficult to discover. That of the common oyster has recently (1882) been detected by Hoek (54). Each nephridium in the oyster is a pyriform sac, which communicates by a narrow canal with the urino-genital groove placed to the front of the great adductor muscle; by a second narrow canal it communicates with the pericardium. From all parts of the pyriform sac narrow stalk-like tubes are given off, ending in abundant widely spread branching glandular cæca, which form the essential renal secreting apparatus. The genital duct opens by a pore into the urino-genital groove of the oyster (the same arrangement being repeated on each side of the body) close to but distinct from the aperture of the nephridial canal. Hence, except for the formation of a urino-genital groove, the apertures are placed as they are in Anodon. Previously to Hoek's discovery a brown-coloured investment of the auricles of the heart of the oyster had been supposed to represent the nephridia in a rudimentary state. This investment, which occurs also in Mytilus but not in Anodon, may possibly consist of secreting cells, and may be comparable to the pericardial accessory glandular growths of Cephalopoda.

Nervous System and Sense-organs.—In Anodon there are three well developed pairs of nerve-ganglia (fig. 144, B and fig. 121, (6)). An anterior pair, lying one on each side of the

mouth (fig. 144, B, *a*) and connected in front of it by a commissure, are the representatives of the cerebral, pleural, and visceral ganglia of the typical Mollusc, which are not here differentiated as they are in Gastropods (compare, however, fig. 67). A pair placed close together in the foot (fig. 144, B, *b*, and fig. 124, (6), *ax*) are the typical pedal ganglia; they are joined to the cerebro-pleuro-visceral ganglia by connectives.

Posteriorly beneath the posterior adductors, and covered only by a thin layer of elongated epidermal cells, are the olfactory ganglia, their epidermal clothing constituting the pair of osphradia, which are thus seen in Lamellibranchs to occupy their typical position and to have the typical innervation, the nerve to each osphradium being given off by the visceral ganglion that is to say, by the undifferentiated cerebro-pleuro-visceral proper side. This identification of the pe pair of Lamellibranchs is due to Spen-

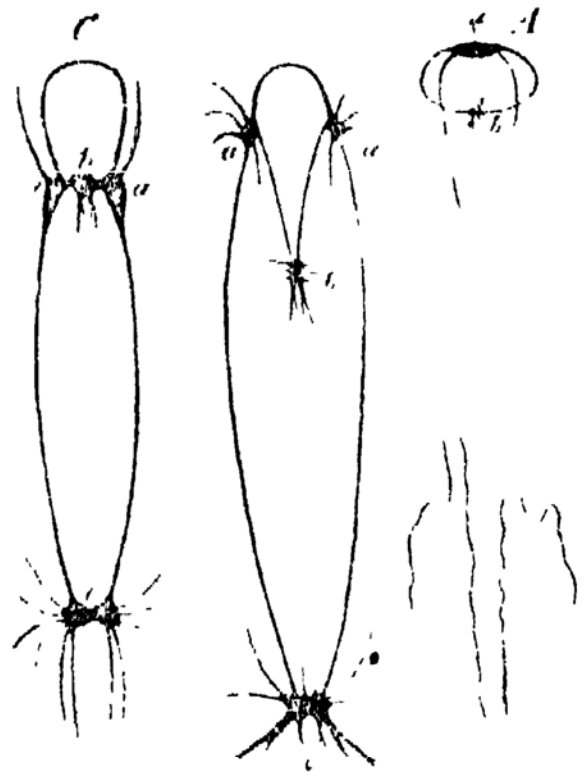


Fig. 144.—N
Lamellibran
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(11 Other

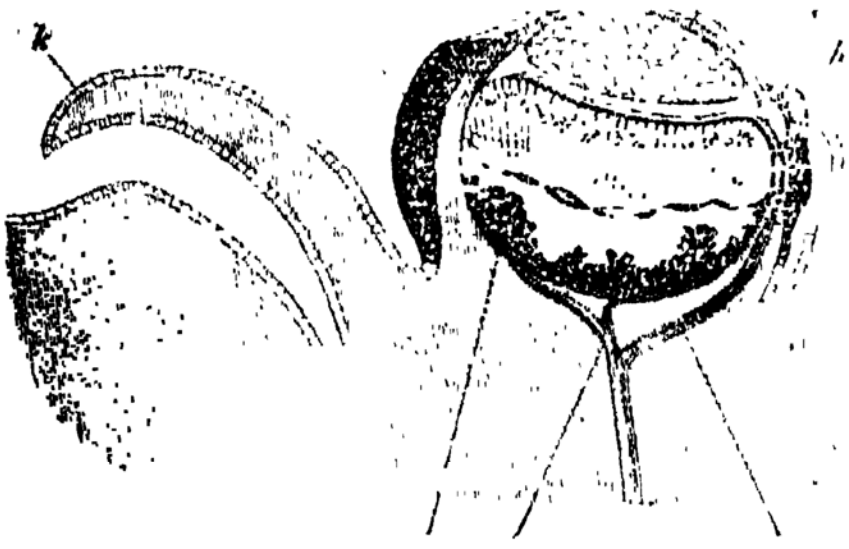


Fig. 145.—Pallial eye of Spondylus (from Hellum; *b*, cellular lens; *c*, retinal body; *d*, optic nerve; *f*, complementary nerve; *h*, epithelial tentacle

anatomists have considered this ganglion pair as corresponding to either the pleural or the visceral of Gastropods, or to both, and very usually it is termed "the parieto splanchnic" (Huxley).

The sense organs of Anodon other than the osphradia consist of a pair of otocysts attached to the pedal ganglia (fig. 124, (6), *ay*). The otocysts of Cyclas are peculiarly favourable for study on account of the transparency of the small foot in which they lie, and may be taken as typical of those of Lamellibranchs generally. The structure of one is exhibited in fig. 146. A single otolith is present as in the veliger embryos of Opisthobranchia. In adult Gastropoda there are frequently a large number of red lime otoliths instead of one.

Anodon has no eyes of any sort, and the tentacles on the mantle edge are limited to its posterior border. This deficiency is very usual in the class; at the same time, many Lamellibranchs have tentacles on the edge of the mantle supplied by a pair of large well-developed nerves, which are given off from the cerebro pleuro visceral ganglion pair,

and very frequently some of these tentacles have und a special metamorphosis converting them into organized eyes. Such eyes on the mantle-edge are in Pecten, Spondylus, Lima, Ostrea (?), Pinna, Pectu Modiola, Mytilus (?), Cardium, Tellina, Mactra, Venus, Solen, Pholas, and Galeomma. They are totally distinct from the cephalic eyes of typical Mollusca, and have a different structure and histological development. They have not originated as pits but as tentacles. They agree with the dorsal eyes of Onchidium (Pulmonata) in the curious fact that the optic nerve penetrates the capsule of the eye and passes in front of the retinal body (fig. 145), so that its fibres join the anterior face of the nerve-end in Vertebrates, instead of their posterior face as cephalic eye of Mollusca and Arthropoda, moreov lens is not a cuticular product but a cellular str which, again, is a feature of agreement with the Ver eye. It must, however, be distinctly borne in mi there is a fundamental difference between the eye of brates and of all other groups in the fact that Vertebrata the retinal body itself a part of the nervous system, and not a separate modification epidermis (nervous as opposed to epidermic). The ture of the repaired eye of several of the above genera has not been carefully examined. In Pect Spondylus, however, they have been fully studied (145, and explanation).

The gonads of Anodon are placed in distinct m female individual. In some Lamellibranchs (for in the European Oyster and the *Pecten opercularis* th are united in the same individual, but here, as i hermaphrodite animals, the two sexual elements ripe in the same individual at the same moment. been conclusively shown that the *Ostrea edulis* de fertilize itself. The American Oyster (*O. virginia* the Portuguese Oyster (*O. angulata*) have the sexe rate, and fertilization is effected in the open wate the discharge of the ova and the spermatozoa fr female and male respectively. In the *Ostrea edulis* zation of the ova is effected at the moment of their from the uro-genital groove, or even before, by m spermatozoa drawn into the sub-pallial chamber by current of water, and the embryos pass through early stages of development whilst contained between cell-lamellæ of the female parent (fig. 69). In Anod pass into the space between the two lamellæ plate, and are there fertilized, and advance

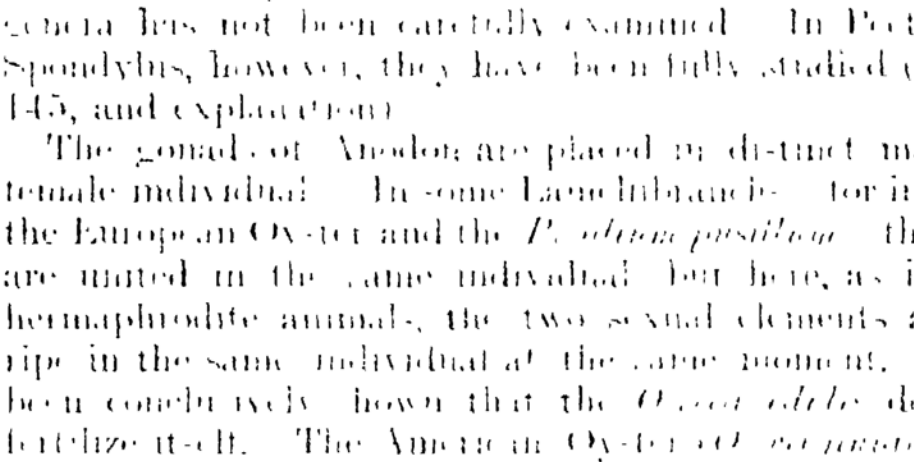


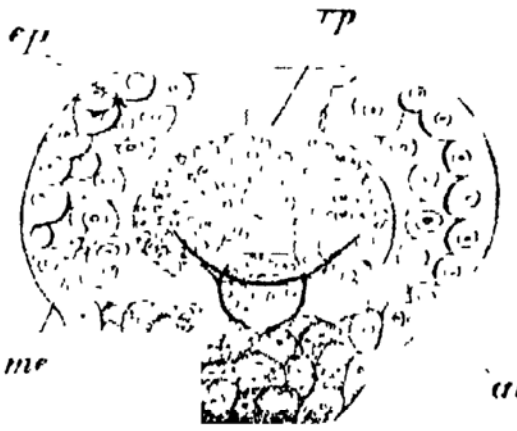
Fig. 147. [illegible] of Anodon [illegible] A, [illegible] B, [illegible] *a*, [illegible] *b*, [illegible] *c*, [illegible] *d*, [illegible] *e*, [illegible] *f*, [illegible] *g*, [illegible] *h*, [illegible]

still in this position to the glochidium phase of ment (fig. 147). They may be found here in th in the summer and autumn months. The gonads selves are extremely simple arborescent glands, whi to the exterior by two simple ducts, one right a

continuous with the wall of the tubular branches of gland (fig. 124, (5), (6), *y*). In no Lamellibranch is e a divergence from this structure, excepting that in e (Ostrea) the contiguous nephridial and the genital ture are sunk in a urino-genital groove, which in other s (Spondylus?) may partially close up so as to con- ute a single pore for the nephridial and genital ducts. ree coxy genital glands are present.

he development of Anodon is remarkable for the curious al form known as Glochidium (fig. 147). The Glochidium

kl



ap. Endoderm
ryonic cells, ar
e mouth-plate an
nvagination, *la*

s the gall-pouch of its parent and swim by alternate ing and shutting of the valves of its shell, as do t Pecten and Lima, trailing at the same time a long

Fig. 149.

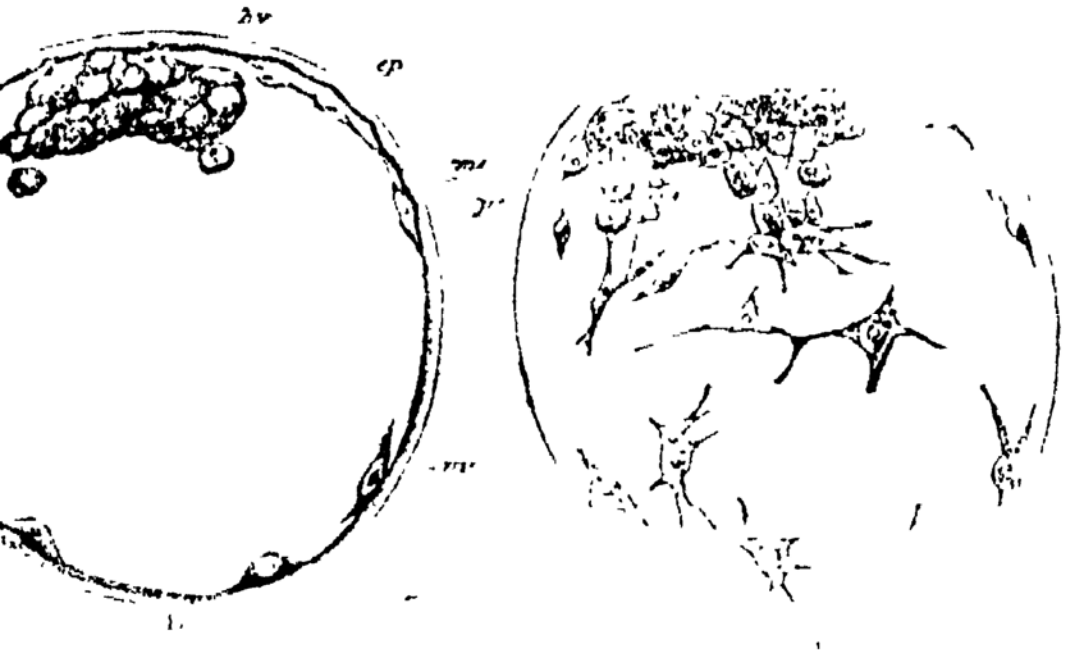


Fig. 150.

149. Embryonic *Limax* (*Arion*) *empiricorum* (from the Ref Lankester). The cells are increased and between the outer and the invaginated sed

150. B. Same embryo, at a later stage, in optical agmated cells *ba* which form the mid-entero which are budded off from the surface of th ves to the inner surface of the ectoderm *ba* the embryo is covered externally by the ectoderm cells which immediately derlie the outer cell-layer.

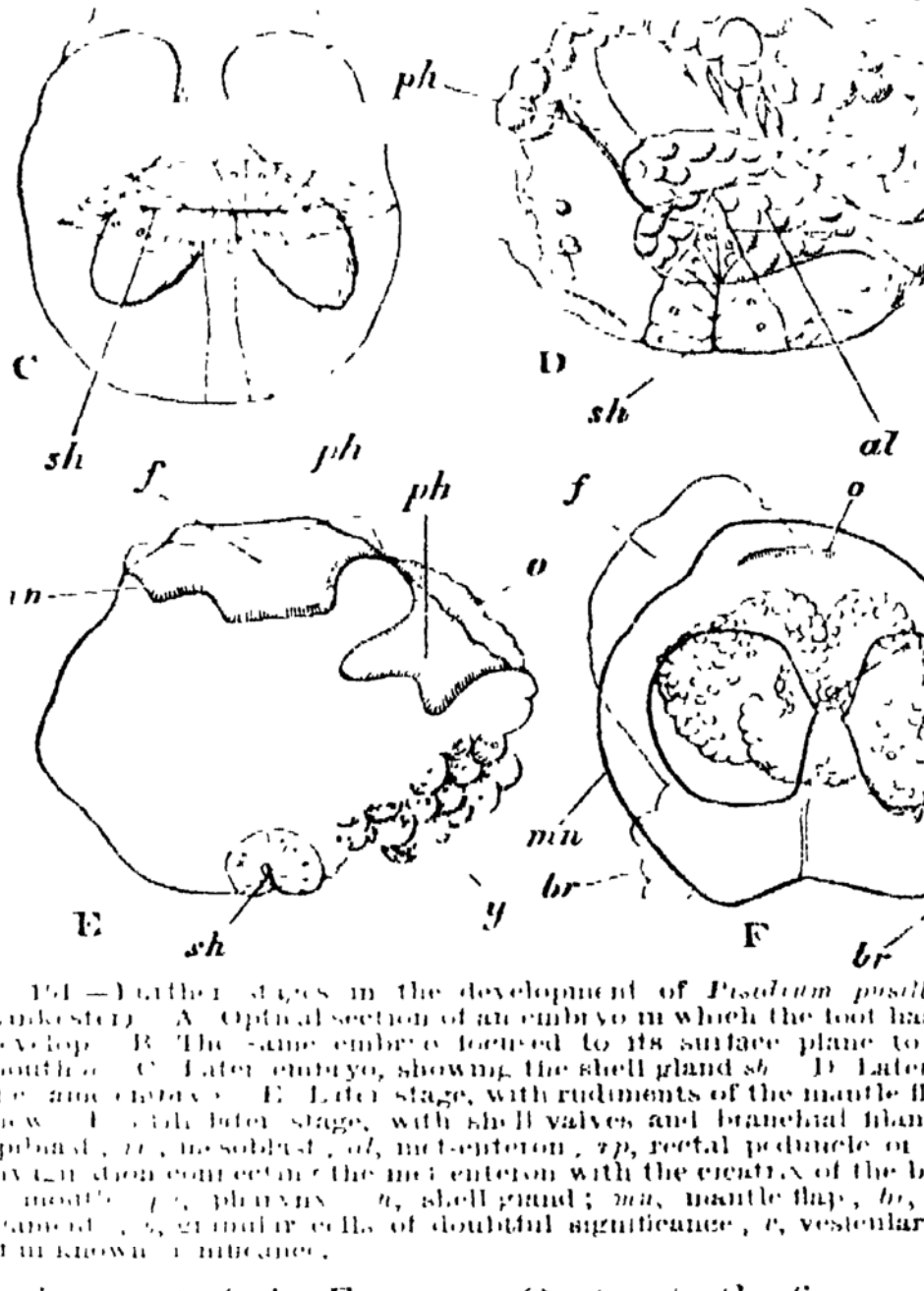


Fig. 151.—Further stages in the development of *Pisidium pusil* Lankester). A, Optical section of an embryo in which the foot ha develop. B, The same embryo focused to its surface plane to mouth. C, Later embryo, showing the shell gland *sh*. D, Later the anus (*an*). E, Later stage, with rudiments of the mantle fl View. F, a still later stage, with shell valves and branchial plan epiblast, *m*, mesoblast, *al*, mid-enteron, *vp*, rectal peduncle or invagination connecting the mid-enteron with the ectoderm of the b mouth, *ph*, pharynx, *sh*, shell gland; *min*, mantle flaps, *br*, branchiæ, *y*, granular cells of doubtful significance, *v*, vestibular of unknown significance.

sus thread. By this it is brought into contact with the of a fish, such as Perch, Stickleback, or others, and effects

development of the European Oyster, to the figure o and its explanation the reader is specially referred An example of the latter is seen in a commo fresh water bivalve, the *Pisidium pusillum*, which h studied by Lankester (**12**). The successive stage development of this Lamellibranch are illustrate woodcuts figs. 148 to 153 inclusive. These sh compared with the figures of Gastropod deve (figs. 3, 4, 5, 7, and 72***). Fig. 148 shows the of the egg-cell into four (A), and at a later stage the in of some of the cells to form an invaginated se

bryonic cells continue to divide, and form an oval containing liquid (fig. 149), within this, at one pole, the mass of invaginated cells (fig. 150, *hy*). These ated cells are the arch enteron; they proliferate and branching cells, which apply themselves (fig. 150, he inner face of the vesicle, thus forming the meso-

Diagram of embryo of Pedalion in the same stage as Fig. 149 (after Lankester). *m*, mouth; *ph*, pharynx; *as*, anal involution; *pl*, pallial fold; *sbs*, shell-gland. (From Lankester.)

r coelomic outgrowths. The outer cell-layer of hich constitutes the surface of the vesicle (fig. the ectoderm or epiblast or dermic cell-layer. The ass of hypoblast or cell-mass now en- but remains con- with the cicatrix of stopore or orifice of ation by a stalk, the edunele (fig. 151, A, he enteron itself be- ilobed and is joined w invagination, that mouth and stomo- *ph*. Fig. 151, B the origin of the *a*, being a deeper the same specimen same position which wn in fig. 151, A. esoblast multiplies lls, which become

Fig. 153. Diagram of [illegible] of Pedalion in same stage as Fig. 151 (after Lankester). *m*, mouth; *ph*, pharynx; *f*, foot; *br*, branchial filaments; *mes*, mesoderm of the mantle-skirt. *B*, origin of hypoblastic phrodermic. The unshaded area gives the position of the shell-valves.

muscular and partly skeleto-trophic. Centrodor ow appears the embryonic shell gland (fig. 151, The pharynx or stomodæum is still small, the ot yet prominent. A later stage is seen in fig here the pharynx is widely open and the foot pro . No ciliated velum or pra oral (cephalic) lobe evelops. The shell gland disappears, the mantle s raised as a ridge (fig. 151, E, *mes*), the paired alves are secreted, the anus opens by a proctodeal th into the rectal peduncle, and the rudiments of ls (*br*) and of the nephridia (B) appear (fig. 151, 153, dorsal and lateral views of same stage), and he chief organs and general form of the adult are

acquired. Later changes, not drawn here, consist growth of the shell-valves over the whole area mantle-flaps, and in the multiplication of the ments and their consolidation to form gill-plate is important to note that the gill filaments are one by one *posteroorly*. The labial tentacles are late. In the allied genus Cyclas, a byssus gland is in the foot and subsequently disappears, but no such occurs in Pisidium. The nerve-ganglia and the probably form from thickenings of the epiblast, but observation on this and other points of histogenesis Lamellibranchia is still wanting.

[illegible]

LLUSCOIDS. See BRACHIOPODA and POLYZOA.

LOCH, or MOLECH—in Hebrew, with the doubtful on of 1 Kings xi. 7, always הַמֹּלֶךְ with the article ame or title of the divinity which the men of Judah

in the last ages of the kingdom were wont to propi the sacrifice of their own children. The phra in speaking of these sacrifices is "to make pass daughter pass through fire to the Moloch" (2 Kings

. xxxii. 35, and so without the words "through fire" viii. 21). but it appears from Ezek. xvi. 20, 21 is piacle denotes a human holocaust,[1] and not, as es has been thought, a mere consecration to Moloch ing" through or between fires, as in the Roman *Palilia* ntal rites elsewhere. Human sacrifices were com- s mute heathenism, and at least the idea of such was not unknown to Israel in early times (Isaac, ah daughter: though in the sunny days of the when religion was a joyous thing, there is no to think that they were actually practised.' It nerwise in the neighbouring nations, and in par we learn from 2 Kings iii. 27 that the proudest of his sons and heir was the last offering which e of Moab made to deliver his country. Even the historical writers to this act the effect of rous indignation against the invading host of Israel, a therefore surprising that under the more favour- time by the westward march of the Assyrian when the old gladness of Israel's faith was ed upon a gloomier sense of divine anger, the idea sacrifice of one's own son, as the most powerful of rite, should have taken hold of those kings of Ahaz and Manasseh, 2 Kings xvi. 3, xxi. 6; who between priests, in their hopeless need of help from religion of Jehovah, to look to strange peoples' rite. Ahaz' sacrifice of his son (which noted a somewhat late authority) must have been an act of despair, human sacrifices are not an ruptions of the popular religion spoken of and Micah. But in the 7th century, when the old had assumed rude hardness, and all religion was ned into cruel fear (Micah vi. 7), before the Micah the example of Manasseh spread to ple, and Jeremiah and Ezekiel make frequent and nt reference to the "high places" for the sacrifice dren by their parents which rose beneath the very t the temple in the gloomy ravine of Hinnom ley (Jer. vii. 31 f., xxxii. 35; Ezek. xvi. 20, 57). It is with these sacrifices that the name of Moloch is always connected, sometimes "the bomb" appears as a synonym. At the same time, rid ritual was so closely connected with Jehovah (Ezek. xxiii. 39) that Jer. might more than once necessary to protect that name of Jehovah- on (Jer. xxxi. 31, xix. 5). So too in the idea of ng the firstborn to Jehovah that is declared and l in Micah vi. It is indeed plain that such a for we have here to do, not with human victim- cal, but with the sacrifice of the dearest earthly ings could only be paid to the supreme deity, and ople never ceased to acknowledge in Israel, though they sought to make sacrifices by the adoption of foreign the which Jeremiah, and after him 2 Kings xvi. 3 a single letter

that Micah everywhere the offering the expression "to Moloch," is rather the other sacrifices) of children and justify the

"(Gen. ii. other men" is of too late to Moloch in old Israel. sacrificial consecration of criminals or [illegible] neighbours (alone of sacrifice in which the child was burnt through fire and Topheth is elsewhere; its meaning LXX. o.

the legislation of Leviticus and the author of Kings to mark out the Moloch or Baal as a false god, d from Jehovah, is precisely parallel to the way in Hosea speaks of the golden calves or Baalim. In ease the people thought themselves to be worsh Jehovah under the title of Moloch or Baal; but the p refuses to admit that this is so, because the w itself is of heathenish origin and character. Moloch," in fact, like "the Baal," is not the proper of a deity, but a honorific title, as appears from the the article with it. According to the Hebrew conso it might simply be read "the king," which is a co appellation for the supreme deity of a Semitic st tribe.[1] And so the LXX., except in 2 Kings xxi and perhaps Jer. xxxii. 35, actually treat the name appellative ("ruler," "rulers"). The traditional pron tion, which goes back as far as the LXX. version of (Μολόχ), appears to mean "the kingship"—an unus sense, which lend probability to the conjecture th old form was simply "the king," and that the later gave it the vowel of בשת, the contemptuous nam Baal (G. Hoffmann in *Z. f. A.W.*, 1883, p. 124).

From these arguments it would appear that the Moloch worship does not imply the introduction in religion of Judah of an altogether new deity, but heathenish development of Jehovah worship, in the fa fashion of religious syncretism, and under that s the inadequacy of the old popular ritual to dive wrath of the Godhead which was inspired by the cala of the nation in the 7th century B.C., and led to mor one new development of atoning ritual. The key phenomenon is to be found in Micah vi., not in an of mythological speculation as to the forces of natur as is supposed in Movers's theory that Moloch rep the fiery destructive power of the sun. Moloch, i in the Old Testament has no more to do with fir any other deity. The children offered to him we burned alive, they were slain and burned like any holocaust (Ezek. *ut supra*; Isa. lvii. 5); their bloo shed at the sanctuary (Jer. xix. 4; Ps. cvi. 38). the late Rabbinical picture of the calf headed brazen of Moloch within which children were burned alive fable, and with it falls the favourite comparison b Moloch and the Carthaginian idol from whose braze children were rolled into an abyss of fire, and Diodorus (xix. 14) naturally identifies with the chil Kronos, thus leading many moderns to make Mol planet Saturn. On the other hand, the Massoret of 1 Kings xi. 7 makes Moloch (without the artic name of the god of the Ammonites, elsewhere Melcom or Malcam. But in this place the LXX. tran certainly found the longer form מלכם in their M the Hebrew still reads in verse 33), while it is plai 2 Kings xxiii. 10, 13 that the worship of Milcom shrine set up by Solomon was distinct from the later Moloch worship of Tophet. In the usual text of the LXX., indeed, this distinction is not m 2 Kings xxiii., but this is an error of the Roman e the Vatican MS. really reading MOAXOA in verse (W. R

MOLUCCAS, Molleccos, or Spice Islands. Th prise, in the wider use of the term, all the islands East Indian Archipelago between Celebes on the w Papuan Islands and New Guinea on the east, Ti the south, and the open Pacific on the north. T

[1] Compare the Tyrian Melkart (king of the city) and names compounded with *melek*, "king," in 2 Kings xvii. 31 latter cases are specially instructive, because Adrammelech an melech were also worshipped by the sacrifice of children.

tributed over an area measuring about 150 miles st to west, and about 800 from north to south, and -(1) the Molucças proper or Ternate group, of which the largest and Ternate the capital; (2) the Batbi, and Sula groups; (3) the Amboin or Amboyna f which Ceram (Serang) and Buru are the largest; Banda Islands (the spice or nutmeg islands *par*), of which Lantor or Great Banda is the largest, ra politically the most important, (5) the south- islands, comprising Timorlaut or Timor Laut, c.; (6) the Kei Islands and the Aru Islands, o he former are sometimes attached to the south group; and (7) the south-western islands or the Sermatta, Letti, Wetter, Roma, and Damar groups. close of the 16th century this part of the archi was divided among four rulers of the Ternate, Jilolo, and Batchian. The northern portion be the Dutch re identship of Ternate, the southern to that of Amboyna.

name Moluc as seems to be probably derived from bar for "king." Argensola (1609) says the terms *dluco*, *Maluco*, and *el Maluco*, Correa (1628), *elos* e the article on Ludwig Verzema on Van Linschoten, Thevenot, &c., and J. de Heredia, *Memoire sur l'ancienne des Indes-en-Deçà et Delà du Gange*, 877 and 1882).

LYBDENUM, one of the rare metallic elements l for atomic weight, Mo 96. It occurs in chiefly in the two forms of Yellow Lead Ore oO$_3$) and Molybdenite (MoS_2). The latter mineral similar in appearance and in mechanical properties hite or black lead, and in fact, was long confounded chemically, until Scheele in 1778 and 1779 proved ifference by showing that only the mineral now nolybdenite yields a white earth on oxidation, etallic radical of the earth, after its discovery by was called molybdenum, from *μόλυβδος*, lead.

ating molybdenite in a combustion tube in a stream of ox- n the trioxide MoO_3 (molybdic acid), which collects in e. The substance, when heated to some moderate degree, thout much volatilization into a yellow liquid which on freezes into a crystalline radiated mass of 4·69 specific It dissolves in 500 parts of cold and in 900 of boiling It dissolves readily in aqueous ammonia or alkali forming *molybdates*. Like silica, it combines with bases in several of proportions. Of the ammonium salts, a mixture said of position $3(NH_4)_2O, 4MoO_3, 4H_2O$ (known in laboratory simply as molybdate of ammonia) is the most important g, as it does, the most delicate, characteristic and widely- le precipitant for ortho-phosphoric acid. To detect phos- ed in any substance soluble in water or nitric acid, add solution of molybdate of ammonia in excess of nitric acid n (not too much) of the nitric solution of the phosphate p the mixture at 40° C.; the whole of the phosphoric y separates out in the shape of a canary-yellow crystal- ate of "*phospho-molybdate of ammonia*," of the composition

$$\left.\begin{matrix}24MoO_3.P_2O_5.3(NH_4)_2O \\ +24MoO_3.P_2O_5.2(NH_4)_2O\end{matrix}\right\} + 10H_2O$$

ng to Gibbs), which is insoluble in the strongest even in e of dilute nitric acid, but soluble in excess of phosphoric ment of this complex ammonia salt with aqueous ammo- le its acid $24MoO_3.P_2O_5.3H_2O$ nd crystallizing from this solution with 9 molecules of

phospho-molybdic acid plays a great part in chemical being a generically characteristic precipitant for all sorts of s, which combine with it, pretty much as ammonium do cipitates insoluble in dilute mineral acids. A solution of l sufficient for this purpose may be obtained by adding te of soda solution with molybdic acid adding phosphate one part for every five of MoO_3, evaporating to dryness dissolving in water, filtering, and adding nitric acid until id becomes yellow.

llic molybdenum is obtained by reduction of the trioxide in n gas at very high temperatures. It is thus obtained in rystalline granules which are infusible even in the oxy- n flame. An alloy of the metal with four or five per cent. of carbon (formerly accepted as molybdenum) fuses in the oxy- hydrogen flame into a silver-white metal, of 8·6 specific gravity which is harder than topaz (Debray).

Analysis. Molybdenum in all its forms is readily converted into molybdic acid by oxidizing agents, such as nitric acid, or alkalies volatile forms into alkaline molybdate by fusion with carbonate of alkali and nitre. Alkaline molybdate is soluble in water, a solution, on gradual addition of hydrochloric acid gives first a white precipitate which then dissolves in the excess of acid. When pieces of zinc are added to such a solution, the latter gradual reduction of the MoO_3 to lower oxides, at once first a blue then a green, and lastly a deep black-brown colour. Molybdic acid colours the blowpipe flame yellowish green. It dissolves in borax, forming a bead which in the oxidizing flame becomes yellow in the heat, but almost colourless on cooling; the reducing flame colours it dark brown and opaque. See the operation of the Duke of Modena.

MOMBASA, or less correctly Mombas, the *Mazua* of the Sawahili, a town on the east coast of Africa, 4° 4′ S. lat., with the best harbour on all the Zanguebar seaboard. The coralline island of which it occupies the eastern portion is 3 miles long by ¾ broad, and lies in the middle of a double inlet of the sea, the southern branch running northward into Port Tudor, so called after the English settlement which it contains, and the northern, which is called after the Portuguese fort. [illegible] Mombasa is now [illegible] Mombasa is one of the finest [illegible] Banyans [illegible] of the [illegible] were tried to entrap [illegible] Guinea, [illegible] troubles which [illegible] force to [illegible] native name *Mvita* was [illegible] The principal merchant [illegible] the [illegible] and farming of the place by Almeyda (1506), [illegible] Lisbon, and Duarte de Menezes (1587), who [illegible] [illegible] Portuguese [illegible] obtained [illegible] [illegible] of Yusuf [illegible] (1631) [illegible] governor of the Portuguese [illegible] it until 1698, when the [illegible] Portuguese [illegible] church of Omán (1650) [illegible] and the main [illegible] Fort Mombasa (1698). In 1824 the Mazrui family, after [illegible] [illegible] early part of the 18th century [illegible] [illegible] secession; but Britain [illegible] [illegible] obtained and captured by [illegible] [illegible] was ordered to make repeated attacks [illegible] [illegible] only got possession in 1874 by treaty [illegible] [illegible] for in 1875 was put down by Barghash [illegible] [illegible]

See Capt. W. F. W. Owen, *Narrative of Voyages to explore the Shores of Africa, Arabia, and Madagascar, &c.* (1833); Guillain, *Documents sur l'Afrique orientale* (1856); Burton, *Zanzibar* (1872).

MONACHISM

THE word Monachism, or Monasticism, primarily meaning the act of "dwelling alone" (μοναχός, μοναζειν, μόνος), has come, by an easy and natural transition, to denote the corporate life of religious communities living a life of poverty, celibacy, and obedience, under a fixed rule of discipline. The root-idea of monachism, in all its varieties of age, creed, and country, is the same — namely retirement from society in search of some ideal of life which society cannot supply, but which is thought attainable by abnegation of self and withdrawal from the world. This definition applies to all the forms of monachism which have left their mark on history, whether amongst Brahmans, Buddhists, Jews, Christians, Moslems, or the communistic societies of the present day, even when theoretically anti-theological.

This broad general conception of monachism is differenced in the following ways. It may take the form of absolute separation, so far as practicable, from all human intercourse, so as to give the whole life to solitary contemplation — the anchoretic type; or, contrariwise, it may seek fellowship with kindred spirits in a new association for the same common end — the cœnobitic type; it may abandon society as incurably corrupt, as a City of Destruction out of which the penitent must flee absolutely (the Oriental view, for the most part); or it may consider itself as having a mission to influence and regenerate society — which has been, on the whole, and with minor exceptions, the Western theory of the monastic life.

The question has been warmly debated whether monachism be an evil or a good, whether a natural, perhaps a necessary, part of Christianity (as being, indeed, the strictest logical issue of the triple vow of baptism, literally construed), or a foreign element introduced into it with unfortunate results, and rather an excrescence on its system than an orderly and healthy development. Unlike many other institutions which have needed the lapse of centuries and the gradual approach of decay and degeneracy to show their weak places, monachism in its Christian form displays some of its most unlovely features while yet almost in its cradle, whereas not a few of its best achievements belong to a late period in its history, and it has throughout displayed a singular elasticity and power of taking a fresh departure, after seeming to have exhausted its energies. Its champions and its opponents have thus always had ample materials for their brief, and there is little probability of the controversy ever coming to an end. But the most philosophical mode of viewing its relation to Christianity is to recognize that monachism has made a part of every creed which has attained a certain stage of ethical and theological development, that there is a class of mind for which it has always had a powerful attraction and which can otherwise find no satisfaction; and consequently that Christianity, if it is to make good its claim to be a universal religion, must provide expression for a principle which is as deeply seated in human nature as does any other, albeit limited to a much smaller section of mankind.

Three causes seem to have combined to produce the phenomenon of monachism in early Christianity, each of them set in motion by the general dissolution of morals in the pagan society of the time, of which we get a sufficient glimpse from the Christian standpoint in the first chapter of the Epistle to the Romans, and from the pagan standpoint in the sixth Satire of Juvenal. These three factors were (1) the Oriental tendency towards retirement, contemplation, and asceticism, influencing the infant Christian church through the agency of the Jewish ascetics, the Essenes and Therapeutæ, who had begun long before the Christian times both the solitary and the common life in Palestine and Egypt, and who probably contributed many converts to Christianity, and became practically merged therein when they disappear from history in the first century of the Christian era; (2) the Hellenic teaching of the Alexandrian Neo-Platonists on the purification of the intellect by abstraction from physical indulgence; and (3), perhaps a more powerful influence than either, that old Roman sense of austerity and discipline which, while looking back sorrowfully to the memories of the simpler habits of republican times, could find nothing amidst the social luxury and administrative weakness of the decaying empire which suited its ideal, save the monastic system with its proscription of luxury, and even of comfort, in every form. The first named of these three factors was, however, probably the earliest to operate. The Scriptures attest clearly the existence of a body of ascetics in the persons of the Nazarites, leading always for a certain period, and sometimes for life, a stricter existence than the ordinary Jew; and John the Baptist furnished examples of the solitary hermit type. The Schools of the Prophets at least seem to have been celibate and cœnobitic communities, living under a fixed ascetic rule; and it is familiar to all that such was the actual discipline of the Essenes (see ESSENES). These, with the Therapeutæ, known to us only from the book *De Vita Contemplativa* (ascribed to Philo), and described as existing, though not exclusively, established in Egypt, bore a close resemblance to the Essenes, differing from them for the most part by greater austerity in the matter of food, and by their preference for the solitary life over the cœnobitic fellowship of the Essenes; for their custom was that each member confined himself to his lonely dwelling (called by the afterwards famous name of *μοναστήριον*) throughout the week, while all assembled on the Sabbath for worship, and for instruction from the senior of the community. So closely does this polity resemble that of several of the earliest Christian societies of the kind that Eusebius devotes a chapter of his *Ecclesiastical History* (ii. 17) to asserting their identity, holding that Philo could have been speaking of none save Christian ascetics, a view in which he is followed by Sozomen and Cassian in ancient times, as also by many moderns. This view has been rendered much more probable by recent inquirers, who seem to have made out that the *De Vit. Cont.* is spurious, and written about 300 A.D.;[1] for there is a general agreement amongst the fathers that the monastic life did not exist till nearly two hundred years after Philo lived; and Tertullian (160-240 A.D.) declares explicitly that Christians in his time did not withdraw *from* society. "We are not Indian Brâhmans or Gymnosophists, dwellers in woods and exiles from life; . . . we sojourn with you in the world" (*Apol.*, xlii.). Yet there is no reason to doubt that the leaven of Essenism was at work in the Church from the earliest time, and helped to form the atmosphere which issued in monachism. Still, the process was slow and gradual, passing through very much the same stages as can be traced by careful inquiry in the case of the Essenes. That is to say, the new converts to Christianity, being for the most part dwellers in cities, were in need of close and daily contact with the heathen society around them, whose relaxation was such as to induce an even greater recession from the habits of self indulgence than the stricter morality of the new creed enjoined, so that a body known by the name of "Ascetics" sprang up very soon within the church

[1] See especially Lucius, *Die Therapeuten*, 1879.

were urged on to still greater severity of life when the rapid progress of Christianity brought large numbers of merely nominal converts in, whose practice fell too conspicuously below their profession. The desire of protest against such a state of things led to the gradual separation of the devotees into a kind of order within the main body, and to their actual withdrawal from habitual intercourse with their less strict fellows, which led in turn to their departure from the towns into more secluded places, even before any formal conception of the monastic life had shaped itself in their minds. But the first glimpse obtainable of the "common life," and that only an indistinct one, is in the New Testament, and applies to women alone. There is mention in the pastoral epistles (1 Tim. v. 9 12) of a class of widows, apparently not as mere recipients of relief, but as constituting an ecclesiastical grade; while in Acts ix 39 it appears as if a number of women belonging to the order were united in some kind of community under the headship of Dorcas, for the narrative rather implies that they were her assistants in making clothing for the poor than themselves the objects of her bounty. This conjecture receives some confirmation from the mention of "the virgins who are called widows" (*τὰς παρθένους τὰς λεγομένας χήρας*) in the shorter recension of the Ignatian Epistle to the Smyrnaeans, and from the statement of Athanasius that Anthony, when himself about to begin the solitary life which he is regarded as having instituted, first placed his sister in a convent of virgins (*παρθενῶνι*), a fact which proves the organization of women at an earlier date in community life than of men, and lends some probability to the notion that it may have begun very soon and ed, especially when the prominence given to the virgins as a separate and seemingly long-established order in the church by such early writers as Tertullian and Cyprian is borne in mind.

Two other causes must be taken into account as tending to stimulate monachism when once it began. First is the theological opinion, early formulated, and never since without many advocates, that two distinct standards of life and holiness are set forth in the gospel, that of precept, and that of "counsels of perfection," the former binding all Christians without exception, the latter being voluntary, and merely offered for acceptance to such as aim at especial sanctity. The second, and even more powerful, agent was Gnosticism, not only in its earlier forms and in the kindred spirit of Montanism, but still more in its Manichaean development, when its dualism led to exaggeration of the antagonism between flesh and spirit, and the human body was regarded no longer as a servant to be trained, but as an enemy to be crushed and beaten down with unrelenting hostility. But in every age of monachism, from the earliest to the latest, social disorders and insecurity have proved the chief feeders of the cloister, never widely popular in times of healthy and orderly national life, but eagerly resorted to as a place of shelter from social turbulence.

There are five main classes of monastic institution, each of which approximately marks a new departure in the history of Western monachism (for the East has never had more than the first), as they succeed one another in chronological order, without in any instance involving the abandonment of the previous foundations. They are (1) Monks; (2) Canons Regular; (3) Military Orders, (4) Friars; (5) Clerks Regular. All of these have communities of women, either actually affiliated to them, or formed on similar lines.

There is no doubt as to the time and the person, when, and by whom, the first decisive step was taken which left a marked interval for all time between those ascetics who continued to live in family life, if not really part of it, or who at least dwelt close to some ordinary church, to which they resorted habitually, and the seekers after some more retired and separate mode of life, whether singly or in communities. During the stress of the Decian persecution (249 250 A.D.) Paul, a native of the Lower Thebaid, born of wealthy parents about 228, was denounced by his brother-in-law to the authorities as a Christian, and fled for safety to the desert, where he established himself in a cave shaded by a palm tree, and with a spring of water close by. There he remained till extreme old age, dying, if we may accept Jerome's chronology, in his hundred and thirteenth year, about 342. Although he did not collect any band of disciples around him, nor even, so far as is recorded, attract any casual visitors, except his more famous successor, Anthony, who is alleged, in a narrative containing many legendary details, to have had an interview with him when himself a very old man, the day before Paul's death, yet there seems reason to believe that the fame of his example spread sufficiently to induce imitation of it, and that anchoretic cells began to be set up sparsely in the deserts even before Anthony adopted that mode of life. Anthony's career differed in various respects from that of his precursor. In the first place, it was voluntary choice, not fear of persecution, which sent him into solitude. He was born about 250 at Coma in Upper Egypt, of wealthy Christian parents, and was left at eighteen years of age in possession of a large fortune and of the guardianship of a younger sister. He had received what was probably a fair vernacular education, but distaste for study or perhaps more probably that difficulty which contemplative intellects experience in the acquisition of language left him unacquainted with Greek or Latin, yet the intimate knowledge of Scripture which he afterwards displayed cannot be satisfactorily accounted for in any other way than as the result of attentive perusal, since mere listening to the lections in church would suffice to convey it; and we must reject therefore Athanasius's statement of his ignorance of letters to denote the absence of culture not as implying actual illiteracy. One day, hearing the gospel read, "Go and sell that thou hast, and give to the poor, and come, and follow Me," he took it as a direct address to himself, and at once returned home, distributed his property amongst his neighbours, reserving only a small sum for the support of his sister whom he placed in charge of some Christian virgins, and then betook himself to solitary life, first visiting the most eminent ascetics or anchorets he could find, in order that he might learn the peculiar merit of each and imitate it. He fixed his dwelling first in a tomb, then in a ruined fort near the Nile, where he remained for twenty years, leaving it but once in 311, to encourage the Christians of Alexandria during the persecution of Maximin; and lastly in a small grove of date palms, a few miles west of the western coast of the Red Sea, near the base of Mount Kolzim, where he made an enclosure and planted it as a garden. He quitted his retirement but once in his remaining life, when he again visited Alexandria in 335, at the request of Athanasius, to preach against the Arians. Yet his fame drew not only frequent visitors to his cell, but numerous disciples and imitators around him, attracted not alone by his personal virtues, but by his cheerful and courteous manners and shrewd practical judgment. He made the solitary life honourable and popular, fully justifying Jerome's phrase in comparing him with Paul, "Hujus vitae auctor Paulus, illustrator etiam Antonius." When Anthony died in 365, aged one hundred and five, the desert was already studded with hermitages in every direction, and the second great step in the development of monachism had been already taken by Pachomius, who stands out in history at once as the founder of the cœnobitic life among Christians and as the author of the first formal monastic rule. Born about

nverted to Christianity in early manhood while in the army he was baptized on obtaining his dis- and at once adopted the ascetic life under the n of the hermit Palæmon, with whom he retired ome and land on the Nile, between Faoûoot and eh. Here he began his new institute, whose dis- rs' features were as follows. The monks were t small cells, each of which contained three inmates, on the relation a *monk* (the usual number in Egyptian foundations was two in each cell, while in e tenant had no partner). A large number of such s stood near each other, named a *Lavra*, and each n had but one common place for meal and other ne. Work and food were apportioned to each according to his physical strength, and such as rmitted exceptional fasting or mortification were not stake the heaviest tasks of bodily labour. Their es to be a close linen tunic with a white goat-hair or upper garment, which they were not to exchange s or mend, but only when they are entitled to the t, when they wore their hood only in addition to They were divided into twenty-four companies nbered according to the letters of the Greek l, into which they were distributed according to ellectual and practical proficiency, the first intelli- ones placed in the *Alpha*, the latest of simple fellow- able (in the *Zeta*), the next complicated. Each s was enjoined to recite a set of ten and a hundred s during meal and ceremonies, and all subject to the who was himself in turn when the ex-penitent ond remained subject to the correction for Arche- or the mother-house which the founder of each s to be served by a steward (*oikonomos*) who was ompatible with the treasurer or steward of Tabenne. nd food was bread and water, their luxuries oil d a few cooked dishes of vegetables, chiefly fruit of neighbourhood in which they ate in great silence s broken by the voice of a reader, appointed to ctures from Holy Scripture. Each man's scrip he covered to hold his dates from his companion- nabled twice daily to recite prayers and not for communion on Sundays and Saturdays. A ubation of three years was required of postulants n upon during which they were exercised in simple labours, and were not permitted to enter upon tacy till they had satisfactorily passed through n. Their work was subservient to their own immediate nd weaving mats or baskets for sale, to procure e for the; their direct labour was to attend to , and, at times went on, other handicraft were d in the cloisters, such as those of smith, tailor, lder, farmer, and so forth. Pachomius ordained to found a convent of nuns governed by very rules, and subject to the authority of a visitor d by himself, a superior of the whole to future the rule of the Pachomian rule that before der died (between 318 and 320) he had no fewer ateen hundred people in his own coenobium, and ous and dependent under his authority. Nor was ence confined to Tabenne and its dependencies carried the rule into the Nitrian desert, where n-and-monk were soon collected. Hilarion bore Syria and Palestine. Its tablets of Schnudi into a, Ephraem Syrus into Mesopotamia, Basil the Great ppadocia and Pontus (though a rule of his own supplanted it later on), and, above all, it was brought ma ms himself into Italy, whence it spread over st till modified in various ways by subsequent legis- nd finally displaced by the Benedictine institute. h was its popularity during as it did a need of the time, that its votaries in Egypt alone amounted by the 5th century to more than a hundred thousand, of whom three-fourths were men. This rule has come down to us in two very different forms: an earlier and probably original one, preserved for us in the *Historia Lausiaca* of Palladius, bishop of Helenopolis (367-430) - a great storehouse of details on Egyptian monachism, which is very brief, and has been summarized above - and a much longer recension extending to 194 heads or chapters, preserved in a translation by Jerome, in whose time the monks governed by it had increased to fifty thousand. It had not, however, a complete monopoly, for there were also similar rules in local use, going by the names of famous ascetics such as Paphnutius, Macarius, and Serapion; nor was it uncommon to find communities where in two or three different rules were followed simultaneously by the various inmates. The rule of Basil, however, proved to the East what that of Benedict did to the West, in that it practically absorbed or supplanted all its predecessors, while, unlike the great Western reform, it has had no subsequent competitors, and remains to this day the single monastic code of the Oriental Church. This rule is embodied in the *Asceticon* of Basil, and also in two recensions, a longer and a shorter one, of the actual body of his code, which are marked with not a little of the shrewd practical sense, as well as lofty piety, which characterized the founder, being especially noticeable for their discouragement of the solitary mode of life, and for their recommendation of labour. The development of Oriental monachism thus coincides with the Basilian rule, and there are only two seeming exceptions to this fact: the institution of the Acoemeti (*akoimetai*), or "sleepless" monks in the 5th century for the purpose of keeping up unbroken prayer day and night - a system copied much later in the West by the communities founded for "perpetual adoration;" and the erection, for these very monks, of the great monastery of the Studium at Constantinople (named from Studius, its founder), which was the Cluny of its time and country, as a centre of the more intellectual monastic life, and as the model of stateliness in ecclesiastical ceremonial.[1] Greek monachism, as an institute, has no history later than the 5th century. The monks indeed constantly appear as factors in the controversies of the centuries which followed, at once the polemical and the political disputes showing them equally fierce and eager partisans (notably in the Iconoclastic controversy, which found them the most ardent champions of images); but they cannot be said to have exerted much influence upon society till a very late period of their history, when they were instrumental in keeping the national spirit and the national religion alive in Russia when suffering under the Tatar yoke, and they performed a like service for Greece during the centuries of Turkish oppression. It may further be added that, however low the intellectual life of Eastern monasteries may appear when judged by a Western standard, the clergy who are trained in them, technically known as the "Black clergy," stand much higher in character, acquirements, and general influence than the secular or "White clergy" of the parishes, whether in Greece or in Russia.

It has been already mentioned that the bad side of monachism appears almost as early as its good side.

[1] The great abbey, at the height of its prosperity, contained more than a thousand monks, and the following list of its staff of officers, due to Theodore the Studite, may be usefully compared with the Western monastic hierarchy: Ἡγούμενος (abbot), ὑποσταλτικός (prior), οἰκονόμος (treasurer), ἐπιστημωνάρχης (ceremoniarius), ἐπιτηρητής (inspector), κανονάρχης (precentor), ταξιάρχης (seneschal), κελλαρίτης (cellarer), ἀριστητάριος (refectioner), βεστιάριος (sacrist), ἀφιπνιστής (vigilator), νοσοκόμος (infirmarer). One or two of the offices do not quite correspond in East and West, but the general resemblance is close.

he system won the admiration of all the most emi
ristian teachers of the age which saw its birth and
owth, and while we are met by a still more remark
t that from the time when monachism was fairly
ned till we enter on the Middle Ages there are
or three names of distinction amongst the clergy,
as writers or administrators, to be found outside
s of monachism, amongst whom the most famous
basil and Leo the Great, nevertheless, there is
account on the other side. Not only did the
speedily find itself encumbered by the Messalians,
s, Gyrovagi, Sarabaites or Remoboth, Circumcel
and other companies of professed ascetics, whi m
, vagrant in habits, and turbulent in conduct, but
e genuine societies had scarcely fewer faults to
s. Lay in their origin, and for the greater part
earlier history having but rarely occasion to
them (a single priest ordained for each monastery
ter to its inmates being the utmost allowed for a
sible time), they were not subject to the same direct
on and discipline as the clergy, in case a whole
ity chose to disregard its rule, though of course it
to deal with an offender who had the force of he
y against him. The clergy were subject to the
ontrol of the bishops, and many disciplinarian canons
ils had laid down rules for their conduct ever the wa
e with the monks for a considerable time, not
ver effectively in the East, and their lax character
n practical independence of any authority except
abbot. And, despite the strictness of the monk
le itself, which, even before actual vows were
ntroduced (probably on the recommendation of
always involved during compliance with it the
gagements to the observance of poverty, chastity,
dience, which make up the triple of the monastic
s, and though pains were taken to exclude unfit
ts (such as criminal slaves who had fled for re
e than ill treatment, or persons who had kindred
nt on them), while a long probation was exacted
l who were accepted, yet it was impossible that
an a small proportion of the many thousands who
in during the first enthusiasm for the new move
ould have had any real sympathy with the re
and aspirations of such a mode of life. Severe
m operates differently on different natures, and
here are some whom it does but discipline and
here are more whom it tends to coarsen and to
, even apart from the many whom it is apt to
th morbidness, if not actual insanity. And it is
ionable that vast numbers of those who entered
monastic life came from the poorer classes, in
f some less toilsome mode of existence than they
viously led, preferring the contemplative societies,
almost no labour, certainly none of a severe and
ast, was practised, to those where agriculture and
tive employments, requiring more energy than net
ket weaving, were enjoined. Such men, undisci
d undisciplined, were liable to be thrown entirely
gear by the complete revolution in their mode of
specially when the community they joined was not
ntemplative, but situated in some place where the
ful soil made tillage nearly impracticable, and the
nbers crowded together were far too numerous for
s which could be assigned them. From the bosom
societies came not only single examples of exagger
ritual pride, bitter fanaticism, avaricious greed of
ty articles whose usufruct was permitted, fierce
ty, and wild religious delusions, but they gave
companies like the *Βοσκοί*, or "grazing monks,"
potamia and Palestine, who roved about, shelter
less and nearly naked, as Sozomen and Evagrius tell us, in
the mountains and deserts, grovelling on the earth, and
browsing like cattle on the herbs they casually found; and
to those fierce band of Nitrian and Syrian ascetics who,
reared in the narrowest of schools, treated any divergence
from their own standard of opinion as a crime which they
were entitled to punish in their own rectors fashion, two
instances of which have left an indelible brand on their
history—the murder of Hypatia in Alexandria, and that of
the patriarch Flavian at the Robber Synod of Ephesus. An
equally insular, but more sporadic and temporary, form
of asceticism was that of the Stylites or Pillar hermits
(στυλίται, κιονίται), who followed a fashion first set by
Simeon, a Syrian monk who spent almost half of the 5th
century on the summit of a column 60 feet in height.
The unwonted kind of austerity at first gave rise to strong
opposition, even from hermit themselves, and a messenger
was sent to Simeon, bidding him in the name of a synod
of bishops to descend from his pillar; but with infinite
tact he managed to persuade him to remain, and he showed himself ready
to comply. So he proved to be the saint, and, having thus
at once them selves that he was not influenced by spiritual
pride, they left him to follow his own devices. And we
have the direct personal testimony of the wise and tem
perate Theodoret that he exercised a strong and salutary
influence over the nomadic Saracen tribes, converting many
hundreds and even thousands to Christianity, he also became
the shrewd and trusted adviser, not only of the peasants
who flocked to be near him, but of Arab princes, Persian
satraps, and even Roman emperors. He cannot be
judged, therefore, by ordinary standard, and it is more
than likely that a life so extraordinary made on his world
at least as much for good, but as the only
contact before us the class to which he belongs, and the
to know he was liable and to have died out with his man
ners, the vermicular Simeon a century later. Even when
the hermit-ideal of monachism appeared in Egypt
and Syria it was upon and the full weight is allowed
to the contemporary picture drawn by great Christian
writers of the time, as ideal of a philosophy true
and purer than that of the Porch or the Academy, as
place where the equality and brotherhood not merely dreamed
of but established fact on the outer world could be seen in
being, as an asylum where children, deserted by their parents or
otherwise orphaned, were carefully reared, where the rich
were heavily taxed, where talents, piety, and gift for
godliness were the rule of all, it must be confessed that
the complaint of the Government, embodied in the hostile
legislation of the emperor Valens in 365, objecting
monks to the corruption (which drew forth an indignant
protest from Christians, that monachism was injurious
to society and to the healthy condition of civil life by
drawing off so large a fraction of the population into the
backwater of the cloister, was perfectly well founded.
And no small part of the overthrow of Christianity in
Egypt and Syria by Islam is due to the practical with
drawal of all the devout from family and public life, leaving
no spiritual energy to cope with the Koran in the town
and village—whether the conquering Arab came to civil
and proselytize.

The history of monachism in the West is far more varied
chequered, and interesting than in the East. It takes
its beginning from the visit of Athanasius to Rome in
340, during his second term of exile, when he brought
with him his *Life of St Anthony* and produced the example
on the Roman Christians who mourned a pattern not less
than as devotees, over the lax and enervated habits of
society. The popular imagination was caught at once,
and not only was the basis of monachism successfully laid
in Rome itself, but Eusebius of Vercelli introduced it

rthern Italy, where it was fostered a little later illustrious Ambrose at Milan. From the very ng a marked difference shows itself in the spirit of monachism as compared with the parent institute East. Partly from dissimilarity of climate, but still om that of racial and national temperament, there ay been less tendency in the West to either abstract plation or severe self torture, such as is equally to many of the Egyptian or Syrian ascetics and Jogis of Hindustan. Hard work, with due inter food and recreation, occupied all that part of a monk's time which was not devoted to prayer or and a careful apportionment of his duties through day gave each hour its appointed task to be ful aving very few loose ends of time to be wasted. ne that the Basilian rule aimed at the same end, t a very minute time table form a part of other n code , but, as already remarked, the work ther had enough not abundant enough to provide healthy labour, or to occupy the mind sufficiently t from vague speculation or morbid brooding dur hours of so called toil. From this fundamental ess springs the broad distinction between the two the monastic life, in that the West did not merely shelter for such as felt unable to endure the storm world, leaving secular society to take care of itself it could, but, contrariwise, employed the cloister as a training school for the strong, as the stand whence to work the lever which moved a world. he more remotely secluded monasteries of the West, of serene, as refuges where in the inmates might lly cut themselves off from all intercourse from t, were rather military outposts and frontier fort lization, which taught the arts of peace, the pro of agriculture, and at least the rudiments of social ty, to the rude and almost nomadic hunters and s, of whom many of the wilder tribes in outlying s consisted. And if such was the case even where nditions seemed but favourable, it may readily be stood what an ample field for exertion the more regions provided

would seem that it was some modification of the nian rule which first made it way into Europe, e interest excited by the movement led to variety on the part of the teachers who opened at Spalato hence in Italy. Thus, Eusebius, abbot of Vercelli ly near Ravenna), translated the Basilian rule into and it soon took root in southern Italy, where it nd to hold its ground for a considerable time. more important part in the propagation of the ic institute in the West was taken by Jerome, who spending a considerable time, beginning in 374, a hermit in the desert of Chalcis, and later at ntinople, returned to Rome in 382, where he ecretary to Pope Damasus. He acquired much ce over a distinguished group of Roman ladies of social position, the most celebrated of whom are and her daughters Blesilla and Eustochium, and ved that influence in urging the adoption of the tic life upon them. Blesilla died early, it was said chevied in consequence of austerities pressed upon hich her constitution was unable to bear, and the ularity which the report brought upon Jerome, tating with the death of his patron Damasus and enuses, drove him back to the East, whither Paula Eustochium also betook themselves, finally settling in Bethlehem, where the elder lady built three con- of one of which she was superior, while Jerome, who ly erected a monastery for monks in the immediate y, acted as chaplain and director to the community. As the taste for pilgrimages had already become d rooted, the convent at Bethlehem was ere long a favo resort of pilgrims, and exerted considerable influen prompting the erection of similar foundations in West. Quite another impulse was given to the fu ance of monachism by Augustine. While, amongs many documents which have been ascribed to him, the one which is of the nature of a monastic code is his Epistle, addressed in terms of severe reproval to the of a convent he had himself founded at Hippo, but had fallen away from discipline, his personal ex gave rise to a new type of the common life, in th formed a sort of college of priests, who shared the epi house with him, ate at a common table, and copi other particulars the observances of monasteries, but out losing their secular character. This was the ori the institute afterwards famous as the Austin Ca foundation of the 11th century. It is true that Eu of Vercelli had anticipated Augustine by collectin clergy of his cathedral (and, as it would seem, the re ing ecclesiastics of the city) into a common dwellin the difference in his case was that he obliged them to the habit and style of monks, and thus was in no sen originator of a new institute. Another important bution of Augustine's to the history of the common he treats in *De Opere Monachorum*, wherein he sets for imperative need of making hard work an invariable of the monastic profession, notably on the groun most of the monks in Africa came from the lower of society, such as freedmen, farm-labourers, and ar who were perpetually injured by being raised into a viewed with more general respect than that from they had sprung, while they were actually subject to privations and lighter employment than they had accustomed to. And he adds that amongst othe consequences of this idleness was that they were tramping the country selling sham relics, which palmed off on the unwary, extorting money in ta tions also, and bringing discredit on their pro by their hypocrisy and vices a picture only too fully repeated by the Mendicants a thousand year the date of this treatise. The 5th century was rapid progress in the spread of monachism in the Chief amongst those who helped to popularize it the name of John Cassian (350-433), a monk of Beth who made a long and careful study of the Eg form of monachism, of which he has bequeathed a able details in his *De Institutione Coenobiorum* an *Collationes Patrum*, the former of which is a treatise monastic life, and indeed virtually a rule, though a what prolix one, mainly derived from Macarius, wh latter is a record of the teachings of some hermits desert of Scete. Both of these works exercised a po influence in their own day, and the second retain repute much longer, having been warmly approve recommended for study by Benedict, Bruno, D and Ignatius Loyola, all four founders of celebrated Cassian fixed himself at Marseilles, where he fou famous monastery of which he was probably abbo which was the centre whence monachism, uniti peculiarities of East and West, was propagated in so Gaul, and notably planted in the island of which became the seat of one of the most e monasteries of the early Middle Ages. Northern had received the institute earlier through the of Martin, bishop of Tours (316-397), who f monasteries near Poitiers and in his own diocese, were soon thronged, so that his funeral was atten two thousand monks. Spain was even earlier in t than Gaul, but there is some obscurity as to the

the introduction of monachism there, all that is certain
ng that it had made its footing good before 380, the
e of a council of Saragossa (Cæsaraugusta) which for-
le priests to assume the monkish habit. Still more
ecurity hangs over the first establishment of monachism
Britain, as to which no trustworthy records have come
vn to us, though all probability points to its importation
n Gaul in some variety of the Pachomian rule; while
rmany did not receive the institute till the following
tury.

t must not be supposed, however, that the principle of
nachism met with no opposition in the course of it
gress. Apart from the opposition of those who disliked
precisely for its merits, for its protest against the
solute morals and enervated habits of a luxurious and
ting society, and for the manner in which it won to
lf many of the noblest and most promising of the
ng and ardent of both sexes, and without taking into
ount the more reasonable objections of statesmen, there
re not lacking warnings of the dangers attending
ggerations of the principle of monachism, uttered by
ne of its most eminent upholders. Augustine's sharp
sures have been already mentioned, and to them may
added the decrees of the council of Gangra in 363,
thereabouts, which anathematize those who adopt a
bate life on the ground that marriage is evil who wear
peculiar dress as a mark of holiness, condemnation such
use ordinary clothing, or who desert their parents or
ldren dependent on them under the plea of devoting to
l an ascetic life. So, too, the great Chrysostom himself a warm advocate of monachism, found himself obliged
teach his flock the sanctity of Christian family life, and
truth that there was often as much selfishness as piety
retirement to a hermitage from the cares and duties of
iety. These arguments and decisions were, however,
ed only at abuses and exaggerations of the monastic
a. It remained for Jovinian and Vigilantius to attack the
ual principle. Their writings have not survived, and
can judge of their arguments only from the account
en of them by their chief opponent Jerome, whose
inent gifts, however, did not include either moderation
controversial fairness, so that it is not safe to assume
t we have all their case before us. As regards
gilantius, he accurately represents the Puritan type of
d protesting against the external part of the popular
gion of his day, often with good reason, but also showing
equal intolerance for harmless, it not useful, practices;
that his condemnation of monachism is only part of his
neral objection to the temper of his time. But Jovinian's
ections seem to have gone deeper. He had been himself a monk (and indeed never resumed secular life), but
disputed absolutely the thesis that any merit lay in
nachism, celibacy, fasting, and asceticism considered in
mselves, save in so far as they contributed to foster the
ristian temper and life, which might and did flourish
ually, he urged, under quite different conditions, while
was by no means unfrequent for spiritual pride, if not
nichæan error, to lay hold of those who devoted themves to the ascetic profession. This was, in fact, going
y little further than Chrysostom had done, or than
us did a short time later. But Jovinian's divergence
m the standard of his day was not confined to practical
estions; it extended to theological doctrines also, and
ordingly his strictures on monachism, probably more
isive and less qualified than those of its other critics,
re involved in his condemnation as a heretic by synods
Rome and Milan in 390. The reaction, of which he
y be regarded as the mouthpiece rather than as the
e representative, was thus effectually crushed, and that
enturies. And though Jovinian is undoubtedly more in accord than his opponents with the modern temper on the subject of monachism, and while it may be true that his teaching might have been a useful corrective in Eastern Christendom, where family life was all but overborne by asceticism, yet the impartial historian must admit that his success would have been an irreparable misfortune for civilization in the West. Such a passionate estimate of asceticism as his, if widely entertained, would have been fatal to the spread of monachism, and thus one of the most important conservative and formative forces in the preservation of the older culture, one of the most powerful dynamical forces in reducing the barbarous materials of early mediæval society to order and coherence, would have been lost to Europe. How it may be asked, what effectual substitute could have taken its place? Even if it was, the movement was not checked for a moment by this partial reaction; and not only did the old monastic communities thrive and spread during the 5th and 6th centuries, but new ones were established, chief among which stand those of Cæsarius of Arles and of Aurelian of Arles in southern Gaul that of Lerins on the islands of the Provençal coast, that of Ledrone in Spain, and the early Celtic ones, of which only traditional fragments survive, but which seem to have been strongly affected by tribal influences. Monastery was often recruited from a single family; the abbacy became hereditary in the family of the founder, a fact which is noticeable even in the case of the abbots of Iona, who for ten generations after Columba were of his family in the tribe of Cinaill Conluain.[1]

But, swiftly as monachism spread in Europe during the breaking up of the Western empire, some of the causes which hastened its progress also tended to its rapid decay. The disturbed state of society, and, in particular, the prevalence of petty warfare, drove many pious persons to seek a quiet retreat in the cloister without more directly religious motives. When once there they found in every place some rule in force which was imported directly from Egypt or Syria, or else, like that of Cæsarius, modelled on Eastern lines, and thus ill suited to the severer climate of Europe and the active habits of the people. The austerities were oppressive for general observance, and led to a widespread neglect of rules which continued in force, while at the same time the very means which seemed to keep them had given rise to a special sanctity in the pretence of their strict way of life. The cry was for a reform, or rather for a wholly new departure in the shape of a rule devised to meet Western needs, not merely adapted more or less clumsily from Oriental ascetism. The task appeared in the person of Benedict of Nursia to be one of the most famous of all monastic codes. Born of respectable family about 480, he adopted the ascetic life at fourteen in a cave near Subiaco, not far from Rome, where he remained for three years, at the end of which he was chosen abbot of a neighbouring convent, then in a very relaxed state. His rule was too strict for his new subjects, who attempted to poison him, whereupon he resigned his office and returned to Subiaco, around which he soon erected twelve monasteries, each peopled by an abbot and twelve monks. Fresh attempts on his life and on the discipline of society drove him out again in the year 529, when he withdrew to his favourite retreat at Monte Cassino, the place where his celebrated rule was drafted in the following year, and which has ever since prided itself on its rank as the cradle of the Benedictine Order and the premier abbey of Christendom. The famous institute which has

[1] Adamnan, *Vit. Columb.*, cd. Reeves.

as a [illegible] to the rule of Basil, which
done has enabled it to permanence, though far below it
a difference, it may be added, in services to humanity.
apacious in its fidelity and in the power of adapting itself
a new [illegible] of circumstance and society to any rule
there [illegible] it (and indeed to most of those devised
ters, far [illegible] it produced in its own immediate day and
[illegible] because afterward [illegible] almost incalculable.
[illegible] troubles, worldly and would, such
and improvement with which the code of seventy-three
[illegible] from
[illegible] to
[illegible] monks to hortatory pre-
[illegible] of school [illegible] strive
[illegible] leave by two [illegible] not the
[illegible] and [illegible] of
[illegible] them [illegible]
[illegible] [illegible] [illegible]
[illegible] [illegible] [illegible]
[illegible] [illegible]

uling that in temperate places a cowl and tunic, thick in
nd thin in summer, with a scapular or sleeveless woollen
passed over the head, and falling down over the breast and
work hours, as also shoes and stockings, all of the ordinary
make and cheapest kind, shall suffice. Each monk is to
hange of these garments to allow of washing, and yet
for use when sent on a journey, to be of rather better
, and to be kept in the general wardrobe when not in actual
The old clothes are to be given up when new ones are served
are to be laid by in the wardrobe for the poor. A straw
blanket, quilt, and pillow are to be furnished for each
l in addition the abbot is to give every monk a knife, a
edle, a handkerchief, and tablets. Chapter lvi. rules that
t is to take his meals with the guests and strangers, with
lege, if guests be few, of inviting any of the brethren he
so long as some seniors are left in charge. Chapter lvii.
s that craftsmen amongst the brethren are to work with the
ermission, and if their work is to be for sale, those who are
l with making the bargains are to deal honestly with poor
and to sell rather below the current trade price. Chapter
s down the rules for the admission of new members. It is
made too easy. The postulant is to be allowed to knock
nce in vain for four or five days, then to be brought into
t-room for a few days more, and so be transferred to the
ouse, where he is to remain under the charge of a senior
two months. If he persevere at the end of this time the
be read over to him, and the option of departure or remain
be offered. If he persevere, he is returned to the novices'
six months' further probation, after which the rule is again
m as before, and yet a third time after a further term of
ths. Not till he has surmounted this final ordeal can he be
ted into the community, and before that it does he must
nself of his property, either giving it to the poor, or making
l of gift to the monastery. Then he is allowed to recite the
profession, including the vow of stability, which he is to lay
own hand on the altar. Chapter lix. provides for the
n of young children, noble or poor, by their parents to the
life, and requires a promise from the latter never to endow
te with any property, directly or in trust, though they may
to the monastery if they please and reserve the income
selves. Chapter lx. regulates the position of priests who
live in the monastery. They are to enjoy no relaxation
y in virtue of their ecclesiastical rank, though the abbot
gn clerical functions to them, and a somewhat like rule is
for clerks in minor orders. Chapter lxi. provides for the
of strange monks as guests, and for their admission to the
n the community. The abbot is enjoined to listen to any
s such a guest may offer, and is empowered to give him, if
as a new member, higher standing than that of his entrance,
bidden so to admit a monk of any known monastery without
onsent or letters commendatory of its abbot. Chapter lxii.
t the abbot may choose a monk for ordination as priest or
but the ordinee is to rank in the house from the date of his
n, except when officiating, or if the community and the
gle him out for promotion by merit. If he misbehave, he
eported to the bishop, and if continuing to misconduct
shall be expelled,—only, however, in case of obstinate dis-
to the rule. Chapter lxiii. lays down rules for the gradation
n the community, and warns the abbot against arbitrary
ent. Chapter lxiv. allows the abbot to be chosen either by
non consent of the whole community, or by a select electoral
e; and the lowest in standing may be chosen as his
t of a bad choice, the bishop of the diocese, the neighbour
ts, or even the neighbouring laity, may intervene to thwart
ion made for the purpose of keeping up abuses. Any annual
point another superior. Chapter lxv. speaks of the ori
asioned in many monasteries by the rivalry of the provost
with the abbot, and advises that no such officer be appointed;
e circumstances of the place need one, the abbot may name
to the post, but he is to be as entirely subject to the abbot
her monk, and may be admonished, deposed, or expelled
nduct. Chapter lxvi. directs the appointment of a porter
r at the gate, and further recommends that every house
ve its own well, mill, garden, bakery, and handicrafts, so
the need of intercourse with the outer world. Chapter lxvii.
hat no monk shall quit the cloister without leave of the
d that, on the return of any from a journey, they are to keep
ers of the community for any faults they have committed
heir absence, and are forbidden to speak of what they have
seen outside. Chapter lxviii. bids a monk who has received
r impossible command to undertake it patiently and obedi
If he find it beyond his powers, he may mention the cause
o his superior; and, if the command is still persisted in, he
y as best he can. Chapter lxix. forbids monks to uphold
l one another in the monastery, even their nearest of kin.
lxx. forbids striking or excommunicating another, without
t's authority, and provides that children, until fifteen, shall
be subject to discipline from all the monks; but any who shall
chastise those above fifteen without the abbot's leave, or be unduly
severe towards the younger, shall be himself punishable by rule.
Chapter lxxi. lays down that the principle of obedience is to prevail
throughout the community, not only towards the abbot or his
officers, but from the juniors towards their seniors. Chapter lxxii.
is a brief exhortation to zeal, and chapter lxxiii. a note to the effect
that the Benedictine rule is not offered as an ideal of perfection, or
even as equal to the teaching of Christ and Paul, but for mere be-
ginners in the spiritual life, who may thence proceed further.

It has been necessary to make this detailed analysis of
the rule, because no mere summary of its general scope
conveys an adequate notion of it, and it plays so import-
ant a part in the history of European civilization that it
is expedient to obtain a clear idea of its detail as well as
of its main outline. The first peculiarity to it meriting
attention is the absence of any severe austerities. Plain
and bare as the food and lodging appear at first to us by
modern notions, yet it is to be remembered that what is
called "comfort" is a wholly recent idea, and even still
scarcely familiar, it may almost be said, out of Great
Britain and its colonies. The scale of living appointed by
the rule secures a greater abundance of the necessaries of
life, not only than was at all common among the Italian
poor of the 6th century, but than is to be found amongst
the humbler peasantry of any European country at the
present day, while even the excluded superfluities entered
but little into the habits of any save the very wealthy.
Next, high thinking, the highest thought of the time,
was united with the plain living as the considerable treas-
land upon reading attests. To this part of the code is due
the great service performed by the Benedictines, both in
the erection of schools, and in the preservation of almost
all the remains of ancient Latin literature which have
come down to us. It made it not only possible but easy
for them to become a learned order, and it is a very
imperfect estimate of the stride forward in this provision
which Milman makes, when he views the injunctions as to
reading as the mere light of expedient to fill up time
somehow. If it were so, the hours for reading would
have been fewer, shorter, and more occasional, merely
rounding off the interval between times of labour, but they
are just as prominent and nearly as long as these. It is
true that Benedict, whose own education had been abruptly
broken off by his early retreat from Rome, did not specu-
latively enjoin the pursuit of learning on his monks; but
they borrowed the idea at once from his contemporary,
the celebrated Cassiodorus, the real founder of monastic
learning, of which his monastery of Vivarium in Bruttium
is the first known school. But the most valuable feature
of the rule is the point or capacity which it assumes to
work. It is scarcely possible to realize at the present day
the dishonour into which toil of all kinds had sunk in the
days of Benedict. Not only had the institution of slavery
degraded many kinds of occupations, but the gradual
disappearance from wide tracts of the yeoman class, ruined and
exiled by the concentration of vast estates (*latifundia*),
or slain in the terrible battles of competitors for empire
or of barbarian invaders, left few save serfs and bondsmen
to till the soil, which the military habits of the invading
tribes led them to contemn any life except that of a
warrior. It is the special glory of Benedict that he
taught the men of his day that work, sanctified by prayer,
is the best thing which man can do, and the lesson has
never been wholly lost sight of since.

The new institute spread with even more astonishing
rapidity than the earlier monachism which it practically
supplanted in the West, and its history, therefore, is,
with one important exception, that of Western conventual
life for some centuries. Moreover, besides marking the
close of the first or tentative era of monachism, when all
kinds of crude essays and experiments were being made,

ng itself the beginning of a new and settled order, he distinction of giving greater dignity and weight female side of monachism than had been the rule y. Numerous and crowded as convents for were in the early church, there is little evidence exercising any powerful influence as a factor in ctual religious life of the time, and though a few of women of eminence, a Euphrosyne or a Macrina, the annals of the common life in the East, yet the Basilian nuns do not play at all so important ecclesiastical history as the spiritual descendants astice, sister of Benedict, for the same flexibility operative control of his rule which made it er for men than its precursors were still more when dealing with the more elastic organization men. Accordingly, the Benedictine nuns offer a ter variety of type than their Eastern sisters, and a much more visible influence upon society, even here newer forms of the organization of women the church were devised which have given it dditional importance. Further, where the most and well-founded objection allowed against monas- that by putting together companies of men and ivers bly from each other, and treating this ercise reli-pea ble condition of the highest kind nt has tended to throw discredit on marriage and ily, and so to weaken society, which is based on ntic alone, a fresh counterpoise can be put in for nedictines. Not merely are they free, as already d, from the anti-social tendencies of Oriental nism, which actually did disintegrate society in best-known institute was the one corrective in the Middle Age of those habits and ideas which tended ade the position of women. The cloister was not the ready asylum indeed for women who had no rm to choose, but it provided the only alternative on to marriage, and that one recognized by public as of even higher distinction and opening to position of influential rank and authority, less ous than the possession of temporal estates, which only serve to attract cupidity, and so invite attack. e of a great Benedictine house was more than l of the wife of any save a very great noble, and, e women were thus not obliged to look to wedlock only path to safety and consequence, they were to mate on more equal terms, and were less likely ewed as the mere toys or servants of the stronger

the special eminence of the Benedictines, in which e without even the semblance of rivalry till the nose, is that they were a missionary, civilizing, and onal body. It is true that the first successful effort st the barbarian conquerors of the empire, somewhat their entrance on that field of labour, and Ulfila the Maso-Goths, Valentinian in Bavaria, and Severi Noricum had achieved much even before Benedict but their work needed to be taken up on a larger in a permanent organization not liable to be ted by the death of any one missionary or group of es. And the task of laying the very foundations ized society, apart from the question of religious ion, was also one never ayed. It was as teacher t for three long ages, even the agriculture, as s of fens and moors, as clearers of forests, as of roads, as tillers of the reclaimed soil, as archi durable and even stately buildings, as exhibiting e type of orderly government, as establishing the rity of peace over war as the normal condition of students in the library which the rule set up in monastery, as the masters in schools open not merely to their own postulants but to the children secular families also, that they won their high place history as benefactors of mankind. No doubt there another side to this picture, even before the order be to deteriorate collectively; but the good actually effec far exceeded the evils which may have accompan it. The Benedictine institute was carried to Sicily Placidus in 531; to France by Maurus, Simplic and then companions in 543, to Spain at a somew later and uncertain date; but did not touch any of Teutonic countries till the very end of the century. T work was chiefly accomplished by another agency, that the Celtic monks, themselves disciples of a Christian presumably carried to Ireland from Gaul, and follow a rule seemingly adapted from that of Pachomius. early history and constitution of Irish and Scott monachism are too obscure to be set down with any c fidence, but it is at least clear that it was mainly tri organization, and even less subject to episcopal autho than the Eastern and Italian forms. The same holds g of the Welsh communities which survived the Sa invasions of Britain. Legend is abundant, trustwor record is scanty, and only a few facts can be rescued fr oblivion. Among them may be included the introd tion into Scotland of a species of monachism resembl that of Augustine, by Ninian, first missionary of southern Picts, who borrowed his institute from Ma of Tours, and set up a cathedral, a house of canons, a school of learning at Whithorn (*Candida Casa*) Galloway before the close of the 4th century, him dying, it is thought, about 432 (Ælred, *Vit. Nin.*). foundation of the second model of Welsh monach (the first has gone below the horizon of history) ascribed to the bishops Germanus of Auxerre and Lu of Troyes, who visited Britain in 429 to combat prevalent Pelagianism, itself a form of opinion due t British monk. They are alleged to have been, directly through their disciples, founders of great monasteries school at Henthland on the Wye, at Llantwit, Llancarv Docwinni, Bangor, Whitland, &c.; while among the m famous names connected with these and similar ho may be mentioned Asaph, David, Illtut, Dubric, Ca Gildas the Wise, and Kentigern, the last-named beir zealous missionary. But Ireland was the true stronghold of Celtic monachism, and before the close of the century was already thickly planted with religious hou Armagh, Clonard, Aran, Lismore, Cluain-edneeh, Clon and, above all, Benchor or Bangor, the famous abbey Comgall, on the coast of Down, near the entrance Belfast Lough, are some of the more conspicuous foun tions, and there are numberless stories recorded of learning, the austerities, and the miracles of their inma The chief interest they have for the student of ecclesiast history lies rather, however, in the colonies they sent f them in their home operations, and it is to the g foundation of Columba (521-597) at Iona, the hiv missions and home of Western learning, more t to any Irish monastery, except Bangor, that the C ried on heathenism is mainly due. The rule of Colum resembles the Benedictine in prescribing three kind employment prayer, work, and reading; while under last-named head not only Scripture but all attain secular learning was included, and it is also certain that work of copying MSS. in a careful and beautiful fash which became so important a part of monastic occupat reached maturity first at Iona. It remains only to sa this connexion that the discipline of Iona, appare borrowed from Irish use, made the abbot supreme,

[1] Published by Dean Reeves in Colton's *Visitation of Derry*, p. and in another form by Haddan and Stubbs, *Councils*, &c., ii. p.

over his monks, as in other rules, but over bishops whose office was simply that of ordaining such as to be promoted to holy orders;[1] they had no rial jurisdiction as rulers, because the monastery, diocese, was the primary local unit in Celtic Chris , and thus a great founder or abbot was of more t and power than a bishop. Another famous pupil monachism, Columbanus, trained at Benchor along is companion Gallus, exercised a powerful influen religious life of his time (543-615), not only founder of important monasteries at Luxeuil, ay, and Bobbio, and as scholar and missionary, but the author of a rule, more severe both in its pro and in its penalties than the Benedictine, with it disputed for a considerable time the field place, hich it might very probably have displaced, had not nedictine institute, as of Italian origin found that at Rome which a Celtic code, became more than ce of divergence from Latin usages, could scarcely

With the mention of another prominent name in t of distinguished Celtic reformers and mi ons hat of Fursey, abbot of Lagny near Paris (c. 650), se this sketch of the Celtic movement in the 6th h centuries, merely adding that its extent and ce may be partly estimated from the number of teries founded in England and various parts of the ent by Irish monks, and the list of Celtic saints rable from the different martyrologies and simila s. The former amount to more than one hundred, ter to nearly three hundred

rning to the Benedictines, the most important event r history after the consolidation of their institute e favour they received from Gregory the Great, f once a monk, who set himself to reform monaste ine, then at a very low ebb save where the new tion was at work. He enacted several regulations e better government of monasteries, such a pro g the admission of any persons under eighteen, g two years' novitiate, enforcing inclosure, treating nishment of monachism with imprisonment for life, nally, in the Lateran synod of 601, exempting teries in all cases from the jurisdiction of bishops (a re due, it appears, to episcopal misconduct and sion rather than to monastic ambition), thereby ing the measure of control which the eighth canon alcedon and the legislation of Justinian I. in 535 ft in the hands of the diocesan, and leaving only ill surviving check, that the bishop's consent was d for the erection of any new monastery. The n of the monk Augustine to England in 596 was, er, destined to produce more immediate and for results than this piece of legislation. It brought monachism into a part of Britain where Welsh hism had been long extirpated, and though little s attended the original foundation at Canterbury, o other houses were destined to be the cradles of hings. Jarrow-on-Tyne, founded by Benedict Biscop, l the illustrious Bede, to whom is due the monastic of York, which in its turn sent out Alcuin to recon European learning under the fostering hand of emagne; Nutcell in Hampshire reared Boniface to be postle of Germany, and founder of one of the most ated and powerful monasteries of the Middle Ages, f Fulda. Nevertheless, decline set in very soon,

and the 8th century was a time of deterioration amongst both the seculars and the regulars. To amend the former Chrodegang, bishop of Metz, instituted in 760 an order of Canons Regular, living by a rule carefully based on and adapted from the Benedictine, with the bishop as abbot, the archdeacon as prior, and with a general likeness in all the details of community life, except that there was no obligation to poverty, and the canons were allowed to enjoy any private property and such fees as they might receive for the performance of their ecclesiastical functions. This rule became extremely popular was sanctioned by the council of Aix-la-Chapelle in 816, and was adopted in most cathedrals of France, Germany, and Italy within fifty years after, besides making some way in England also. It prevailed till the institute of the Austin Canons was substituted for it. And as regards the laity among the regulars at this time, there is extant a very interesting letter from Boniface addressed to Ecgbert, archbishop of York, calling his attention to the excessive number of monasteries in northern England which were conducted without a rule, and were often merely fictitious institutions founded by laymen with the object of obtaining charters of privilege which would exempt them from civil and military burdens, such laymen then assuming without warrant the title and powers of abbots, and filling their houses either with monks expelled from their own convents or with lay retainers induced to receive the tonsure and promise obedience. Boniface call on the archbishop to convene a synod and institute a visitation for the correction of these abuses. The cause of the decline of the monasteries is to be sought in their popularity, which led to their great estates and other kind of wealth, leading to the relaxation of the vow of poverty, which was interpreted as merely forbidding individual property, in the growth of pluralities, and in yet another cause which at first does not seem to lead in the same direction, the growing custom of ordaining monks to the priesthood, thereby attaching laymen, to fit them better for missionary work. But this led, not only to much more intercourse with the society of a lax and turbulent age than suited with canonical rules, but to ambition, as it became customary to fill several sees with monks of a certain abbey. The declension, notably in the habit of the superiors of wealthy houses, had become very marked, when a reformer arose in the person of St Benedict, of Aniane in the modern department of the Herault (750-821), who, in gratitude for an escape from drowning in the Trebia in 774, adopted the monastic life, and changed his name Witiza to that of the great Nursian monk. But he accounted the Benedictine rule too easy, and adopted instead the severest practices of Eastern monachism. He quitted the house of Seine where he had been professed, and betook himself with a couple of companions to Aniane, where by 782 he had built a monastery for a thousand monks, with dependent cells, and collected a considerable library, paying special attention to the acquisition of the rules of the different monastic bodies both of East and West. He was translated by his warm patron, the emperor Louis the Pious, to another house for him near Aix-la-Chapelle, where he acted as in one sense a superior-general and inspector of all the Benedictine houses, and drew up a harmony of all the rules he had collected to aid him in the task of reform. What he actually effected was the practical abolition of most of the competing codes, so as to leave the Benedictine in nearly sole possession, and to procure the enactment of a large body of canons in the council of Aix-la-Chapelle before mentioned, which laid down detailed provisions for the government of monasteries whose very minuteness made them vexatious and ultimately intolerable, so that the reform lasted scarcely two

[1] Bede tells us: "Habere autem solet ipsa insula rectorem abbatem presbyterum, cujus juri et omnis provincia et ipsi episcopi, ordine inusitato, debeant esse subjecti, juxta exemplum doctoris illius, qui non episcopus sed presbyter extitit et monachus" (*Hist. Eccl.*, iii. 4); though, after all, the principle is precisely the Benedictine rule as applied to priests.

ion from its inception. Parallel with the time of de- and partial reform just described was the rise and f the noble and far-sighted school-system projected al machine and entrusted to the superintendence an. Its relation to monachism as distinguished history of education, is that one of its main was the capitulary of 789, which directed that, the primary school attached to each monastery, more important houses were to found and open y ones also, with a higher range of subject, even schools were interior or claustral, and only for or monks and novices, not exterior and free to the public. Several of these schools rose to consider eminency and repute, notably those of Fulda, St Gall, and Rheims, discharging to some extent the s of universities. But the weakness of the later s involved this plan in the troubles which ended reak up of the empire of the Franks, and the 10th saw the end of it. In England monachism shared mon destiny of decay. It had been marked during od known as the Heptarchy by a degree of royal unparalleled elsewhere (for it may almost be said number of kings, queens, and persons of royal s here to betook themselves voluntarily to the cloister not under political compulsion, as often in contry France exceeds the aggregate of those in all untries. Yet it is likely that the fashion set in helped to hasten decay, by inducing many persons the monastic life with little vocation for it to the nd it is certain that secularity (chiefly manifested ccessful dress, protonsure, and drinking habits) became among the English monks of the 8th and the art of the 9th century. The decay was further ated by the spread of the institute of Chrodegang, ished the supply of recruits to monachism proper, a new life of canons regular was preferred. The nce affected the convents of nuns, for an order of ce was established about this time on similar lines. bright spot in the history of 9th century monas- the conversion of Sweden by Ansgar, a monk m the famous house of Old Corbie in Picardy, Albeit Benedictine had been mainly planted by a rom the stricter Columbanian house of Luxeuil, thus kept the tradition of a purer time almost ed.

10th century emphatically the "Dark Ages" or Lead was the time when monachism, both in d West, touched its lowest point. Three causes ted to this in the West: first may be placed the the Northmen; next, the growth of the feudal conventual abbot into secular lord in virtue of held by their monasteries being chargeable with bligations; and lastly, the seizure and impropria- monastic revenues by kings, princes, and bishops. of these causes was at work in the East also, complicated, as we learn from the decrees of a held at Constantinople in 861, by the founda- monasteries intended from the first merely as of pecuniary advantage to the founders, although ces of Greek monks in the conversion of Bul Moravia, and somewhat later, southern Russia, that the cloister had not become quite effete der the conditions of the Byzantine empire in .

the state of things was in the West, even at the of the 10th century, may be learned from the of the council of Trosly, near Soissons, in It speaks of the ruin of many abbeys by the , and of the disorderly condition of many which d. Monks abandon their profession; married lay abbots, with guards and hunting retinue, occupy the dormitories of monks, canons, and nuns; and the rules are universally disregarded. But, as constantly before, so then, reformers were at hand. Berno first abbot of Cluny in France, Dunstan in England, and, somewhat later, Anno archbishop of Cologne in Germany, undertook and to a considerable extent effected, the work of reform. Only the first of these, however, calls for special notice here, and it will suffice to say that Berno, after having been abbot of Beaume, was set by William the Pious duke of Aquitaine, over his new foundation of Cluny in 910, where he speedily initiated a reform of the Benedictine rule, whose very name, and even the memory of the reforms of Benedict of Aniane, had been forgotten in nearly all the so-called religious houses of the time. This new rule is the first example of the establishment of an order within an already existing order, of which it still formed part, many subsequent instances of which occur later. It was stricter than the original code in several particulars, notably as regards fasting and silence; and it laid especial stress on liturgical splendour. Cluny became the head of a large number of dependent houses, and under the government of Berno's successors, Odo, Aymard, Maiolus (who refused the papacy), Odilo, and Hugh I. rose to great eminence, but was nearly brought to ruin by Pontius, abbot in 1109, who was soon deposed, and succeeded by Hugh II., and then by Peter the Venerable who completed the work of drafting the statutes of the new order, begun long before, but not finished, by his predecessors. In his time (1093-1156) the Cluniacs spread over not only the whole of France, but had houses in Italy, Spain, England, Palestine, and in Constantinople itself, and the "Arch-Abbot," as he was called, had more than 300 churches, colleges, and monasteries under his authority. It is enough to say, with regard to Dunstan's reforms in England, that they were directed to two objects, the substitution of monks for secular canons, and the introduction of the Benedictine rule, till then practically unknown in England, into the monasteries, — for the monachism introduced by Augustine belonged to an earlier type.

The 11th century is noticeable for several events in the history of monachism; first of which stands the foundation of the Order of Camaldoli by Romuald, early in the 11th century, a strict community of hermits, living by the system of an Eastern laura of detached cells; but this society has never been of much importance. The Order of Vallombrosa, founded by John Gualbert in 1039, is more remarkable, as being the first to introduce the grade of "lay brothers," which plays so large a part in later monastic annals, the object being at once to open the cloister to a class previously barred by the obligation to recite the office in choir, which necessitated a certain degree of education, and to lighten the strain on the choir-brethren by relegating the rough work of the monastery to an inferior grade of inmates, thus securing more time for reading and meditation for the cultured monks. A series of struggles between bishops and abbots in this century in respect of monastic jurisdiction — the practice having constantly vacillated in despite of Gregory the Great's decision 400 years earlier — issued mainly, though not wholly, in favour of exemption, and the reforms pushed everywhere rehabilitated monachism in popularity. The great stimulus given to the spirit of ecclesiastical discipline and energy by the Hildebrandine movement continued not only during the reign of Gregory VII., but for a considerable time after: amongst its results were the Order of Grammont, founded in 1074, but not transferred to the place whence it is named till 1124; the far more celebrated and influential Carthusians, a peculiarly ascetic

community, established by Bruno at the Chartreuse, near Grenoble, in 1084, which still boasts that it is the only order which has never been reformed on the ground of deviation from its original institute; and the Order of Fontevraud, founded for both monks and nuns (more strictly, canons and canonesses) by Robert of Arbrissel in 1100. Regarding the last named two remarkable facts may be cited: that the founder in 1115 entrusted the superior-generalship of the whole institute to the abbess of the nuns; and that he provided that new abbesses should always be elected from secular women, as having more practical knowledge of affairs and capacity for administration than women trained in a cloister. There is yet one order more belonging to the period of new foundations, of higher note than most - that of the Cistercians, founded by Robert of Molesme in 1098 at Citeaux, near Dijon. This society, chiefly famous as that to which Bernard of Clairvaux belonged, carried its asceticism into a region whence the other monastic bodies had banished it, that of Divine service. The barest simplicity in buildings, church furniture, and worship was enjoined by the rule: plain linen or fustian vestments, iron chandeliers, brass or iron censers, no plate save a chalice and a tube (and those of silver rather than of gold), no pictures, stained glass, or images, and only a few crosses of painted wood, and the most rigid simplicity in chanting, — such was the ceremonial code with which they challenged the costly ritual of Cluny. A more durable innovation was the institution of "General Chapters," to which every abbot of a Cistercian house had a right to be summoned to share in the deliberations held at the chief establishment, and which he was even bound to attend, that, while each dependent house thus obtained a representation in the parliament of the order, it could be called on to render to the central authority an account of its own doings. The Austin Canons, already mentioned, were probably founded at Avignon about 1061, and the Order of Premontré by Norbert in 1120. This society was simply a stricter body of Austin Canons, standing towards them much as Cluny did to the Benedictine. But there are yet two other institutes of this active period which differ from all previous foundations. So far, the new orders are merely modifications, more or less worthy of the original Egyptian system, but the crusades gave birth to two entirely unprecedented forms of monachism — the Military Orders, of which the most celebrated are the Templars, the Hospitallers, and the Teutonic Knights, and convents of women, affiliated to these orders, who were appointed to serve in the lazar houses, hospitals, and similar institutions attached to them, and whose rule, for the first time in monastic history, was drawn up on a distinctly active and not a contemplative basis. Work of the sort had been done long before, but only as a casual accident, not as the primary object of a community.

The military orders arose in a more accidental fashion than any other variety of monachism, being due to the desire felt to lessen the perils which attended pilgrimages to Jerusalem, their almost as much part of the religious craving of Christendom as the hajj to Mecca is with devout Moslems. The Templars were at first designed only as an armed escort to protect the visitors from attack, and the idea of permanent guardianship of the Holy Places did not shape itself till later; while the Hospitallers (afterwards famous as Knights of Rhodes and of Malta, as the main bulwark of Christendom against the Turks, and as maintaining the police of the Mediterranean against all pirates and rovers), borrowed the first idea of their institute from the knightly order of St Anthony of Vienne, founded in Dauphiné about 1095, and devoted themselves originally to tending sick pilgrims at Jerusalem. The Teutonic Knights date from the third crusade, and owe their foundation to the sufferings of the duke of Swabia's army at the siege of Acre, as it would seem that the Hospitallers were unable or unwilling to supply the needed assistance. The knights, when at last the Eastern crusades were abandoned, turned their arms against the heathen of Prussia, which they conquered, as also Livonia, Courland, and Pomerania, besides keeping the Slavonic enemies of Germany in check by frequent raids into Lithuania and Poland, holding their ground as a sovereign order for three centuries, till the Reformation brought about their fall. The common characteristic of all these orders was the union of the seemingly incompatible qualities of the monk and the soldier in the same persons, of the convent and the barrack in the same house. But the contrast was not so sharp to men of that age as it would be to modern ones, for while knighthood was surrounded with religious ceremonies and sanctions on the one hand, and on the other the feudal rank of barons and abbots made them in some sense military chiefs, occasionally even taking the field in person, there was no difficulty in accepting the permanent combination of what was often formerly unduly united. The military orders passed away when their work was ended: the Templars, victims of a great crime, closed by a ghastly tragedy; the Hospitallers, and those Spanish and Portuguese orders that were enrolled as regiments against the Arab invaders of the Peninsula, though titularly still existing, yet really ceased to be more than a name when the Moslem power in Spain was finally broken. But the active organization of war is a more fruitful germ, and has never since ceased to put forth new developments, varying with the notions of each period. To this epoch belongs also the beginning of that policy of the Roman see of utilizing the monastic orders, won over by special privileges and exemptions, as a body of supporters almost a militia more to be relied on than the secular clergy, and thereby the seed of discord between secular and regular, destined to work much mischief later was sown, and also the beginning made of that centralization of monachism which tended from the first to its unpopularity and decay.

It was found that a new order was the best safeguard for enthusiasm which might become dangerous if encouraged, but which could be made a valuable auxiliary if allowed to take shape in a form acceptable to society, hoping to attract precisely such and it is worth remarking that it was even so when the wise policy was departed from that Peter Waldo vainly sought in 1179 recognition and sanction from Pope Alexander III for his proposed institution of lay preachers, gave rise to a sect of the Waldenses, which still existing and which has been a great trouble to the Roman Church quite disproportionate to its numbers and importance. The Carmelites, founded by Berthold of Calabria on Mount Carmel about 1150, and incorporated under the rule by Albert, Latin patriarch of Jerusalem in 1209, were the first order of importance which sprang up at this time. The Celestines, another order founded at Sulmona in Lombardy in 1215, are most chiefly for their [illegible] for men and women, the Begynne, [illegible] houses specially suitable for their [illegible] of education whence many later active [illegible] and of the Humiliati, [illegible] 1196, [illegible] for the reconciliation of captives among the [illegible] and Saracens, founded by John de Matha and [illegible] Valois in 1198, never rose to great importance [illegible] the Servites, an order of the [illegible] 1233, powerful in Italy. The period of rapid multiplication was quickly followed by one of equally rapid decay, the first to show clear tokens of decadence being the rigid Cistercians, who never recovered their old meaning, and who, it may be mentioned, were accounted much of that hatred of the Church of the Fathers in

by the natives, which, given fresh fuel by the Reformation, has lasted to the present day.[1]

Yet another fresh departure in the history of monachism, in some respects the most momentous of all, was taken in the 13th century by the institution of the Mendicant Orders, or Friars. Pope Innocent III., in the 13th of the 70 constitutions or canons he promulgated at the Lateran council in 1215, had expressly forbidden the foundation of any new orders, bidding all who desired to embrace the more strict life join some approved community, and similarly directing that such as desired to found new houses should take their rule and constitution from one of the sanctioned types. But circumstances were too strong for him, and this very pope was destined to sanction two of the most remarkable orders which the Latin Church has ever produced. The time was an anxious one. The speculative activity of the age, coupled with the unrest in the church, was multiplying sects, to which its remedies, and still more from the contrast they afforded to its presented, not only to that of the secular society of the day, but to that of the ecclesiastics, notably those of rank, whose pomp and luxury gave rise to the brilliant stimulus of a revolutionary spirit among the common, which the great pope, who was then the most conspicuous figure in Europe, did not fail to observe. No effectual weapon of resistance seemed at hand, the parochial clergy, yielding to the difficulties which an isolated ritual life threw in the way of intellectual effort (far greater then than even now), had almost everywhere sunk into both and incapacity; the monastic orders were content, in the better instances, with maintaining their own internal discipline, and had no surplus energy for external work, while in the worse examples (as in that of the Cistercians, just referred to) they served rather as beacons of warning than as patterns for imitation; and, in short, there was an ever increasing mass of home mission work to be done, and no one to do it.

But the two men who were to do it were already at hand in the persons of Francis Bernardone of Assisi and Dominic Guzman of Osma. The ruling idea in the mind of the former was the elevation of poverty to the first place among Christian graces, as the most obvious way of conforming the life of a Christian to that of the founder of his faith; the more intellectual Spaniard dreamed of an aggressive body of highly trained preachers, able to grapple with the subtle attacks of the heretics, to expose the unsound creed, and to appeal in clear and powerful language to the unconverted, amongst whom the Albigenses and other sectaries were making considerable progress. Francis, the poet and devotee, in consequence of a [illegible] prevision which the [illegible] orders [illegible] for their [illegible], and bidding his followers to [illegible] as fully forgotten [illegible]

[illegible] by a lady of Provence to [illegible] abbey [illegible] to be the founder [illegible] house [illegible] which were [illegible] Before the [illegible] the [illegible] even the [illegible] provide [illegible] another with the [illegible] little [illegible] the cook, who [illegible] that the [illegible] the monks to [illegible] for them to be as [illegible] might, that some of their [illegible] plunging her into [illegible] that the [illegible] at length living; a [illegible] Ireland, till recalled by the bishop, who was forced to send him away [illegible], after appointing a deputy, that this deputy, when drunk had wounded two of the monks, who thereupon murdered him, so that the house was practically past reformation, and ought to be dissolved.

no thought for the morrow, appealed to the p imagination, always ready to kindle at the sight of g self-sacrifice; Dominic, with not less insight as a t whose first care was for doctrinal orthodoxy, as t Francis was for personal piety, saw that there demand ready to spring up for more exact and int religious teaching than could then be had, save in great cities. The occasion which urged him to th he undertook is noteworthy. He had long been a of Osma, the strictest and sternest member of an community, when in 1203 he had to go on a journe his bishop, which brought them into the very midst Albigenses in the county of Toulouse, where they s powerless the clergy were to contend against thei On their road home the bishop and Dominic m three papal legates returning discomfited from Lang but attended with as much pomp as a triumphal p would have justified. Dominic rebuked them stern me them that it was not by splendid retinues and garb that the heretics won their converts, but by preaching, by humility, by austerity, and by a seeming holiness. Both the new founders soug obtained at Rome, after some difficulty, the appr their new institutes, and that in the very year 121 had seen the formal prohibition of all fresh Francis speedily returned to his home, but Dominic idea had by this time expanded from that of con merely the Albigenses of Provence and Languedoc of influencing the whole world of nominal Christia outer heathen, settled himself in Rome, where th appointed him to the important office of Master Sacred Palace, which has ever since been held Dominican, and carries with it the authority o censorship of the press. The two new foun borrowed from each other, Francis copying Do scheme of itinerant preachers, and Dominic impos his disciples the mendicant poverty of Assisi. The particulars, the total absence—at any rate at first—of endowments as had proved a snare to the older so and the substitution of itineracy for inclosure, features which distinguish the friars from the mon preceded them. The Franciscan institute was attempt to democratize the church; Dominic's Preachers, though recruited freely from men of a grade have always had somewhat more of an aris to be about them, due to their intellectual calling have held a high place in Christian art, counting a their proudest names as Fra Angelico and Baccio della and their reputation for orthodoxy and for a pur of mixed theology than the Jesuit one has alway have. They also count amongst their members t most eminent divine of the Middle Ages, A Magnus and Thomas Aquinas, and they have been as producing zealous missionaries; but the one gr of their claims is that they have been the direct official of the Inquisition ever since the formal e tion of that tribunal as a permanent organization Franciscans, less distinguished for mental triumph their competitors have yet some famous names, which are Duns Scotus and Roger Bacon—for B mar though set by the Franciscans as the "S Doctor" in competition with Aquinas, the " Doctor" of the Dominicans, is scarcely entitled hich intellectual rank—and at one time they seeme to establish as firm a hold on the university of Ox the Dominicans did on that of Paris. The swiftest and popularity attended the two new orders; pr and exemptions were showered on them from wealth, in despite of their vow of mendican emulously thrust upon them by the laity; and, al

a remarkable and widespread religious revival, a dead-lift to ministerial efficiency in every direction, repaid their early labours, while they had between them almost a monopoly of the popedom for nearly two hundred years. And one peculiarity of their organization gave them a degree of strength which no other orders possessed. Each monastery of the older societies was practically isolated and independent of all others, unless it were itself a dependent priory or cell belonging to a greater house. Some societies had, it is true, general chapters, but these were rare, and at best only effectual in establishing a certain uniformity of practice in all houses of the same rule. But the Friars, like the Templars and Hospitallers of an earlier day, and like the Jesuits of a later one, were enrolled in something of military fashion, under a superior general, with wide powers, who directed and controlled their actions from one central point. Every group of neighbouring friaries was formed into a *congregation* under a local head or provincial, and he was always in direct communication with the general, so that a common government united the whole body into a compact mass. But their very success was fatal to their character. The vow of poverty was the first part of their institute to break down. Even before they began to be counted amongst the richest orders of Christendom, there is indisputable evidence that of Bonaventura, fourth general of the Franciscans, that the mendicant system was working nothing but mischief. He tells us, writing while the order was still very young, and within fifty years of the founder's death, that it was even more entangled in money cares and business concerns than the endowed communities, precisely because there were no funds available to fall back on in emergencies, that the brethren, discouraged from work by mendicancy, were habitually idle; that they roamed about in disorderly fashion under pretext of questing; that they were such brazen and shameless beggars as to make a Franciscan as much dreaded by travellers as a highwayman, that they made undesirable acquaintances, thus giving rise to evil reports and scandal; that conventual offices had to be entrusted to untried, unspiritual, and incompetent brethren; that vast sums were lavished on costly buildings, and that the friars were greedy in the pursuit of burial fees and of legacies, so that they encroached upon the rights of the parochial clergy. If such were the mischiefs at work before the first zeal had begun to cool, it may readily be gathered how entire was the failure at a later time. Indeed as regards the Franciscans, not only did they endeavour to evade the stringency of their statute even in their founder's lifetime, but the whole society was soon divided into two hostile camps, one of which desired to adhere closely to the original rule, while the other was content to fall in with the habits of the "possessioners," as they had been wont contemptuously to name the endowed orders. And what is very curious in this connexion is that the friars who were loyal to the principle of poverty broke away for the most part from the church, forming new sects, such as the Fraticelli, or attaching themselves to elder ones, like the Beghards and the Apostolici, which handed on in secret the Gnostic traditions of the third century, apparently stamped out in the crusade against the Albigenses, while those who openly disregarded the will of their founder remained steadfastly in the Latin church. No order, except the Benedictines, has had so many branches and reforms as the Franciscans; amongst which it will suffice to name the Capuchins, the Minims, the Observants, and the Recollects; while the Poor Clares, the nuns of the institute, have also divided into Clarissines and Urbanists. The institution of Tertiaries, seculars affiliated to the order as honorary members, while continuing to live in the world, and adopting a certain modified daily rule, was a powerful factor in the success and strength of the order, and was adopted, but with less conspicuous results, by the Dominicans. The rivalry of these two great bodies with each other, prolonged with much bitterness for centuries, and their disputes with the parochial clergy, whom they long displaced in general repute and influence, belong rather to general church history than to the annals of monachism, and may be passed by with this brief allusion, while it suffices to say that all the support they, and the other less important communities of the same kind, such as the Carmelite and Austin Friars, received from the popes, who were effective allies, they were in every country where their houses were found was not able to avert their decline in general estimation, and there is no figure in later mediæval literature on which the vial of contempt and indignation are so freely poured as on the begging friar, and that, it must be said, deservedly.

By the 13th century the apogee of later monachism and the decline became instantly at the very outset of the 14th (which is also the date of ordination becoming the normal entry for church work, instead of the exception as formerly), continuing down to the crash of the Reformation. The great schism of the West, the rise of the Wickliffites and Lollards in England, and of the body later known as Hussites in Bohemia, could not fail to act injuriously on the monastic orders; and, though the creation of fresh ones continued none of those founded during this era were influential, and few durable. It will suffice to name some of the more prominent:—the Olivetans in 1313 who were rigid Benedictines; the nuns of Bridget of Sweden in 1363, who followed a rule compiled from those of Basil and Augustine; the Hieronymite monks in 1374; the Brethren of the Common Life founded by Gerard Groot in 1376, who did much for education and in home mission work, but are chiefly famous now in virtue of one member of their society, Thomas à Kempis; the Hieronymite Hermits in 1373–1377; the Minims in 1435, the Barnabites, a preaching and educational order, in 1530, the Theatins (a body of Clerks Regular who aimed at little more than restoring the tone of clerical life, made but little progress to authority, and are indeed mainly noticeable as having suggested to Ignatius Loyola several points which he adopted in regulating the mode of life to be practised by the members of his society in 1534), and the Capuchins in 1525.

In the Reformation period [illegible] the more reformed bodies had [illegible] in the foundation of even the rules of the [illegible] the constitutions of the Society of Jesus, Pope Gregory [illegible] Paul IV. [illegible] follow [illegible]

[illegible] Dr. Döllinger's *Fables respecting the Popes of the Middle Ages*, pages [illegible] and piety, but also on the condition of [illegible] the veil and openly contemplated [illegible] *Revelations* of Bridget of Sweden (1302–73) [illegible] cils of Constance and Basel, and by Popes Urban VI., Martin V., and Paul V., fully confirm the darkest features of this testimony as regards the religious houses of the 14th century.

th without wrong to any one, and good religious can be put
place. At present we think the best thing to be done is
s all the unprofessed youths from their monasteries."

s formal document showed the current of high
stical opinion, so the lay view took expression in
stol's *Obscurorum Virorum* of Ulrich von Hutten,
s to the Dominican of the 16th century almost
Provinciales of Pascal were to the Jesuits of the
Whole they came also under the more delicate scalpel
nus-wit. Not that the objections were wholly
it is evident from Thomas Aquinas's defence of
sm against its detractors that they were nearly all
the 13th century. The interests involved were,
r, too vast and complicated, the supposed impolicy
limitation on so large a scale of the charges a
monachism by the men of the New Learning too
to allow of any such sweeping measure of reform
proposed by the cardinals being carried out. A
amount of discouragement flown toward the older
s, the enactment of some partial corrections by
cil of Trent, not touching any principle whatever,
parently saying something became public feeling
for something to be said, and, above all, the crea-
a new type of order, the famous Company of
us (1534), represent the total action taken by
man Church during the actual crisis of the Refor-

Apart from such direct revolts from the Latin
ch as those in Bern, Zurich, Denmark, and Sweden,
t once involved the monasteries in the general
w of the old system of things, religious, the most
ble proceedings in the reaction against monachism
e taken in England, at a time when no breach
Roman Curia was thought of. So far back as
h century kings John and Edward I., and yet
1337 Edward III. had confiscated the "alien
" as those houses were called which were dependent
foreign monasteries, and the last named let out
ds and tenements until the peace with France in
hen he restored their estates, and similar land were
them both in his reign and in that of Richard II.
V. showed them more favour, but in 1410 the
Commons proposed the confiscation of all the
lities held by bishops, abbots and priors, petitioning
crown to employ the revenues thus saving a
army of knights and men-at-arms, meanwhile the
of some of the noble families, to endowing a
hospitals, and in making small yearly payments to
lish clergy. This fact alone the unpopularity
hurch and the religious orders at the time, and,
the large scheme was dropped. Yet in 1416
closed all the alien priories, and vested their
on the crown. They were for the most part
to cells to rival houses, but some portion, at
passed into private hands, apparently
. Hence there was nothing to excite surprise
opposition when Cardinal Wolsey in 1524
d bulls from the pope authorizing the suppression
small monasteries and the application of the
to other religious foundations on the plea that
revenues were quite inadequate, and not home of
education or learning, whereas a learned clergy was
ively needed to combat the new religious opinions
ere making headway. And that the monasteries
subject to errors, vices, and scandals appears
e fact that only about one half of all the foundations
known to have been made in England were in
the dissolution. There is little
o lend the charges of immorality brought against
ls when Henry VIII. had once resolved on the
of the monasteries, seeing how the path opened
by Wolsey could be followed up. The characters of the
king himself, of Cromwell, his chief agent in the dissolution, and of Layton, Legh, and others of the visitors
appointed to inquire into the condition of the houses, are
such as to deprive their statements of all credit; and
besides, the earlier Act of dissolution, granting the smaller
monasteries to the king, limits the charges of misconduct
to them, expressly acquitting the larger houses. Never-
theless, when the appetite for plunder had increased with
the first taste of booty, accusations of precisely the same
sort were brought up against the great monasteries,
though in no instance has any verifiable proof been pre-
served.[1] But there can be no reasonable doubt (especially
in view of the visitations of Archbishop Warham and other
pre-Reformation prelates), that the religious houses, viewed
simply as corporate estates, had been very badly managed
for a considerable time, were heavily encumbered, and a
weight round the neck of financial progress in England;
and that, as spiritual agencies, they had mainly outlived
their usefulness, so that, lamentable as were the circum-
stances of their destruction, and scandalous as was the
waste of the property seized, there is little reason to sup-
pose that any practical benefit would have flowed from
their continuance, whatever might have been the advantage
of an honest and economical measure of reform, or even of
transfer to other purposes on the principle of *cy près*.[2]

The negative evidence of the effeteness of the older
orders supplied by their very small share in the counter-
Reformation, which lay virtually in the hands of the
Jesuits alone, is reinforced by the reports made by the
emissaries of the new company to their superiors, which
attest that the accusations of the German reformers against
both the secular and regular clergy on the score of ignor-
ance and dissoluteness were only too well founded.
Accordingly several new societies were instituted during
the latter half of the 16th century, aiming at putting new
wine into the old bottles of the Carmelites, Cistercians,
Augustinians, Dominicans, and Benedictines; but none of
them proved of much importance. A larger measure of
success attended some established on an active basis, such
as the Fathers of Christian Doctrine, a catechizing order
erected by Pius V. in 1571; two communities for tending
the sick, one founded in Italy by Camillo de' Lelli in
1584, the other, the Brothers of Charity, by John of
God at Granada in 1538, but not formally sanctioned till
1572, and still more prosperity attended the Ursuline
Nuns, a community chiefly devoted to the education of
young girls, founded at Brescia by Angela de' Merici in
1537, and confirmed by Paul III. in 1544. Yet, with the
single exception of the Jesuits, no new society could be said
to have laid hold in any degree of the popular mind, nor
were the attempts to revivify the elder bodies continued.
It remained for two newer still to rehabilitate the waning
respect for monachism of all kinds, and that by borrowing
one chief feature of the Jesuit organization, the abandon-
ment of that principle of isolation from the outer world
which lies at the root of true monachism.[3] Of these the

[1] A full examination of the case against the monasteries will be found in Dixon, *History of the Church of England*, vol. i. pp. 324 *et seq.*

[2] The number of houses suppressed and overthrown by the two Acts of 1536 and 1538 was as follows:—186 Benedictine houses, 173 Augustinian, 191 Cistercians, 34 Dominican, Franciscan, Carmelite, and Austin friaries, 32 Premonstratensians, 28 Knights Hospitallers, Gilbertines, 20 Clunacs, 9 Carthusians, 3 Fontevraud, 3 Monteroes, 2 Bonhommes, 1 Brigittine; total, 616. Their aggregate revenues were valued at £142,914, 12s. 9d. annually.

[3] After the Jesuits rose into note and popularity, a very curious and little known extension of their institute was made in Flanders. Two English ladies, acting with the sympathy and counsel if not at the recommendation of F. Gerard, rector of the Jesuit college at Liege, founded a community which they named Jesuitesses, adopting

was the Oratory, founded by Philip Neri in 1558, but approved by authority till 1577, and copied inde ently by Cardinal de Berulle at Paris in 1611. There no vows imposed on the members of this society, gh they lived under rule, and they employed them- s in doing all kinds of clerical work under episcopal vision. The Italian house is chiefly celebrated as g included the famous Cardinal Baronius amongst rliest recruits; but the French one held a high pla o religious revival of the 17th century, well nigh ing the Benedictines of St Maur in learning (with representatives as Simon, Thomassin, Morin, and bran,he), and the reformed Cistercians of Port Royal ety, though sharing with the latter the reproach of anism. But the second was far more influential, and een fruitful ever since in the work of r copy t as in its own. It was the institute of the Si ter- narity, established by Vincent de Paul in 1634, on ines of the ancient community of the Ho-pitalle of St Augustine, but with some remarkable modi ons, not only in respect of the vows, which were only y and inward, but in the spirit of their discipline a ilated in his own memorable words, "Your convent be the houses of the sick, your cell the chamber of ring; your chapel the parish church, your c, treets of the city, or the wards of the hospital your the general vow of obedience, your cross the boa od; your veil to shut out the world, holy modesty. original scheme of Francis de Sales for the Nuns of Visitation, founded in 1610, was almost identical he opposition was then far too strong, and he w d to make them a cloistered community. Vincent of Mission Priests, more commonly known as La o was also a successful and useful institute, though vying in the extent of its influence with the other, , as has been implied, has powerfully affected the ization of many of the active communities which since been formed. No religious body did more to e French monachism to bear up against the general gny it encountered during the 16th, 17th, and early centuries, a temper on the part of the public due ore than one cause. In the first place, the wars of on had done much to harden and coarsen the feelings oth sides, and rigid adherence to the extreme positions atholics or Huguenots, as the case might be, was ot bove any gentler and higher ideas. Next, the mona s of both sexes had all but universally fallen into the onage of the crown (in virtue of the concordat of gna, between Pope Leo X. and Francis I.), and were d away as apanages for a dissolute nobility, who ndered the revenues, and suffered discipline to become ed, often to the generation of serious scandals. Thi ersation operated in two ways. It made the monks s hard and bad landlords, grasping closely all the l privileges and monopolies which they continued to , a proceeding which bore hard on the tenants and urers, so that the monks shared to the full the unpopu y of the nobles (precisely as was the case in Germany, ng the Peasants' War of 1525); and the evil repute of the convents of whose real character we get at least one trustworthy glimpse in the account of the abbey of Mau- buisson which Angélique Arnauld reformed came home to all the Huguenots and their friends, because both before and after the legal continuance of the edict of Nantes they were used (according to a very early application of monastic houses not yet obsolete) as prisons, where Huguenot women and girls were shut up in order to bring about their conver ion, forcibly if necessary, but somehow in any case. And there is evidence to show that the Huguenots resented this policy most bitterly, not only on political grounds, but be cause they were firmly persuaded that the moral of their wives, daughters, and sisters were in no less peril than their faith in such place. When to this resentment is added the hostility of the Jansenist to the school of opinion which had persecuted them, razed their famous house of Port Royal, and literally flung the bones of its deceased members to the dogs, it will be easy to judge how powerful were the forces making for the overthrow of monachism, and how little even such stern reforms as De Rancé's at La Trappe, which has always had a marked attraction for ole and organization of the famous company, and taking the three vows, but, with a bold disregard of precedent, not only omitting ustomary vow of inclosure, but actually sending the members of ociety out as itinerant preachers. Their object was to train a of emissaries for the Roman Catholic mission in England, who obtain entrance and escape the incidence of the penal laws in a er impracticable for men. They had considerable success for a and Mrs Ward, their projector, obtained some degree of papal oval, and became "mother-general" over more than 200 of these preachers in the various colleges of the society. But after an nce of about eighty years it was suppressed by Pope Urban VIII 30.

[illegible] Some of the often disputed the name of [illegible] interpretation [illegible] a point which has be [illegible] ce of those words to discussion, known [illegible] ers," [illegible] dict to the readers of *Marmion*. It [illegible] ed that of Clarendon by the parliament of Paris [illegible] crown to consume the death of a prisoner [illegible] much evil to France, but produced perhaps eve Germany where what were styled "Noble Abbey ns, only one to which were in the inferior capacit of lay members, were barred against all who could not prove patrici descent and a certain number of aristocratic quarterings. A relic of th survives in the so-called *Stiftsdamen* Protestant and Catholic for n canonesses in Germany; and the notion was at any rate a respectab as that which holds [illegible] in some continental countries even now, where wome who can pay a certain sum at entrance are [illegible] as choir sister while those who cannot do so must accept the [illegible] condition of la sisters.

Pontiff . . . become by saying that for some time past the
e See, con ideration not the abundance only, but the super-
religious in Europe, had become convinced that some of
legislative from the first design of their founders, had
into a total perversion of discipline, and that it was just to
by the sanctions for the laity to adopt the expedients
were for tendency when they see that the multitude of
their suppression had their cause instead of making them more
That this summary had been made in that matter by sup-
not the was not enough . . . A great
convent had been suppressed . . . and
in the work by proceeding to the final
which by their location made of late,
and numerous . . . That he p
. . . to be entrusted on a matter of so much importance to
. . . good will of the . . . ecular prince . . . The remark
. . . th a recommendation to the republic of Venice to appoint
. . . of San Spirito and the churches in their city and to
. . . an average tonnage which equips the cost of the war to
(Ranke, *Die Römischen Päpste*, App. No. 191.)

the policy that instigated war not carried out by
. . . VII . . . nce of . . . and there is evidence that
did not spread as time went on. The emperor
I., in his character of grand-duke of Tuscany,
. . . be published at Florence in 1781,
. . . to require property in mortmain,
. . . of instruction pointing
. . . eral disadvantages of enclosing articles
, such as convent, college, and the like, of the ex
. . . nated families. And the measures implied in the e
. . . nt was carried into operation by the suppression
. . . al convent of nuns, for which the reluctant con
. . . the pope (Benedict XIV.) was solicited. When
. . . died in 1765, and was succeeded in Tuscany by
. . . her Peter Leopold the latter began his reign with
. . . ey be styled a complete code of written law for the Roman
. . . by abolishing the bull *In Coena Domini* null and
. . . Tuscany, and forbidding the promulgation of publi
. . . there. . . . He was beset with appeals from
. . . and pro . . . ation to
. . . in the latest . . . ossibly to moral scandals of the
. . . most local . . . event of more especially those
. . . he date from . . . Dominican, accusations which
. . . ntrasted with the . . . t of time and place. The
. . . was that he . . . ed as a home of ecclesiastical
. . . to be drawn . . . 70, a grievance frequent
. . . ent for the abolition of monachism, to the
. . . ion of all . . . t of monachism, a
. . . ibution of revenues . . . from the direction of
. . . , which were to . . . pplied in . . . ation
. . . to the endowment of . . . And the Jan-
. . . ia and Pietro Scipione . . . Ricci, upon entering on
. . . e in 1780, at once began to inquire into the
. . . which existed in the Dominican province of his
. . . tion, especially in Pistoia, the result being that he
. . . annexed the Dominican friary, and prohibited
. . . new elections. The pope at that time was Pius
. . . a chief devotee, warmly in favour of monas
. . . cally and of the lately suppressed Jesuits in
. . . so that he took up the cause of the friars
. . . and reports had prevailed for 150 years),
. . . d a series of enactments against Ricci. He had
. . . the ecclesiastic who wrote a strong memo
. . . accompanied with proofs furnished by Ricci, and
. . . d the pope that such the latter were promptly
. . . wn, and the convent obliged to submit to
. . . many pre-directions, he would himself reform at
. . . n discretion . . . in Tuscany.
. . . ely, the latter was retracted, and Ricci was given
. . . rity to repress the disorders complained of. There
. . . ny similar evidence forthcoming as to the condition

. . . which documentary evidence will be found in the Appendix
. . . ter's *Letters of Scipione de' Ricci*.

of the monasteries in other parts of Italy; but Tusc
likely, from local causes, to have been above, rathe
below, the average moral level. Against this g
tendency to monastic decay may be set the foundat
the Passionists in 1725, and of the Redemptori
Liguorians in 1732; but these two institutes, though
and respectable, have never exerted much influence.

There is little to chronicle in regard to the later
of monachism in Spain and Portugal. Peter of Alca
as reformer of the Franciscans of the latter coun
the middle of the 16th century, and his more f
contemporary, Teresa, as reformer of the Carmeli
Spain, are eminent figures in the annals of their tim
they cannot be said to have produced any perm
effect on the fortunes and tone of their several mot
far less upon the common life in general. The sta
out of all varieties of opinion, at any rate in resp
outward expression, by the Inquisition in the Pen
makes the evidence scanty and vague; but the fac
Portugal took the lead in 1759 in striking at the J
then the most eminent and powerful of the orders, t
far surpassed in mere wealth and numbers throu
Western Europe by the Franciscans, and that its pol
this respect was quickly followed by Spain, attest
. . . owth of a hostile feeling by no means likely to
been limited to the great company. In fact, if pr
rhymes and proverbs may be trusted, the charges a
against the religious orders in Spain do not seem to
differed from those alleged elsewhere, whatever may
been the amount of truth in them. And the testimo
Blanco White, always to be trusted on matters with
experience, is decidedly adverse.

The terrible crash of the French Revolution,
affected, directly or indirectly, every country in E
was not least influential in its incidence on monas
On the one hand, the actual destruction which it br
upon the religious houses of France was adopted as p
the revolutionary programme in all countries where
institutions were still intact; and, on the other, there
considerable measure of improvement brought abo
not a few places by the fear of public opinion, whi
new institutes which continued to spring up were a
invariably active, both founders and the sanct
authorities recognizing that any society seeking to
a footing good must needs first prove its capaci
practical usefulness. In France itself the laws
abolished all religious communities were relaxed b
advance in favour of the Sisters of Charity even
the Terror and the Directory; while in 1801 a dec
the Consular Government, issued by the Minister
Interior, authorized Citizeness Dulcan, former super
that society, to revive it by taking young women to
or hospital work: and various other active commu
were restored by Napoleon in 1807. Further re
took place at the Restoration, the most celebrat
which was the Dominican, owing to the talents an
eloquence of Lacordaire and the group he gathered
him. But Benedictines, Carthusians, Trappists, and
orders of the older type were not slow to avail
selves of the opportunity to return and to found
amidst a poverty which recalls the original instit
their abbey and priories. But they met with little
under the Orleanist monarchy, and the Second Empi
their time of most security and progress. Since it
they have again been actively discouraged by a s
party in the Republic, and their position remain
carious. France has been, further, the chief seat o
many new societies founded for some especial depar
of charitable work, the most characteristic examp
which is perhaps that of the Little Sisters of the

ouse and tend aged invalids. As a broad general
nearly every post Reformation institute is styled, not
Order," but a "Congregation", but the only d
n which can be drawn between the e two names
t. "order" is the wider, and may include several
gations within itself (as the Benedictine order,
ample, includes the congregations of Cluny and
Maur), while a "congregation" is a simple unit,
te in itself, and neither dependent on another
te nor possessed of dependent varieties of it own.
r distinction drawn between the elder and younger
s is that the former are said to make "solemn
the latter only "simple vows." The difference
not in the matter of the vows, which are usually
ne in all cases, nor even in the ceremony attending
utterance, which may also be alike, but in the
r binding efficacy of the solemn vow in Roman
law, which rules that they so bind the member to
iety, and the society to each member, that neither
r the connexion, so that only the pope can dis-
that in rare and exceptional cases (here
added that the term "religious" is restricted in
n Church to communities whose institute has been
y approved by the Roman see, and whose vows
life, and not merely renewable (a principle which
s the Sisters of Charity, for example, from the use
title. By the laws of France (and of some other
es, life vows are invalid and even prohibited, but
hey make part of the original institute, such ac-
al by the civil power is not held to reduce them to
nomical level of temporary vows.

rning to the history of Western monachism the
the religious houses in Spain date from the law of
ne 1835, which suppressed nine hundred monasteries
ow, and the remainder had but a short respite be-
ere dissolved on 11th October of the same year. In
al, where a bias against the Roman Church has been a
onal part of patriotism ever since the revolution of
when the pope sided with Spain against the hot
aganza, there was little decline to protect the
eries when it happened that the crown wanted
ossessions, and they were all suppressed by the
of 28th May 1834. No European country had so
religious houses as Portugal in proportion to its
tion and area, and the number of the foundations
d in 1834 exceeded 500. In Switzerland a com-
le measure of suppression followed the war of the
bund in 1847; while in Italy, the last country
monachism had remained almost unmolested, an Act
ssed in the Sardinian Parliament on 7th July 1866
suppression of monasteries within the Piedmontese
ons, and for the confiscation of their property.
easure was extended to the whole of Italy after the
tion of the kingdom, the orders were expropriated
; their houses were declared national property and
ort to secular uses, no exception being made in
favour of San Marco at Florence, of Assisi, of Va
brosa, or even of Monte Cassino itself.[1]

On the other hand, several Roman Catholic soc
have attained considerable success in the United S
and Canada, thus in some degree recovering fo
principle they represent part at least of the ground l
Europe, while in three religious communions out o
pale of the Latin obedi Evangelicals of Ger
the Reformed of France and the Church of England
organization of women for charitable and religious
on the lines of various old institutes has been ac
carried out. The Deaconesses of Kaiserswerth, fou
by Pastor Fliedner in 1836 derive part of their rule
even of their dress, from the Duke de St Aign
themselves lineal descendants of the ancient Ho pitall
the crusades, and have received into several comm
the Stra burg and Mulhausen Deaconesses derive
partly from the French Revolution and partly from
point in the Moravian or unitarian itself branded
from these centres Europeans to whom the A
Protestantism really owes its origin, while the various An
communities of which there are several have been
freely from different sources, according to the pecu
and knowledge of each founder. Some attempt
reviving the common life for men also have been
made, but none on any large scale, only one has
exhibited any signs of vitality, a preaching orde
Cowley near Oxford, which has obtained some footi
England, and has even been able to spread to Americ

[1] The Benedictine congregation of Monte Cassino is the most important and best known of modern times. Founded by Ludovico Barbo, abbot of Santa Giustina at Padua, in 1408, it was reformed by Giustiniani, bishop of Belluno, in 1504, and by Cardinal Gerolamo Seripando in 1530. It was suppressed by the French in 1798, but restored in 1837 by Pope Gregory XVI. It has its own constitutions, and is governed by a president-general, elected every six years by the abbots of the congregation. Its members are known as Cassinese. See Mabillon, *Annales Ordinis S. Benedicti*, vols. v. and vi. (Paris, 1739); Tosti, *Storia della Badia di Monte Cassino* (Rome, 1842–1843); Gattola, *Historia Abbatiae Cassinensis* (Venice, 1733); and Bertaux, *Dominique de la Rochette* (Paris, 1904).

Chronological Table of Monastic Rules

igious communities which have been formed at various times in the Western Church, amounting to several hundreds, and not nearly all of which are even now extinct, it is impossible to give more than a selection. Nor could a list of those even approximately complete be given, since many of them have been suppressed and revived more than once, and in different countries at different times, while some among them have been approved by authority and recognized by authority as published, it is their object to observe, and have separately and independently local varieties or branches of identical rules, and in that case the date of the earliest foundation where a number are enumerated, and practically disappeared from view, though, as still lingering in one or two houses, not absolutely extinct. The following table gives the more remarkable foundations in chronological order, some of the earliest of which are only approximate, and even uncertain, for the historians often vary as to the exact year, sometimes even that of the founder, and usually that of the final approval by authority.

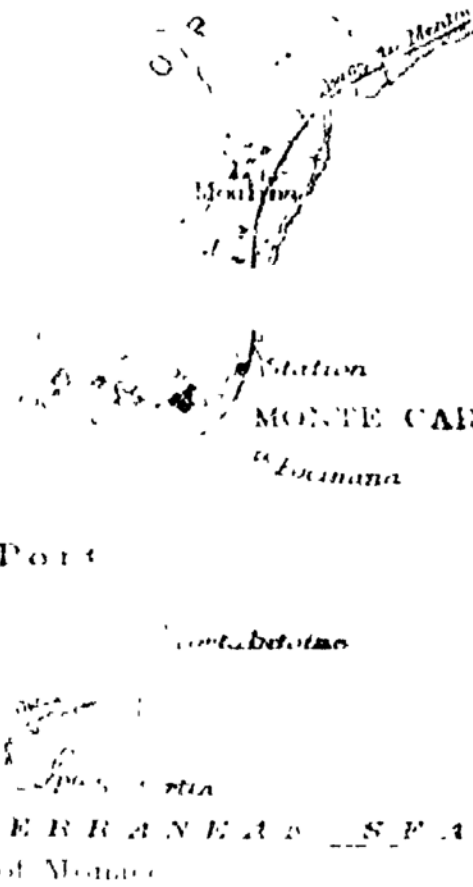
Name	Founder	Place	Date	Notes	Order	Diocese
Monks of the Thebaid	Paul the Hermit	Upper Egypt		Ascetic Canons (continued)	Ascetic	Orthodox E
Tabennites	Pachomius	Tabenna in the Nile	400	Severest Sleepless	Ascetic	Africa, Mesopotam
Basilian Monks	Basil the Great	Matiza, Pontus.		Monk.		

MONACHISM

Name	Founder.	Place	Date	Name.	Founder.	Place.
Monks of Lerins	Honoratus of Arles	Isle of Lerins, France	1131	Mitigated Carmelites, or "Billettes"	Pope Eugenius IV	Rome (?).
Benedictines or Black Monks	Benedict of Nursia	Monte Cassino, Italy.	1134 (?)	Congregation of St Ambrose ad Nemus	(?)	Milan.
Wearmouth	Benet, Hilda, David	Wales	1143	Order of Nuns	Frances of Rome (?)	Rome.
Monks of Iona	Columba	Iona, Scotland.	1170	Minims, or Hermits of St Francis	Francis de Paola	Vincennes,
Monks of Lérins	Caesarius	Arles, France	1180	Daughters of St Martha (Hospitallers)	Nicolas Rolin, chancellor of Burgundy	Beaune, Fr
Nuns of the Conception (?) of Jesus	Palmerio, wife of Pope Leo I.	Rome	1181	Augustines of the Lombard Congregation	Gregorio Roccha	Pavia.
Canons Regular	Chrodegang	Metz	1188	Maid Servants	Bishop de Bogpard	Metz
Benedictines of Cava	Peter	Cava, Italy	1191	Barnabites or Clerks Regular	Pope Innocent VIII.	Rome.
Canons of Mont Cenis	Bernard	Mt Cenis, Italy	1193	Friars Penitents	Jean Tisserand	Paris.
Canons Regular of the Holy Sepulchre	Godfrey	Neufchatel, Normandy	1197	Antoinettes	Queen Jeanne de Valois	Bourges, Fr
Cistercians	Robert	Molesme, Champagne	1204	Theatines	Giovanni Pietro Caraffa (Pope Paul IV.)	Chieti or C Italy.
Canons Regular of St Augustine of Verona	Ezelino	Verona, Public Square	1208	Friars Humiliati, or Reformed Franciscans	Matteo di Bassi	Chiari
Cistercians	Robert	Molesme, Champagne	1214	Order Penitents of St Magdalen of Pazzi or Discalced Carmelites	Girolamo Emiliani	Pavia
Premonstratensian Canons Regular	(?)	Premontré				
Canons Regular of the Holy Cross	Theotonius Augustine	Portugal	1216	Regular Canonesses of St Augustine	(?)	Spain (?).
Benedictines of the Holy Ghost	Guy of Montpellier	Jerusalem	1217	Barnabites of St Paul	Gianpietro Antonio Morigia	Milan.
Premonstratensian Canonesses	Hermann Joseph	Steinfeld	1218	Friars Minor	Ignatius Loyola	Montmartre, Paris
Hospitallers of St Mary of Mercy	Peter Nolasco	Barcelona	1220	Dominicans	Angela de' Merici	Brescia, Ita
Premonstratensian Canonesses	Hermann Joseph	Steinfeld	1227	Franciscans	John of God	Granada.
Hospitallers of St Mary of Mercy	Peter Nolasco	Barcelona	1228	Daughters of the Congregation of the Holy Child	Ann Englishwoman, named Ward	Flanders.
Trappists	Armand de Rancé	Soligny	1230	Oratorians	Philip Neri	Rome
Premonstratensian Canonesses	Hermann Joseph	Steinfeld	1231	Benedictines of the Holy Sacrament	Doctor	Ocaña, Spa
Canons Regular of the Holy Cross	Theotonius	Portugal	1234	Friars of Christian Doctrine	Pope Pius V.	Rome
Premonstratensian Canonesses	Hermann Joseph	Steinfeld	1237	Franciscans	Jean de la Barrière	Feuillans, France.
Hospitallers of St Mary of Mercy	Peter Nolasco	Barcelona		Oblates of St Ambrose	Carlo Borromeo	Milan
Trappists	Armand de Rancé	Soligny		Friars Minor of St Basil	Pope Gregory XIII	Rome.
Benedictines of the Holy Sacrament	Pierre Bérulle	Paris		Clerks Regular, Ministers of the Sick	Camillo de' Lellis	Rome.
Canons Regular of the Holy Cross	Theotonius	Portugal		Canons Minor	Agostino Adorno	Genoa.
Premonstratensian Canonesses	Hermann Joseph	Steinfeld		Discalced Augustinian Canons	Thomas d'Andrada (Thomas de Jesus)	Talavera
Trappists	Armand de Rancé	Soligny		Congregation of Priests	Vincent Mussart	Francon-sur-sous-bois
Benedictines of the Holy Sacrament	Pierre Bérulle	Paris		Discalced Trinitarians	Juan Baptista Garcias	Val de P Spain.
Trappists	Armand de Rancé	Soligny				
Benedictines of the Holy Sacrament	Pierre Bérulle	Paris		Notre Dame de St Paul	Madeleine d'Ebrenbleu de Sommus	St Paul, Fr
Canons Regular of the Holy Cross	Theotonius	Portugal		Discalced or Reformed Dominicans	Jerome Machadis	Peru.
Premonstratensian Canonesses of Bethlehem	Hermann Joseph	Steinfeld				
Trappists	Armand de Rancé	Soligny		Congregation of the Holy Cross	Mary Ward	St Omer, Fr
Visitandines	Francis de Sales	Annecy		Nuns of the Visitation	Jeanne Françoise de Chantal	Annecy, Sa
Nuns of St Clare	Francis of Assisi	Assisi, Italy		Discalced Carmelites	Marie Lavallée	Paris.
Order of Valliscaulian Fathers	Walter Espec	Calder, Yorkshire		Priests Oratorians	Cardinal de Bérulle	Paris
Premonstratensian Canons Regular of the Holy Cross	Theotonius	Portugal		Canons Regular of St Sauveur	Fourrier de Mataincourt	Lorraine.
Hospitallers of St Mary of Mercy	Peter Nolasco	Barcelona		Nuns of St Clare		Nancy
Dominicans	Dominic	Prouille		Discalced Conventuals	Joseph Calasanza	Rome.
Hospitallers of St Mary of Mercy	Peter Nolasco	Barcelona		Discalced Carmelites	Antoinette d'Orleans	Poitiers.
Premonstratensian Canonesses of Bethlehem	Hermann Joseph	Steinfeld		Congregation of Benedictines of St Maur	Didier de la Cour	Verdun, Fr
Trappists	Armand de Rancé	Soligny		Hospitallers Nuns of the Charity of Our Lady	Simone Gamgam (Mother Frances of the Cross)	Paris.
Visitandines	Francis de Sales	Annecy		Lazarists	Vincent de Paul	Paris.
Nuns of St Clare	Francis of Assisi	Assisi, Italy		Nuns of Our Lady of Refuge	Marie Elizabeth de Rastam	Nancy
Order of Valliscaulian Fathers	Walter Espec	Calder, Yorkshire		Sisters of the Cross	M. Guerin	Roye, Pica
Premonstratensian Canons Regular of the Holy Cross	Theotonius	Portugal		Sisters of Charity	Vincent de Paul and Louise Legras	Paris
Hospitallers of St Mary of Mercy (Hospitallers of Redemption)	Peter Nolasco	Barcelona		Order of Mercy	Antoine Yvon and Madeleine Martin	Aix, Prove
Premonstratensian Canonesses of Bethlehem	Hermann Joseph	Steinfeld		Sisters of the Blessed Sacrament	Antoine Lequien	Marseilles.
Trappists	Armand de Rancé	Soligny		Bartholomites, or Clerks Secular of Common Life	Bartholomew Holzhauser	Salzburg.
Visitandines	Francis de Sales	Annecy		Nuns of the Good Shepherd	Madeleine Lamy	Caen, Fran
Lazarists or Priests of the Mission	Vincent de Paul	Paris		Order of Our Lady of Charity and Refuge	Jean Eudes	Caen.
Premonstratensian Canons Regular	Norbert	Premontré		Eudists, or Marian Priests	Jean Eudes	Caen.
Oblates of St Ambrose	Charles Borromeo	Milan		Daughters of Providence	Madame de Polvillon	Paris.
Hospitallers of St Mary of Mercy	Peter Nolasco	Barcelona		Sulpicians	Jean Jacques Olier	Paris.
Hermits of St Jerome	Pedro Fernandez Pecha	Valladolid, Spain		Order of St Joseph	Henri Maupas du Tour	Le Puy en V France.
Hermits of St Jerome	Lope Gonçalvez or Gonçalo	Pisa		Nuns Locum Nuns of Perpetual Adoration	Catherine de Barré (Mechtilde du St-Sacrement)	Paris.
Brothers of the Common Life	Gerard Groot	Deventer, Holland		Sisters of Richemont	Pierre de Betancourt	Guatemala, America.
Redemptorist Monks of Jerome Calippus	Jerome Calippus	Monte Cassino, Italy		Hospitallers Nuns of St Thomas of Villanova	Ange Le Proust	Lamballe, France.
Hieronymite Nuns	Maria Gonzalez	Toledo.	1661	Lazarist Brothers	Pere Vachet	Chaumont,
Congregation of the Holy Cross	Basil Anthony Moreau	Rome	1663	Reformed Trappists	Armand de Rancé	La Trappe.
Congregation of St Joseph or Reform of Mont Cassino	Servant de Rubeo	Padua	1673	Brothers and Sisters of the Child Jesus	Nicolas Barré	Paris.
Canons Regular of the Holy Sacrament	Alphonsus Salmeron	Rhodes, Sicily	1679	Daughters of Providence	Madame Morel	Charleville France.
Hieronymites	Martin Vasquez	Nova Toledo	1684	Sisters of the Presentation	Marie Poussepin	Sainville, F
Order of Recollects, or German Benedictine Reform	Johann Burkard	Abbey of St Matthias, Treves.	1686	Ladies of St Cyr	Madame de Maintenon and Louis XIV.	Versailles.

Daughters of the Good Shepherd	Madame de Combe	Pa	1842	Deaconesses of St Loup (Swiss Relat.)	M. Germo	Franc
Sisters of Charity of St Paul the Apostle	Louis Chauvet	Leveville-les-Che nard, Fr	1843	Notre Dame de Sion	PP. Theodore and M. A Ratisbonne	Paris.
Congregation of the Good Saviour	Elizabeth de Sainville	St Lo, Ne mandy.	1846	Society of the Holy Child dren	Cornelia Connelly	Derby,
Religious of Most Blessed Sacrament	Pere Vigne	Bon ervaise Roy France	1847	Society of Holy Trinity of Devonport (Angl.)	Priscilla Lydia Sellon	Plymou
Daughters of Wisdom	Marie Louise Trichet and Grignon de Montfort	La Rochelle	1851	Sisters of the Poor Child dren	Clara Cey	Ve ia C
Passionists	Paul of the Cross	Rome	1849	Poor Handmen Jes Christ	K Clare	Dernbac many
Redemptorists, or Liguorians	Alfonso de' Liguori	Scala, Italy	1849	Sisters of St Mary the Virgin (Angl.)	Miss Lockhart	Wantage
Society of the Christian Retreat	Antoine Sylvio Receveur	Fontenelles, France	1850	Sisters of the Most Holy	Communion	Manches
Ladies of the Sacred Heart	Madame Barat	Ve	18	Seventh	Cardinal Wiseman	Harcourt London
Dames de St Andre	Seraphine Hauvaliet	Fo ay, Bel gium				
Marist Fathers	Jean C. M. Colin	Lyo			Bis W Ripon (Angl.)	London
Oblates of Mary Immacu	M de Mazenod	Ai			Abbe Pe Cal	Pro
Sisters of Jesus and Mary	Pere Coindre	Ly			Mo Hier	ne Ba
Marist Brothers	Abbe Champa	Lyo			Bro Mo Claude Mar	Crowe,
Sisters of Notre Dame	Jean Bapt		18	of the Mo	Dr John Mi Nic	Eas Gr
Secours de l'Esperance	Abbe Noyon					
Brothers of Christian In struction	Abbe Dau		18			Pon
Faithful Companions of Je ty of Nazareth	Madame d Hou me Ro				Ba J Pe Ch	
Sisters of Bon Secour	M					
Marist Sisters	Jean Claude Cou					
Sisters of Mercy	Catherine McAu					
La Sainte Enfance de Sacre Coeur	Abbe Debrabour					
Institute of Charity, or Rosminian Fathers	Antonio Rosmi ni Ser					
School Sisters of Notre Dame	Bishop Michael					
Daughters of the Cross	Canon Le					
De (Lutheran)	Theodor Fl					
Naverian Brothers	Theod					
Deaconesses (French Reformed)	M Vernes					
Little Sisters of the Poor	Abbe Le P					
Deaconesses of Strasburg (Luth.)	Pastor H					

ONACO (French *Monaco*), the smallest of the seven principalities of Europe, with an area of 8·31 square , a population (1878) of 7019, and an army of 72 is situated on the coast of the Mediterranean, 9 miles of Nice, and bounded on all sides by the French rtment of the Maritime Alps. Previous to 1861, the communes of Mentone (Menton) and Roccabruna uebrun) were sold to France for 4,000,000 francs, the was about a third larger; but the population, which those portions again included would now be 15,000, only about 8000. Monaco has long had the reputa of being one of the most beautiful and sheltered on all the Franco-Italian coast: *non Corus in illum habet aut Zephyrus, solus sua littora turbat Caurus*, Lucan: and a luxuriant growth of aloes and prickly s (introduced in 1537), palm trees, eucalyptus, lemon , and geraniums gives a warmer colour to the scene Lucan can have known. The town occupies the level mit of a rocky headland, rising about 190 feet from shore, and still surrounded with ramparts. Though ly modernized, the palace is a fine specimen of Re ance architecture; the new "cathedral" (French Re ance style), the new church of St Charles, and the mm may also be mentioned. Behind the rock, between Tête de Chien and Mont de la Justice, the high nds rise towards Turbie, the village on the hill which s its name from the *tropaea* with which Augustus ed the boundary between Gaul and Italy. On the rn side lies the little port or bay of Monaco; along ower ground at the head of the bay stretches the vil of Condamine with orange gardens, manufactures of nes and liqueurs, and the chapel of Ste Devote, the n saint of Monaco; farther to the east, on the rocky slope of the Spelugue (espelugue = cave) are grouped the buildings of the Casino, Monte Carlo and the ma and hotels which the influence- to



Plan of Monaco

they were traversed by the new road to Mentone, Cor caused them to be covered with soil by Italian e and since 1858, when the first stone of the Cas land, the process of artificial embellishment has been

the most magnificent scale. The gaming establish- now in the hands of a joint stock company with a of 1,000,000 francs. None of the inhabitants of have access to the tables, and their interest in the ance of the *status quo* is secured by their complete from taxation, and the large prices paid for Gambling tables were set up at Monaco in but it was not till 1860 when M. Blanc, expelled Lombardy, took possession of the place, that Monte gan to be known.

ng and culture. Spade husbandry generally prevails. Th common manure is a compost of lime and burned turf Marl is abundant, but is little used, and gypsum also is foun

The number of holdings in 1881 was 17,849 of which as n 10,781 did not exceed 15 acres in extent, and 4870 of these exceed 5 acres; 6451 ranged between 15 and 50 acres, and were above 200 acres. The area of arable land was 278,755 a 87 per cent of the whole, while 5258 were under plantation bog and marsh, 5230 barren mountain land, and 21,582 water and fences. The following table shows the areas under the ent crops in 1870 and 1880.

Horses numbered 10,329 in 1872, and 10,666 in 1882. Some were mules numbered 300 and 169, and asses 1314 in The number of cattle in 1872 was 81,333, and in 1882 only an average of 2·9 to every 100 acres under cultivation average for Ireland being 25·8. Sheep between 1872 and declined from 42,964 to 9,856, a very inconsiderable number increased from 26,000 to 29,972, goats from 887 to 1239 poultry from 94,544 to 131,260.

According to the latest return the land was divided among proprietors who possessed 311,440 acres, with a total annual v 2,961,222. The average of the properties was 211 ac the average value per statute acre 17 shillings. The lar even proprietors possessed upwards of 10,000 acres, E. P. S 20,556, marquis of Bath 17,762, earl of Portrey, 17,345, Rossmore 14,839, Sir John Leslie 13,621, Viscount Templ 12,515, A. V. Hope 11,700.

Manufactures.—The only manufacture of consequence is which of late years has been on the increase. The num cotton mills in 1881 were 10, of which 6 were worke water, 3 were worked by water and steam.

Ethnography.—The county includes 5 baronies, 23 pa and 15 town-lands. Assizes are held at Monaghan, and q sions at Carrickmacross, Castleblayney, Clones, and Mon There are 5 petty sessional districts within the county, and another. It includes the poor-law unions of Carrickmacr Monaghan and portions of Castleblayney, Clogher, Clones, Lisnaskea, Dundalk. It is in the Belfast military distric circuit of Armagh. There is a barrack station at Monaghan the Irish parliament two members were returned for the and two for the town of Monaghan, but at the Union Mo were disfranchised.

Population.—The population in 1841 was 200,142, but i to have diminished to 111,873, in 1871 to 111,969, and in 1 to 62,071 females, of whom 50,077 were male and 62,071 female In 1861 75 per cent. of the inhabitants were Roman Ca 16 per cent. Episcopalians, and 11 per cent. Presbyterians number of emigrants from 1 May 1851 to 31st December 18 to 10, or about 1840 persons per annum; while during the year ending 31st March 1881 the annual rate of emigrat per 1000 of the population. The death rate to every th of the population for the ten years ending 1881 was 16·9, th to 2·4, and the marriage rate 8·6. The towns possess su to 1000 inhabitants are Monaghan 3369, Clones 2216, C to 2007, Castleblayney 1810, and Ballybay 1651. Mon county town, received its name *Muineachan* (the town of monasteries founded there at a very early period. The to corporated by James I., but it was little more than a hamlet until the close of the 18th century. Besides the usual county bu courts, a Roman Catholic college, and National model s

History and Antiquities.—In the time of Ptolemy, Mo formed part of the territory of the Scoti. Subsequently it to the district of Oriel or Orgial, and long known as Maec country it became shire ground in the reign of Elizabeth.

The antiquarian remains of Monaghan are comparatively meagre. At Clones there is a round tower in good preser but very rude in its masonry, another at Inni-keen dilapidated. Near Clones there are two large raths. Al there are several old Danish forts there are no mediæval ca importance. The only monastic structure of which any re mains is the abbey of Clones which was also the seat of a bis The abbey dates from the 6th century, but was rebuilt in t century after destruction by fire. On the site of the Fra abbey at Monaghan a castle was erected, which was in a condition in the time of James I.

MONAGHAN, an inland county of Ireland in th of Ulster, bounded E. by Armagh, S.E. by S. by Meath, S.W. by Cavan, W. by Fermanagh by Tyrone. The area is 318,806 acres, or 498 The north-western part of the county includes great central plain of Ireland, but in the south-east an upraising of Lower Silurian rocks. The surface is r although none of the hills are of great elevation. an equal range is that of Slieve-beagh, 1255 feet above sea-level. Formerly much of the

ne of trees, in the early decades of the nineteenth century ...nery is to be viewed from monotony by the large num small lakes and streams. The lakes number in all 200. The principal rivers are the Finn, which leaves centre of the county and passes into Donegal; Blackwater which forms the boundary with Tyrone ...ter Canal passes the towns of Monaghan and ...ffording communication between Lough Neagh ...h Erne. Peat occurs at several places. There ...no of workable coal in the north-west of the The rock-salt is not only abundant and good, in the portion of the rocks it can be obtained at ...nall expense and in any quantities. Free-stone and slate are ...d in considerable quantities. The other mineral ...lead ore, antimony, fuller's earth, marble, and ..., but the quantities obtained are inconsiderable.

Climate and Agriculture.—Partly owing to the large proportion ...nd water the climate is somewhat moist. The soil in the ...al portions of the county is very fertile where it rests on ..., and there seldom is any lack of depth, which is esp...ially ...ficial cultivation; but in the hilly districts a stone retenti...ails, which could be made productive only by careful drain

MONARCHIANISM, in its technical Christo... sense, designates the view taken by those Christian

the church, towards the end of the 2d century uring the 3d, opposed the doctrine of a hypostatic (hypostasianism) or of an independent personal subre of the Divine Word. It is usual (and convenient) ak of two kinds of monarchianism,—the dynamistic e modalistic. By monarchians of the former class was held to be a mere man, miraculously conceived , but constituted the Son of God simply by the in high degree in which he had been filled with Divine n and power. This view was represented in Asia about the year 170 by the anti Montani tic Aloci, ed by Epiphanius on account of their rejection of the Gospel; it was also taught at Rome about the end 2d century by Theodotus of Byzantium, a currier, as excommunicated by Bishop Victor, and at a later y Artemon, excommunicated by Zephyrinus. About ar 260 it was again propounded within the church ius of Samosata (*q.v.*), who held that, by his unique ucy, the man Jesus gradually rose to the Divine , so as to be worthy of the name of God. Modalistic rchianism, conceiving that the whole fulness of the nd dwelt in Christ, took exception to the "subordinaism" of some church writers, and maintained that the Father and Son were only two different denominations same subject, the one God, who "with reference to ations in which He had previously stood to the world d the Father, but in reference to His appearance in ity is called the Son." It was first taught, in the ts of the "monarchia" of God, by Praxeas, a confrom Asia Minor, in Rome about 190, and was opposed tullian in his well known controversial tract. The new the "patripassian" as it was also called, became ned that God the Father had suffered on the cross. d fresh support in Rome about 215 from certain s of Noetus of Smyrna, who received a modified t from Bishop Callistus. It was on the account ppolytus, the champion of hypostasian subordinatian ong with his adherents, withdrew from the obedience stus, and formed a separate community. A new and atory phase of patripassianism was expounded at a hat later date by Beryllus of Bostra, who, while holding divinity of Christ not to be *ouse*, or proper to Himself *πατρικὴ* (belonging to the Father), yet recognized personality a new *πρόσωπον* or form of manifestation part of God. Beryllus, however, was convinced of ongness of this view by Origen (*q.v.*), and recanted synod which had been called together in 244 to it. For the subsequent history of modalistic monism, see Sabellius.

NASTICISM. See Monachism.

NASTIR, Bitolia, or Toli Monastir, a city of ria, now the chief town of the Turkish vilayet of ia, is situated at a height of 1880 feet above the a western inlet of the beautiful, fertile, and many l plain which, with a breadth of about 10 miles s for 10 miles eastward from Mount Perister feet high) to the Babuna chain. It is embosomed masses of foliage, and crossed by a rough channelled am stream, the Drahor, which joins the Czerna or , a tributary of the Vardar. The military advanf its position at the meeting place of roads from a, Durazzo, Uskiub, and Adrianople led the Turks 1820 to make Monastir the headquarters of the lian *corps d'armée*. Since then its general and eral importance has greatly increased. A considermount of gold and silver work (especially clasps and) is made by the local craftsmen. The population at 40,000.

stir, so called from the monastery of Bukova (The Beeches), ndred feet up the slope of Peristeri, is identified with the ancient Heraclea Lyncestis on the Egnatian Way; and its b is still called the bishopric of Pelagonia from the ancient the plain. In 1833 the town was the scene of the massacre Albanian beys.

MONBODDO, James Burnett, Lord (1714 author of work on the *Origin and Progress of La* (published in 1773), and *Ancient Metaphysics* (1779 one of the most marked characters in Scottish l cycles in the 18th century. He was born in 17 Monboddo in Kincardineshire, studied at Aberdee Groningen, and quickly took a leading position Edinburgh bar, being made one of the Lords of S in 1767. Many of his eccentricities, both of conduct opinion, appear less eccentric to the present gene than they did to his contemporaries, though he se have heightened the impression of them by his hum sallies in their defence. He may have had other r than the practice of the ancients for dining late an forming his post prandial walk in head of m a e His views about the origin of society and language a faculties by which man is distinguished from the afforded endless matter for jest to the wits of hi but readers of this generation are more likely to b puzzled by the frequent characteristic touches of ge acuteness of his conclusions than amused by his s city. These conclusions have many curious points of fact with Darwinism and Neo Kantism. He re kidnapping man as one of the animals, and of collecting about cases of tribes to throw light on the problem civilization having come into contact with the one intimate knowledge of Greek philosophy with the In both respects Monboddo was far in advance neighbours. His happy turn of [illegible] might be adopted as a motto by the Evolutionist Neo Kantian would meet head to head to be told that he put by circumstances of birth at 1773. His [illegible] ated from the writings from the Platonic and poetical t honourable among writers of his own class on subjects as he handled confirmed the view of his temperament that he was one, and to a great extent supremely ated and precocious. He died 26th May the advanced age of eighty six.

MONCTON, a town of the Dominion of Canada Westmorland, New Brunswick, 89 miles by rail east of St John; a port at the head of navigation Petitcodiac, and the point of the west loop and g offices of the Intercolonial Railway. The popul about 1900 in 1871, was 4032 in 1881, the grow the place has been favoured by the establishment of refining factories, a cotton factory for cotton and bra water since the Canadian Parliament in 1879 adop policy of protection. For the year 1881–82 the a amounted to £61,814 and the import to £252,571.

MONDOÑEDO, an episcopal city of Spain, 27 north northwest from Lugo, in the province of that , at about 1200 the Sixto, a small tributary of the N on the Atlantic side of the Cantabrian chain, reach to an elevation of 1800 feet by considerable hill population in 1878 was 10,112. The principal bu are the ruined Late Corinthian fragments of the cathedral, a convent of Franciscan friars of Ma which is now used for a theatre and a palace, ches the royal hospital. The manufactures, which are unimp include lace making, linen weaving, and leather fac ture.

According to local tradition the bishopric of Dumium Braga, was transferred to San Martin de Mondoñedo (three from Mondoñedo) in the 8th century, at which time it w ed by Dona Urraca in the beginning of the 12th centu about sixty years prior to 1233 the see was at Lugo. After

r nearly a century and a half in the hands of the Moors, nedo was recaptured by Ordoño I. in 858; and the Christian on was made permanent by Alphonso III. in 870. It was y surprise by the French in 1809.

NDOVI, a city of Italy, in the province of Cuneo, les east of Cuneo and about 55 west of Genoa by as formerly the chief town of the Sardinian province ndovi, and between 1560 and 1719 the seat of a onte s university. The central quarter occupies the t of a hill 1670 feet high, and contains the hexa pace s, a citadel erected in 1573 by Emanuel Phili he cathedral of St Donatus, a spacious episcopal and the statue of Beccaria, who was a native of n. At the foot of the hill along the banks of the Ellero (a tributary of the Po) lie the industr commercial suburbs of Breo, Borgatto, Pian della and Carassone, with their potteries, tanneries, works, &c. The mansion of Count San Quintino della Valle was the seat of the printing-press whic 1472 issued books with the imprint Mons Regalis; modern times the Ducal press founded by Emanue bert has acquired a great reputation. The popula the town was 9637 in 1871, with the suburbs that of the commune 17,726 in 1861, and 17,902 in

Breo is identified with a certain Colonia Brebolensis; b dovi proper — Mons Vici, Mons Regalis (Monteregale, or Vic probably did not take its rise till about 1000 A.D. The l dates from 138[illegible]

MONEY

Definition and Functions of Money. The precise on of Money is a question presenting no small ty, and it has been complicated by the attempts of riters to define the term so as to lend support to favourite theories. The real difficulties of the subject wever, chiefly connected with paper money, and as le of the question has been dealt with in the article (*q.v.*) it will here be sufficient to adopt the short ehd description of money given by a distinguished an economist as being "that which passes freely and to hand throughout the community in final dis of debt, and full payment for commodities, being d equally without reference to the character or credit per on who offers it and without the intention of the who receives it to consume it or enjoy it or apply it other use than in turn to tender it to other pu di of debt or payment for commodities."[1] In this the essential features of money are plainly set forth, as is frequently the case in economics, particular and to bring within the description may be found functions which money discharges in the several m are (at least in the opinion of all writers worth g here) clearly marked. The most important is facilitating exchange. It is not necessary to dwell great importance of this office. The more consider d industrial organization how that it is based on ision of employment. But the earliest economic saw clearly that division of employment was possible only by the use of a medium of exchange. law that the result of metering out [illegible] to bring about a state of things in which each al produced little or nothing directly adapted to his own want, and that each one was to live by ing his product for those of others. They saw, er, that this was not feasible without some object all would be willing to accept for their peculiar pro or otherwise the difficulty of getting those together who [illegible] would be a complete hindrance to exchange, which alone made division [illegible] possible. A second function hardly inferior in ance to the one just mentioned is that of affording measure or means of estimating the comparative value of dif commodities. Without one common commodity as and of comparison this would be almost impossible. rather than carry it and wanted to buy bread or a t would be very troublesome to ascertain how much e ought to obtain for a coat or how many coats he should give for a horse,"[2] and as the number o modities to be dealt with increased the problem wo come harder, "for each commodity would have to be in terms of every other commodity." Indeed it reasonably maintained that the idea of general valu not be formed without the existence of money, and s known of savage races tends to bear out this view. adoption of some one commodity renders the com of value easy. "The chosen commodity becomes a *denominator* or *common measure of value* in terms of we estimate the values of all other goods,"[3] and thus which its primary function renders exchanges pos acts as an intermediate term in each exchange, also exchanges easier by making them definite. Anothe tion of money comes into being with the progress of One of the most distinctive features of advancing tion is the increasing tendency of people to trus other. Thus there is a continual increase in relat contract, as may be seen by examining the develop any legal system. Now a contract implies someth be done in the future, and for estimating the value future act a standard is required; and here money already acts as a *medium of exchange* and as a *measure* at a given time, performs a third function, by affordi approximate means of estimating the present value future act, and in this respect may be regarded as a *st of value*, or, if the phrase be preferred, *of deferred pay* Some writers attribute a fourth function to money, much as they regard it as being a means of easily up value. Doubtless it does supply this need, wh especially pressing one in early civilizations owing to scarcity which then exists, but with the prog settled government the need becomes less extreme. forms of investment grow up, and the habit of h money become unusual. It is therefore better to the functions of money as being only three in numb to furnish (1) the common medium by which exc rendered possible, (2) the common measure by the comparative values of those exchanges are est and (3) the standard by which future obligatio determined.

2. *Causes which Determine the Value of Money. Q of Money needed by a Nation.* The problem of the minute causes of the value of money is a particular the general problem of values, but there are circum which render the inquiry more than usually comp Before considering these it will be well to deal wit of the phrase "value of money" which has led to mu

[1] F. A. Walker, *Money, Trade, and Industry*, p. 4. For further information as to the terms here relative to the proper of "Money," the reader may consult J. S. Mill, *Prin. of Pol* bk. iii. ch. 12, § 7; Jevons, *Money*, pp. 21[illegible] *sq.*; E. de *Marche Monetaire*, pp. 2[illegible]; and especially Mr H. s article "What is Money?" in the *Fortnightly Review* 79), also his *Principles of Political Economy*, pp. 231 *sq.*

Mill, *Prin.*, B. iii. ch. 7, § 1.

[4] W. Bagehot, *Economic Studies*, pp. 42 43. [5] Jevons, *Mo*

[6] For an ingenious argument against the use of the terms "m and "standard" of value, see F. A. Walker, *Money*, pp. 4 *sq.* *Money, Trade, and Industry*, pp. 27 *sq.*, 60 *sq.* The shorte uniformly used here for his larger treatise.

. In mercantile phraseology the value of money
the interest charged for the use of loanable capital.
when the market rate of interest is high money is
be dear, when it is low money is regarded as cheap.
ever may be the force of the reasons in favour of this
is only mentioned here for the purpose of excluding
For our present subject, "the value of a thing is what
exchange for: the value of money is what money
xchange for, or its purchasing power. If prices are
money will buy much of other things, and is of high
; if prices are high, it will buy little of other things,
of low value. The value of money is inversely as
l prices, falling as they rise and rising as they fall.[1]
n the general theory of value it appears that the
mate condition which determines it is the equation
en supply and demand; and this is clearly the case
eference to money. These terms, supply and demand,
however, some elucidation. Let us consider what is
by the supply of, and demand for, money. The
of a commodity means the quantity of it which is
l for sale. But in what shape does the offer of money
place? By being offered for goods. "The supply of
, then, is the quantity of it which people are willing
out;" or, to put the point more concisely, it is "the
oney *in circulation* at the time." Again, to select
f demand, "the demand for a commodity is the power
g power offered for it." Demand in the general case
ney consists of all the goods offered for sale. There
wever, a peculiar feature in the case of money which
from its position as the medium of exchange, viz.
money is, so to say, in a "constant state of supply
emand," since its principal service is to
s of purchasing commodities.[2] From this follow
he factors which determine the value of money within
n time are: (1) the amount of money in circulation
2) the amount of goods to be sold. On closer examination
it will, however, appear that there are other elements
taken into account. In the first place, the quantity
oney is not by itself the sole element on the supply
In some instances a coin will not circulate more
two or three times in a year, while another coin may
hundreds of purchases. In determining the value of
y these varying rates of circulation have to be combined, and by taking an average we may establish the
nce of a fresh element to be estimated, namely, the
ge rapidity with which money does its work, or, to
Mill's expression, "the efficiency of money." On
le of demand, again, it is not the quantity of commodities
that is the determining element, but the amount of
and the same article may, and generally does pass
gh several hands before it reaches the consumer;
this it follows that (if the consideration of credit in
rious forms be omitted) the value of money is inversely
quantity multiplied by its efficiency, the amount of
nsactions being assumed to be constant. This formula
res, however, some further explanation before it can
cepted as a full expression of the truth on the subject.
st be noticed that it is not commodities only that are
nged for money. Services of all kinds constitute a
portion of the demand, while the payment of interest
e various forms of obligation requires a large amount of
circulating medium. The potent influence of credit
must be dwelt on. This latter force is the main element
considered in dealing with variations of prices, but

so far as it is based on a deposit of metallic money
be looked on as a means of increasing the effici
money, and therefore as coming within the formula
above. In its other aspects it lies outside the r
this article. Some interesting conclusions may be d
from the results we have arrived at. One of these
the "increased development of trade," or "expan
commerce, *of itself* tends to lower not to raise
for, by increasing the work which money has to d
the amount remains the same it lowers its value.[3] A
consequence is that a large addition may be made
money in a country without any effect being produ
prices. This is evident, since money only acts on
by being brought into circulation, therefore, if the
which is added to the national stock is not used
way, prices will remain unaffected.

We have now sufficiently considered the proximate
ditions which determine the value of money, the ne
y to inquire. What is the ultimate
The value of freely produ
In ordinary theory
cost of production,
ifferent cost, by the
portion. We have
up
principal
and are produced
the part produced
value. The
condition
that there are
duction, and
Moreover,
"The latent
of their
of production
place in the
ideration is
reflection."[4]

where the article is produ
for production of the mo
to consider how far the
of money. Gold and sil
money are the products of
therefore the
of cost ought to determine
however true only under
competition is perfectly fr
at, for competition, the cost
is true only "in the long
ate conception to effecting
Mill
which the

[1] This view which seems to meet
Adam Smith, *Wealth of Nations*,
J. Carnes, *Essays on Political Economy*,
[2] *Pure*, B. iii. ch. 8, § 2.
[3] *Wealth of Nations*, p. 78 (ed. M'Culloch).

[1] For a clear statement of this, see J. E. Carnes, *Leading Principles*, ch. 2.
[2] The leading exception to this is in the case of money which is hoarded for an indefinite period, and is therefore withdrawn from circulation.

the speculative nature of the industries connected
e production of money renders the cost of produc-
delement very hard to ascertain. Another considera
ich gives a peculiar feature to the problem of money
- that in the case of other commodities a change in
production affects value without any actual change
supply. The knowledge that a commodity can be
d at a lower cost will cause a reduction in its value,
not true of money. Either the quantity or the
y of money must be altered to change its value.
course, are affected at points in the circulating
When all these circumstances are taken into
become clear that the most correct way to
the question of money value is that which looks on
and demand, as interpreted above, as the resul
value for a limited time, while regarding cost
tion as a force exerting an influence of more
ent duration during long periods. Where
e of a state is arbitrarily limited, the value of
ey plainly depends on supply and demand as we
expected it.
f the questions which arise is: What quantity of
mechanism is necessary for the proper working of the
al organism? To this, no precise answer can be given.
ver, even in the case of precious metals, the quantity
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mechanism is necessary for the proper working of the
al organism? To this, no precise answer can be given.
ver, even in the case of precious metals, the quantity
n W. Petty was of opinion that the amount of coin
be in a country was one tenth the rent of land, one
the amount of circulating rent, and one fifty-second
the annual wages of labour. Locke's view was that
th of consumers' goods annually purchased, was
sufficient. Modern statistics, however much
command of more exact data, decline to
a quantitative answer, and content themselves
ating the conditions which the problem involves.
we must take account of the work which money has
rm, and the speed at which it circulates. The
the same piece of money changes hands twice as
people will want twice as much money. The second
mount of trade transacted, the amount of bar-
ney doubled, the amount of money must be also
, unless at the same time the improvement in credit
ibuted. The efficiency of money is a third element
affect the quantity needed, and this is also
nt on the habits of the people and the facilities of
action. Other elements which can be only briefly
d are the degree in which credit exists between
ons, the amount of travelling which takes place
ercial outbreak, organization which exists
ets for which capital is to be estimated, the extent
ce of hoarding, &c., for all money hoarded
s withdrawn from circulation, and therefore increases the
ney needed. The habit of using in the retail
of large amounts only exemplifies this element in
. Again, the existence of barter does away
money would be required to
the exchanges effected by barter. The custom
ng with credit has a similar effect. The above
not have been considered the questions [illegible]. When we
plate the [illegible] from an international point of
he amount needed [illegible] allowance is made for the
ransportable [illegible] namely that which will keep
ry's prices at a [illegible] with those of the countries
hich it has commercial relations.[1] For otherwise
istry would have [illegible] either of importation or
ortation, which would [illegible] a flow of money to
ntry whose prices were lower than the general level.

Thus, then, is the condition which determines compa
prices between different countries; and, prices be
determined, the quantity of money needed to keep up
prices depends on the conditions above indicated.
case of England reliable statistics tend to show tha
gold in circulation was, in 1872, about £105,000,00
the note circulation £13,000,000. In any Contin
country the amount would probably be proportionally
greater, owing to the fact that there is in England a g
development of credit.

3. *Early Forms of Currency.* Up to the present w
considered money as being fully established and pr
adapted to fulfil its various functions. We have n
trace the steps by which a suitable system of currenc
evolved from a state of barter. It is important for a
understanding of the question to grasp the fact th
changes took place originally between groups, an
between individuals. This explains the slow grow
exchanges. Each group produced most of the a
necessary for itself, and such acts of barter as took
were rather reciprocal presents than mercantile exch
Such is actually the case at present among modern sa
"It is instructive to see trade in its lowest form a
such tribes as the Australians. The tough green
valuable for making hatchets, is carried hundreds of
by natives, who receive from other tribes in retu
prized products of their districts, such as red ochre fo
their bodies with. They have even got so far as
peaceful trade-parties, unharmed through tribes at w
that train of youths might be met, each laden with a
and one on his head to be carried to his distant
and hoped into a good customer. When strangers
tribes they are received at a friendly gathering o
ribbons, and presents are given on both sides. No
there is a general sense that the gifts are to b
exchanged, and if either side is not satisfied there w
grumbling and quarrelling, but in the roughest k
barter we do not yet find that clear notion of a u
value which is the great step in trading." This
description of what is going on at present among
race enables us to realize the way in which money
into existence. When any commodity becomes an
of desire, not merely from its use to the persons desir
but from their wanting it as being readily exchan
for other things, then that article may be regarded a
monetary money. Thus the greenstone and ochre
their way to being promoted to the position of cu
and the idea of a "unit of value" is all that is nec
complete the invention. "This higher stage is found
the Indians of British Columbia, whose strings of h
shell worn as ornamental borders to their dresses
the most obvious currency to trade with, "a string of or
quality being reckoned as worth one beaver's skin."[2]
shells, therefore, are in reality money, inasmuch as
discharge its functions.

On a review of existing savage tribes and ancient races
our investigation we are surprised at the great variety of
which have been used to supply the need of a circulating m
Shells, for instance, seem to be one of the earliest forms of
They are to be found at present among the Indians of Alask
Solomon Islands, while accounts of leather money seem t
that their use was formerly more general. As the huntin
gave place to the pastoral, and animals became domesticat
animal itself, instead of its skin, becomes the principal form
money. There is a great mass of evidence to show that, in t
different regions and at very different times, cattle formed a c
for pastoral and early agricultural nations. Alike among
barbarous tribes and in the survivals discovered among c
nations sheep and oxen both appear as units of value. T
find that at Rome, and through the Italian tribes generally,
and sheep formed the oldest medium of exchange, ten shee

[1] F. A. Walker, *Money*, p. 57. [2] E. B. Tylor, *Anthropology*, pp. 281-282.
[3] Tylor, *loc. cit.* [4] Whymper, *Alaska*, p. 285.

l equivalent to one ox. The recognition of these objects as
l legal representative of value, or, in other words, as money,
traced back to the epoch of a purely pastoral economy. A
landic law bears witness to a similar state of things; while
ous fines in the different Teutonic codes are estimated in
The Latin word *pecunia* (*pecus*) is an evidence of the earliest
money being composed of cattle. The English *fee* and the
term *feudal*, according to its most probable etymology, are
from the same root. In a well-known passage of the *Iliad*
ne of two different sets of armour is estimated in terms of
The Irish law tracts bear evidence as to the use of cattle as
he measure of value in early Irish civilization. Within
few years it has been prominently brought before the public
n form the principal wealth and the circulating medium
the Zulu and Kaffirs. On the testimony of an eye-witness
ssured that, "as cattle constitute the sole wealth of the
so they are then only medium of such transactions as involve
e, payment, or reward."[4] We find that cattle were in
the pastoral Indian tribes to the United States Government
he prominence of slavery in early society led to
that slave would be adopted as the measure of exchange and
he measures of value in the Irish law tracts
ordinarily measured a female slave. They were at present employed
purpose in Central Africa and also in New Guinea; and
to the agricultural stage a greater number of objects
pable of being applied to currency purposes. Among these
e used even at present in Norway, where dried cod-fish
nd tea. The most remarkable instance of such a currency
being used as currency is to be found in the
we adopted as legal tender by the English Government in Nova
a. Another class of articles used for money consists of
nt, which among all uncivilized tribes is a highly prized
equa doll mentioned before as a token of betrothal
whales' teeth among the Fijians, and by other tribes among the
South Sea Island tribes, and finally any article of food which
can be easily worked. Manufactured articles of the same
ne under the preceding head form a more civilized form. Thus
s used in Abyssinia and Mexico, while the metallic sphere,
which will require a more careful examination, has in
n finally driven all of them into a secondary competition, and
nd have become the sole substance for money proper.

Metallic Forms of Money. Their Superseding other Substances. Special Advantage of Silver as Money.—The use of metals as a form of money can be traced far back in the history of civilization, but, as it is not possible to obtain the historical order of their respective adoption for this purpose, we will take them in the order of their importance, beginning with the lowest. Iron, judging from the statement of Aristotle, was extensively employed as currency in a remarkable instance of this which at once occurs to the mind is the Spartan money, which is clearly a survival of an older system that had died out among the other Greeks. Though by modern writers it has been attributed to a deliberate

In conjunction with copper, iron formed an early
se currency, and till recently it was a subsidiary
e in Japan. Iron spikes are used in Central Africa.
Adam Smith notices the use of nails for money in
nd.[6] Lead has also served as money, as it does at
t in Burmah. Copper has been more widely employed
either of the previously mentioned metals. Its use
as a parallel standard with iron has just been men
. The early Hebrew coins were chiefly composed of
ile down to 269 B.C. the sole Roman coinage was
y of copper. Till a very recent period it formed the
gal money of some poorer European states (as Sweden),
as the subsidiary coinage of the United Kingdom till
esent bronze fractional currency was introduced. In
ot so favourable a material for money as copper, but
rly English coinages were composed of it, probably on
t of the fertile tin mines of Cornwall, and in later
halfpence and farthings of tin have been struck. The

next metal which comes into notice is silver, which
the last few years was the principal form of money
even still is able to dispute the field with its most formi
rival. It formed the main basis of Greek coins, an
introduced at Rome in 269 B.C. The mediæval mone
principally composed of silver, and its position in
times will have to be subsequently noticed more at le
Gold, which is the most valuable of the metals widely
for monetary purposes, has been steadily gaining g
with the growth of commerce. The earliest trace of
in common with that of silver is to be found "in the pr
of the ancient Egyptians weighing rude checkers of
of gold and silver."[7] The only other metals used for
platinum and nickel may be briefly disposed of.
former of these was coined for a short time by the R
Government and then given up as unsuitable. The
is only used as an alloy.

The examination of the form of currency, both m
and non-metallic, in which we have been enabled
certain definite conclusions as to the conditions which
evolution of currency proceeds. It appears (1) that
metal tend to supersede all other forms of money
progressive people, and (2) that certain metals to
supersede the others. From this we are led to consi
qualities which are demanded in the precious metal more
to conclude that the presence or absence of these qu
is the reason of the adoption or rejection of any
such purpose.

(1) In the first place, it is necessary that the mate
money should be divisible, or, in other words, port
and to this condition all the commodities we have re
conform, for otherwise they would never have attain
position of being a medium of exchange. This q
then is not the reason for the preference of one form
others. (2) The second necessity is that the
of the article shall be in some proportion to its we
both as to put the one with another we may
that it shall be portable. Want of this quality has
fatal obstacle to many early forms of money, notwithstan
place. Skins, furs, and tobacco were found very d
to transfer from place to place. Iron and co
suffer from the one defect which disqualified exce
moreover these articles were perishable. (3)
further demanded that the material of money shall
same throughout, or that one unit shall be equal in
to another. This is a second reason for the wide
currency enjoyed by coin, as the difference between
and another head is of course often considerable
metals possessing a uniform character in the re
often become rare if they are directly employed
(4) A fourth reason is that the substance should
convenient size, developed and moulded, united
heated, to the desired form, peculiarly possessed
metals as they are rarely tarnished, while alloy or p
tion often greatly diminishes by detection, and it must
be added that the amount is connected with regard to a
(5) Money must also be durable. This at once r
from the list of metals for money all rarer ones
very deficiency. Iron, copper, or bronze would
speedily worn away. Iron, too, is liable
such substances as have a base value, i.e. are not
to currency. (6) Money should be easily divisible
and there should be no trouble in ascertaining it
The condition is one of the reasons why precious
have never been much used as money, there are
to estimate. The same objection applies to mo
metallic currencies, and is only obviated even in th
by the process of assaying. (7) The last condition

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ommsen, *Hist. of Rome* (Eng. trans.), i. p. 203.
e episode between Diomede and Glaucus in the 6th book
aine, *Early History of Institutions*, Lect. vi.; *Brehon Laws*
(ed. by Drs Hancock and Richey).
y H. Dickmore, quoted by Maine, *op. cit.*, p. 113.
A. Walker, *Money, Trade, and Industry*, p. 22.
ealth of Nations, p. 11.

Tylor, p. 283.

s desirable for the money material is, that its value steady. This, however, is of but slight importance societies, and it is only as deferred payments become ant feature of industrial life that this requisite is ected. It is enough for the other purposes of money shall not vary within short periods, which is found feature of metals, and especially of silver and gold, ose especially varies widely in value from season to From the foregoing examination of the requisites le in the material of money it is easy to deduce the l law, which the history of money discloses, since compared with non-metallic substances, evidently those requisite in a great degree. They are all , homogeneous, divisible, and recognizable, and in of these superior advantages they are the only es now used for money by advanced nations. Not case different when the election has to be made the different metals. Iron has been rejected of its low value and its liability to rust, lead from ense, tin from its tendency to break, nickel, as well as copper also, are ineligible ir low value, which hinders their speedy transmission adjust inequalities of local prices.

limination of these metals leaves silver and gold as suitable material for forming the principal currency. years there has been a movement toward the n of the latter as the sole monetary standard, silver egarded as suitable only for a subsidiary coinage. this question, which is reserved for subsequent on, may be regarded as the principal matter of ssy in connection with metallic currency. The special of gold and silver which render them the most material for currency may here be noted. The t the metal changes only by low degrees; they ily divisible into any number of parts which may ited by means of fusion without loss, they do egrate by being kept; their form and compact make them difficult to counterfeit; their cost of pro especially of gold, is considerable that they great value in small bulk and can of course be ted with comparative facility and thereby). The power common to both these metals of all these needful in money more fully and forcibly Contrast which for example that gold and silver alone small volume of equal exactness, ease of transport without loss, easily marked by natural and brilliant, able almost to eternity. The view has been to an extreme form in the proposition of Turgot, y became universal money by the nature and force , and pendently of all convention and law, from he declaration has been drawn that to prescribe silver evolution of the nature of things.

Origin, Function, and the Principal Questions The development of monetary system) can be traced down to the establishment of metallic in the early stages of their existence, by weight. The Hebrew records bear witness to the Greek writers. Aristotle, for example, the circumstances which led to the of exchange, proceeds to point out that it was and determined in value by men putting a stamp , in order that they might save them from the trouble thing it.[4] There are two distinct stages in the introduction of coining. In the first, only the quality fineness of the metal is denoted by the stamp, no being made to fix the weight. In other words, the acts as a kind of *hall mark*. The Chinese cubes may have been the earliest money. Herodotus attributes the first use of coined gold and silver to the Lydians; in another passage he mentions that the first Greek was at Ægina, by Pheidon of Argos.[6] The second was to certify the weight as well as the fineness of metal, thus completing the invention. The necessity preventing any interference with the coin after it has been stamped led to the adoption of a regular form, and, while hexagonal or octagonal coins are to be found, the normal shape of a coin is that of a flat circle, each side of which stamped, as well as in many cases the edge. By this contrivance all persons into whose hands the coin came guaranteed as to quality and quantity, and we may probably infer that the great improvement in coinage which the Grecian colonies was the effect, and also in some measure the cause, of the expansion of their commerce in the century B.C. From Greece the art of coining spread, Italy being introduced by the Greek colonists in Italy. Since then coinage as an art has always existed in the more advanced societies. The progress of invention, however, does not end with the introduction of the art of coining, since a number of practical questions arise in reference to the best system to be adopted, which in a more protracted period present great difficulties to those who are called upon to solve them. One of these, before the public, is What is the best shape for coins? The answer has usually been in favour of the circular, but square and other pieces are also to be found.[7] Closely allied with this is the question of the most suitable limits of size. The inferior limit is plainly fixed by the convenience of those using the coin. They ought not to be so small that they can be easily lost, or can with difficulty be taken up. In cases of violations of this principle occur in the case of the English threepenny piece and the American one dollar gold piece. The superior limit is a more difficult point. Its determination turns partly on the difficulty of forming large pieces, and partly on the facilities which large coins afford. The American gold double-eagle gives proper treatment. It is an easy process to drill a hole which can be concealed by hammering, while in some the coin has been sawn in two, and the interior removed the outside surfaces being soldered together; platinum is put in the midst to maintain the weight. A general rule it may be laid down that no gold coin larger than the English sovereign, or silver one at all than the half-crown, should be issued. Another consideration to be borne in mind when determining the size of coins is the relative amount of wear which takes place. Experience proves that large coins are less than small ones.[8] According to experiments made at the mint in 1853, the loss per cent. per annum on half-crowns is about 3s. 6d., on shillings, 4s., and on sixpences, 7s. This result has been confirmed by other inquiries. It thus follows that the larger coins are less expensive in their use. Limited by the fear of their being taken which. Again, the character of the stamp to be im

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[4] *Pol.* (edition of Bekker), Morgan, vol. xv. p. 117.

[5] Jevons in the *Contemporary Review*, January 1881. See also Walpool, *Circulation*, Book of the Land reprint, p. 10. Barnes, *Legal Measures of Value*, p. 131, note, and for criticism of the statement in Blackstone, see F. de Laveleye, *Revue*, July 1881.

[6] i. 94, 8. The whole passage is worthy of quotation, as showing how clearly Aristotle conceived the primary function of *ἐπεὶ δὲ πρὸς τὰς ἀλλαγὰς γιγνομένου τινὸς ἀνάγκη τοιούτου τι ἀνεύρηντο πρ σεως ὄντος καὶ λαμβάνειν. ὃ τὰν χρησίμων αὐτὸ ὂν χρεῖον εἰς τὰς χρήσεις πρὸς τὸ ζῆν, οἷον σίδηρος καὶ ἄργυρος, τοιοῦτον ὅρισται τὸ μὲν πρῶτον ἁπλῶς ὁρισθὲν μεγέθει καὶ σταθμῷ τὸ τελευταῖον καὶ χαράκτηρά ἐπιβαλλόντων, ἵνα ἀπολύσῃ τῆς μέτρησις αὐτούς.*

[7] Herodotus, i. 94.

[8] *Ib.* vi. 127. See also for a discussion of Pheidon's Grote, *Hist. of Greece*, ii. pp. 319 *sq.* (Cabinet ed.).

[7] An instance of the latter is the *itzibu* of the Japanese which is an oblong flat piece of silver.

[8] Jevons, *Money*, p. 155.

natter requiring much care. The objects aimed at posing the stamp are (1) to prevent the coin being rfeited, and (2) to prevent any of the metal being ted. The former of these objects can be best at by making the device such as can be obtained only verful and expensive machinery. The most improved ds must be adopted, and the greatest pain taken t the device perfectly executed. The latest improve in the process of coining is the introduction of the oint press. The latter difficulty is best obviated by special care in marking the edges of the coin. Ancient were issued with unstamped edges which presented pediment to clipping, but modern coins at least those size, are protected by the edge being milled or by a being inscribed round it. The combination of milled with a raised legend would be a still more effectual of protecting the coinage from interference.

other matter of importance in the process of coinage nature and proportion of alloy to be used. The ity for some mixture arises from the fact that gold lver are both naturally soft, and, to obviate the, cop s been mixed with them, so as to produce a harder nce. The Austrian ducat is the nearest approach to among the principal coins of Europe, being com of seventy one parts of pure gold to one of alloy. English gold coins are eleven twelfths pure gold, while lver ones are thirty-seven fortieths pure silver. The of the difference is purely historical. The general proportion is nine tenths gold to one tenth alloy, while e coinages the proportion of silver to alloy is nearly o one, the countries composing the Latin Union g adopted that proportion in order to reduce their r silver coins to tokens. Copper is the usual material oying, but the Melbourne mint used silver for some It is this silvery alloy that accounts for the yellow rance of many Australian sovereigns. These, however, pidly disappearing, as it is profitable to melt them.

It has been mentioned above that the wear of coins is greater than that of large ones, and it e added here that the wear of coins in general is an tant question in connexion with their legal circula- The English sovereign is believed to remain above ast current weight for from fifteen to twenty years. e technical processes of coining, &c., reference may be to the article MINT.

next topic to be considered is, Who should issue y? In the earlier stages of currency the question ot so prominent, but the establishment of comme ht it forward. In Greece each city being autono claimed and exercised the right of freely coining as d, the coins being, of course, received in other cities t their real value. The consequences of this system generally beneficial. The Greek coins were usually their nominal value, as debased coinage was unable culate beyond the place of issue, and therefore ex ly inconvenient to the members of the state issuing Under the Roman republic private persons were bly allowed to bring metal to be coined, though the seem generally to have had the name of one of the ls for the year on them. Under the empire the ne became established that the right of coining be l exclusively to the emperor, and till the fall of the ern empire this was acted on. After the establish of the various barbarian kingdoms, each sovereign ed the privilege of coining, a right which in France xtended to or rather usurped by the principal nobles.[2] gland the king alone coined silver.[3] At present the control of the operations of the mint is completely hands of the executive; and, until recently, no ques theoretical grounds as to the propriety of this meth ever been raised.[1]

In close connexion with the right of coinage the consideration as to the proper persons to be expense of the process. At first sight the answer plain enough. Coins are a manufactured article as much as plate, and are rendered more valua being assayed, weighed, and certified. It appears fore quite proper that those who bring metal coined should bear the expense of the coinage, other words, should give up a part of the metal mint, this payment for the service rendered to them same manner as those ordinary letters pay the post partment for their transmission. This course ha nally adopted. England, however, has taken a d line. In order to encourage the coinage of the p metals, no charge was made at the mint beyond t volved in the necessary delay in the operations, and at present the coin with gold. Though this arran was originally introduced in obedience to the princ the mercantile system which regarded gold and s being peculiarly wealth, it may be defended on re ground for it is the expense of the mint is very compared with the amount of coin turned out, and coin produced received by the nation, so that the re expense may quite fairly be defrayed from the r revenue. Again, as the profit on the silver coinage to circumstances to be subsequently discussed i that may be set off against the free coinage of gold charge levied on coinage confined to the expe curred, is called *seigniorage*, but is anything above th it is known as *seigniorage*, which latter term is al to denote both kinds of charge. The effect of sei ture the term must be extended so as to cover th of coins is to lower their, in fact as Locke has seigniorage is always a kind of depreciation, unle paired with limitation. If the true quantity of m in circulation there will be a greater number of coi therefore nominal price will be higher. It is, h possible that the increased prices may check the tion of the precious metal, thus making the value metal higher than it would otherwise be. Whet will happen or not depends on the actual condit production, and is incapable of being predicted. advantage which undoubtedly results from a ch coinage is that it check the tendency to melt coi exported, for where a seigniorage is imposed co more valuable than the uncoined metal by the am the seigniorage. It therefore becomes the interest holder not to melt down the coin, as in doing so the extra value given by the coinage. Another ta the expense of currency is the loss which arises t wear and tear which money undergoes, and the con ing pieces. The l largest item is the interest the total amount of m

To take the case of England the value of the c estimated at about £130,000,000. The

[illegible] Adeph [illegible] book of [illegible] No one [illegible] lo interference, however slight, to the [illegible] of sovereign. Mill, *Pol. Econ.*, Book v. ch. ii. § 2. See also Jevons, *Money and the Mechanism of Exchange*, pp. 100-102, and J. E. Cairnes, *Political Essays*, p. 264.

[1] See Lenormant, *Contemp. Rev.*, February 1879.

[2] Hallam, *Middle Ages*, i. pp. 205-206.

[3] Lord Liverpool, *Coins of the Realm*, ch. v.

Lecky, *History of England*, i. 191 *sq.* It is impossible to agree with Locke that uncoined bullion would be worse than coin when a seigniorage is charged on the latter. He ignores the fact that the value of the precious metals is partly due to their use as currency, and that the seigniorage represents a tax levied on the extra value resulting from the use of the money.

at 5 per cent would amount to £6,500,000. This ap
y heavy charges justified by the fact that it is desi
have a currency possessing, or at least based on, value
portion of a metallic currency is, however, combined
weight, a strong reason for the great developments
entative money and credit in modern times, with
nt that gold and silver are hardly ever used in large
transaction, all such payments being made by
, which are cleared off against one another. For a
unt of the modern organization of credit, see the
BANKING.

Various Methods of Debasing or Depreciating the Currency. The earliest ex
currency which presents no debasement is responsible
be true to that case those of the various Greek states
even here many details remain in obscurity. The
currency system is compara ly better known
the mediaeval currencies from the time of Charle
(800 A.D.) elaborate material are available, which
ly increase in bulk and precision as we approach
odern time. The general treatment of the history
before the Norman Conquest (q.v.) but the history
etary depreciation is important in connexion with
ory of money, as illustrating the value of sound
e knowledge.

l coinage became a late function, a continued debase
a impossible, since it was open to every one to refuse
ey offered in payment if it was not up to the proper
d. When however coinage became a function of
ment from motive for ement soon pre ented
ve (1) The cost of co bilities on the rulers,
ance, especially debased ages, led to the
of the currency coul e more profitable
m it larger with the of any deduction
the representative of a that the spen
d in the operation of co ing. (2) The necessity of
ey ment was that of ded for such a debasement
d all debts at the expense of all creditors. It was
mmon that rulers, reluctant of the ultimately common
of a rise of wages, should seek to relieve
ve without exciting the odium incurred by the levy
y taxes. A more pe ing case than the foregoing,
where most profitable course, that of a sweep
rest, where large numbers of the community are
d with debt, and a depreciation of the monetary
d seem the simplest mode of escaping from a
a situation. Whatever may be the inducements
on the perilous course of tampering with the
y, Lombard a long experience has proved fatally
ts disastrous effects. Once the practice of
kes of France during the Hundred Years' War
extremely unsettled state of the currency and the
of further reductions in the value of the coin
Lombard has given a graphic picture of the evil
Vegliaco all restrictions depreciated silver currency
the end of the 17th century. And a debasement
sheet by the representative a further element of evil
ng, namely that such device will soon be seen
d to be insufficient for the evil that result from
ncil that a law may be reasonably hoped that all evil
ve from abandoned the practice to
ntinuous of are produced by
ntinuous currency and this is
expedient adopted under the pressure of difficulties.
proper to observe that coin may be debased in
ifferent way (1), by diminishing the quantity of
of the metal of a certain standard of which any coin
given denomination is made; (2) by raising the
l value of coins of a given weight and made of a
metal of a certain standard, that is, by making them c
or legal tender at a higher rate than that at which
passed before; (3) by lowering the standard or fineness
the metal of which coins of a given weight and denom
tion are made, that is, by diminishing the quantity of
metal and proportionally increasing the quantity of all
The last of these methods is the most dangerous, since
detection of it is more difficult, as it is so much easi
discover the weight than the fineness of the metal in a
but all of them produce the same results and are ad
for the same reasons.

Early Debasements. The first debasement of coinage known
an good evidence is that of the Athenian coinage by Solon in 59
In order to overcome the severe distress of that period in Att
reduced the quantity of silver in the coins more than 25 per ce
that 138 new *drachmae* (the standard Athenian coin) were only e
but to 100 pieces of the older coinage. This proceeding was pe
mitted by the general state of things previously existing and
boosted since. It is probable that another debasement
gold coinage took place at Athens in 168 B.C. during the str
pensive war. We should doubt have been met on the
this determined. It may, however, be said that general
the time maintained the standard of money, though
be were not secure for dishonesty in this respect. The ex
ordinary coinage is no proof of a tendency to defra
as it was regulated at a certain substance, and issued at
allowance to the expense of coining. As remarked befor
comparative novelty in relation to the coinage may be
explained by the ne ent of the Greek states so that a de
coinage was unable to circulate beyond the boundaries o
foreign state. The best perception of the more advanced
banker and check takings on this subject may have also
prepared to these results.[1]

Early Depreciations. The earliest Roman coinage was
posed of an alloy of copper (*aes*), and this continued unc
ged the time of the First Punic War. Silver was introduc
ut the proportion between it and the more upper
bout 300 B.C. The upper currency was first debased during
Punic war at the most critical period of the Hannibalic
ne; the Roman had declared the silver and copper coin,
the legal value of the silver currency more than a third, and
gave coinage an above the value of the metal.[2] Soon afte
the upper money whose successive debasements are re
ably[3] came to have been reduced to the position of a
currency, so that it is not really a case of debasem
Ireland. The silver *denarius* which at first was gi
hundredth pound, had been debased to $\frac{1}{84}$th of a pound. In 9
number of plated denarii were issued at the rate of one for
genuine pieces issued. This proceeding, which was simp
the Republic was proposed by Drusus, but in 81 B.C. a pr
for calling in the plated pieces was passed, and was extr
popular. It is probable that a slight debasement took place
Sulla; and one of the Cornelian laws seems to state the co
of the theory of money.[4] The denarius was lowered under N
Claudius, while the later period of the empire is a se
continued to decline with the currency. The gold *aureus*
hundredth of a pound but at the time of Augustus it was only
which under Constantine it had come to be only $\frac{1}{72}$d. The
currence of Hellenic with Roman monetary history seems to
that a considerable number of small states, all issuing coin
were liable to meddle with the standard than the mint of a
large empire. It also proves the value of an acquaintance
monetary theory, if we can judge by contrasting the views
Greek thinkers with those of the Roman lawyers.[5] A few wo
may here be added against the danger of a careless
reliable, as expressed in ancient or even mediaeval
ideas of time. It is extremely hard to acce

[1] Lord Liverpool, *Coins of the Realm*, p. 37.
[2] Greenidge, *Roman Public Life*, part II. ch. II.
[3] *I.e.* vol. III. p. 116, note 1.
[4] For a full discussion of this point see Lenormant in *Co*
Journal, February 1879.
[5] Mommsen, *Hist. of Rome* (Eng. trans.), I. p. 458.
[6] *I.e.*, p. 173.
[7] *Dig.* XVIII. xxviii. ch. 13.
[8] Mommsen, *l.c.* pp. 113-114; Lenormant, *op. cit.*
[9] Compare, for instance, the passage previously cited from Ar
with the following:—"Quia non semper nec facile concurrebat u
ut haberet quod ego desiderarem, invicem haberem quod tu a
velle, electum est rerum usui pubblica ac perpetua aestimatio d
tatibus permutationum aequalitate quantitatis subveniret;
materia forma publica percussa usum dominumque non t
substantia praebet quam ex quantitate."—Paulus, *Dig.*, XVIII. 1

given by any ancient writer, since the varying factors necessary be estimated are so many, viz., (1) the weight of the coin, purity, (3) the value of the monetary metal at the time, value of the commodity sold in relation to other things, question whether the commodity was in its normal state as supply and demand; to all these may be added (6) the ty of determining whether the figures have not been altered the fall of the Western empire the various barbarian sove adopted silver as their principal coinage, combined with eatest diversity in the systems adopted. On the revival of pire under Charlemagne an effort was made by him to establ general system of currency based on the silver pound a and thus corresponding to the unit of weight. This system troduced into England, and thence into Scotland; but the decay of the Carlovingian empire prevented the uniformit preserved in these different countries, while the differen ments in each produced widely divergent systems, which quire separate notice.

Debasements. The first debasement undergone by the h silver coinage was in 1300, when Edward I reduced the t of metal in the coin by 1½ per cent., or, in other word shillings and 3 pence were coined out of the Tower pound of 20 shillings as previously. This was the prelude to a of changes which were carried out during the next three cen and which terminated in 1600 when the pound troy of was coined into 62 shillings—a debasement of about 7 been devised. The reduction carried out in 1601, when shillings were coined from the troy pound, was a most mutation of its value in discharging debts, for it was in and the Scots up to

The [illegible] of 12 as well as by the abolition of the pollard in 1 silver at the mint. The pound Scots from 6th Henry to 6th Edward VI. 1-43 Edward I. has been peculiarly noted Liverpool as a time of peculiar interference with the coin metal. The old proportion of 11 oz. 2 dwt. of metal to ts. of alloy, was altered to 10 oz. of metal per pound to or one half, 1 oz. of one third, and this was fixed to pure metal and 2 oz. of alloy. A tendency to reduction under Edward VI., and was carried out in the coinage of 1560, which is generally known as the pound. Various proposals to depreciate the silver coin were made since then and on different occasions, especially in 1600. The most remarkable of the minor changes for debasing the standard was that of Lowndes, which advanced in 1695 when the discussions preparatory to the re of 1696 were being carried on. Lowndes proposed to make the pound troy of standard silver more by 1/6 than 25 per cent. He was supported by Locke, who in his *Several Papers concerning Raising the Value of Money* contributed materially to the development of monetary theory, and coinage was mainly in consequence of his views in accordance with those of Newton and Montague, based on the following principle. The first English gold coin, which is clearly proved, was that of 1257, in the reign of Henry III. A small number of gold pennies were coined in the year and added to the existing silver coins. Previously to this date the use of gold for business transactions could not have been carried commerce of the country was necessarily limited. It is probable that for the few transactions of foreign trade pieces of coins issued by the Greek emperors at Constantinople, and called *byzants*, were used.[6] Another gold coin, known as the from the place where it was first coined, was struck in 1250. The regular series of English gold coins begins in 1344, when Edward III. coined, in imitation of the florin mentioned, a large number of florins at the rate of 50 to the pound. The gold coinage was, however, for a long period only part of the monetary system, and suffered a series of the last of which took place in 1717.[7] The present English system is regulated by the Coinage Act of 1870, which consolidates previous Acts on the subject. The schedule Act, which is reproduced at p. 184 of the present volume, full information as to existing coins, their weight, tolerance, &c.

Scottish Depreciations. The coinage of Scotland was departed from primitive Carlovingian system through the influence of England, for a long period remained the same as that of [illegible]. The [illegible] under which the resources of Scotland suffered during the wars with England, as well as perhaps the example of the ally France, led the Scottish sovereigns to debase their coin all proportion to the English system. This was the reason prohibition of Scots coin as currency *de facto* in England variation in coins became so great that in 1600 the of silver, which contained about three pound sterling English made into thirty-six pound Scotch, the latter being thus time much debased. After the union of the crowns no steps were taken to assimilate the two systems, which continued as before till the complete union of the two countries. At the latter date a complete recoinage on the basis of the system was carried out, that necessary, the coins of both the countries made. The most valuable form was that of the with exception by the Scotch people, and a large amount old Scottish currency was [illegible] exported.

Irish Depreciations. [illegible] coined in Ireland the English standard in [illegible]. The Irish coinage was, of course, and the [illegible] the mother country [illegible] [illegible] [illegible]

l."[7] Similar depreciations took place in the cases of the *marcello* and the Portuguese *rei*. At the present these ... subordinate where they have not been abolished, as to little practical interest.

... well to notice before concluding the question of ... tion that it is the poorer classes who especially ... a change in the coinage. The reasons of this ... plain, for from their ignorance they are less able to ... and the nature of the alteration, and, even if it were ... the absence of available resources places them at a ... disadvantage in comparison with others. Matters and ... are quick to discount, so to speak, the nominal ... if the depreciated money and prices are much more ... adjusted to the new state than wages, so that it ... confidently asserted that a debased coinage is ... by common consent to be more helpful to classes of society ... remark appears to account for the use of inconvertible ...

... Effects of the Production of the Precious ...

In considering various monetary questions it is ... to have some acquaintance with the economic ... of the production of gold and silver. The technical ... connected with the processes of preparing these ... for use are to be found in the articles Gold and ... (*q.v.*). The first point to which we will here direct ... is the field over which production extends. ... time or other these two metals have been found ... continent. Asia Minor in early times possessed ... gold, or rather amber-colour, and Ceylon also ... chiefly concerned gold mines. China and India ... produced silver to a considerable extent. Egyptian ... how that gold was commonly known in that ..., probably proceed from Nubia and Abyssinia ... opposite side of Africa too, the name of Gold ... now that the metal was there exported. Neither ... Africa, however, has been the main contributor ... (as) of money in more modern times. The ... of Carthaginian Africa were a source of supply to ... ks, and were worked as a state monopoly. At ... date the Babylonian and Assyrian empires had ... ge accumulated ... ore of gold. The Phoenician ... tions of gold from the Red Sea coasts (Ophir) are ... from Scripture.[8] The Persian kings, from the time ... levied tribute on all their provinces—in gold ... India, in silver from the ... same district, and ... part of this was stored up in the royal treasuries. ... dency of sovereigns to accumulate had all through ... history important effects on the economic structure ... At present it is quite natural to assume that the ... of money are distributed by means of international ... and tend to keep at an equal level all the world ... an assumption which is in general well grounded, ... an important exception exists. Ancient history ... a widely different set of forces in operation. Gold ... were produced by slaves under the pressure of ... were drawn toward the ruling part of the great ..., in a word, war, not commerce, was the distributing ... From this condition of affairs it is easy to see ... whatever may be the reasons for assigning to gold ... from a potent influence over the value of money in ... times (and grounds have been already advanced ... belief that this influence has been exaggerated), no ... sons then existed. The production of the precious ... metals was carried on, as the great buildings and ... works of those periods, on non-economic grounds, ... therefore produced quite different effects. The whole ... tory of the Persian monarchy to its overthrow by Alexander ... (330 B.C.) shows that the mass of the precious ... hoarded up continued constantly to increase. On the ... ture of Persepolis by the Grecian army an enormous treasure ... was found there, some estimates placing it as high as ... 120,000 talents of gold and silver (£27,600,000).[9] ... the temples, too, were receptacles for the precious metals, ... that the stock accumulated at about 300 B.C. must have ... been very great. The only causes which tended to diminish ... therefore were the losses arising from wars, when the royal ... treasuries were liable to be plundered and their contents ... persed. There was therefore a more unequal distribution of ... the material of money than at present. The growth of the ... Roman dominion led to important results, since under the ... rule the Spanish mines were developed and became a large ... source of supply. The great masses of treasure set to ... Rome, so that it became the monetary centre of the world. ... The overthrow of the Republican government and the ... peace which followed also affected the conditions of production. The inefficiency of the Roman administration ... made it advantageous to let out the mines to farmers, who ... worked them in a wasteful and improvident manner, and ... the supply of slaves was reduced, thus depriving the latter ... of their principal agency for carrying on production. The ... result was a continuous decline in the store of money. ... Jacob has made an attempt to estimate the amount at the ... death of Augustus (14 A.D.), and he arrives at the conclusion ... that it was £358,000,000.[10] Without placing much ... value on this necessarily conjectural estimate, it is safe to ... assume that this period marked the highest point of accumulation.

The succeeding centuries exhibit a steady decline, but ... it is of course impossible to attach any value to even the ... most carefully guarded numerical estimates. The problem ... upon which has since so often attracted notice—the ... of the precious metals to the East—began at this time ... and was a subject of complaint to the Roman writers, ... while the stock of gold and silver being thrown into ... more general circulation suffered more from abrasion, and ... was more likely to be lost than when stored up in the ... royal treasure houses and temples. These causes tended ... to depress the scale of prices, while the barbarian invasions ... produced a strong effect on the supply by driving off ... the mining population and damaging the various installations ... used for working the mines. The conjectural estimate is, that about 800 A.D. the total supply had been ... reduced to £33,000,000 (or about one eleventh of what ... it had been at the death of Augustus).[11] A new period ... in the history of gold and silver production may be said ... at this date. The Moors, now firmly established in ... Spain began to reopen the mines in that country which ... had been allowed to fall into disuse. Other European ... mines also were opened.[11] The international system of ... currency based on the pound of silver as a unit which was ... introduced by Charlemagne must have tended to economise ... the wear of the metals. We may therefore conclude that ... from this date (800 A.D.) the supply was sufficient to ...

[6] Liverpool, *Coins of the Realm*, p. 127.

[7] ... readers requiring to be informed on the subject of the various currency ... may consult Lenormant, *Monnaies dans l'Antiquité*, for ... nies, Lord Liverpool, *Coins of the Realm*, for England, and ... of Le Blanc and Poulton for France.

[8] Pactolus in Lydia was wholly famed for its "golden sands." ... xv. 28.

[9] Herodotus, iii. c. 96; also Grote, *Hist.*, iv. pp. 162 *sq.*

[10] Jacob, i. p. 23.

[11] It was at this time that the most productive European ... were discovered, namely, those of Saxony and the Harz Mountains, ... as well as the Austrian mines, which were the chief sources of ... during the Middle Ages.

[7] A commercial agency which existed for the distribution ... and silver was the Phoenician system of trading, which extended ... over the Mediterranean.

[8] Jacob, *Production and Consumption of the Precious Metals*, ... p. 221.

[9] See Pliny, *H. N.*, xii. c. 18.

the loss by wear and exportation,[1] and accordingly
d the metallic supply as fixed in amount until the
change in the conditions of production, which was
esult of the discovery of America. Though 1492 is
date of the first landing, yet for some time no im-
nt additions were made to the supply of money.
conquest of Mexico (1519) gave opportunities of
ing the silver mines of that country, while the first
s of Chili and Peru were almost simultaneously
vered, and in 1545 those of Potosi were laid open.
this latter date we may regard the American supply

BLE I.—*Estimated production of gold and silver from* 1493

Period.	Years.	Amount in Kilos.		Value in Mds of Trade	Relative Value of Gold to Silver
		Gold.			
1590	93	162,400	1,216,000	60	11
1544	91	171,800	2,146,000	92	11
1580	6	243,000	10,970,000	950	11
1600	90	147,600	8,378,000	905	11·9
1690	20	170,400	8,158,000	800	1 0
1640	20	166,000	5,852,000	570	11
1660	20	175,400	7,296,000	691	11
1680	20	186,200	6,540,000	618	11
1700	20	215,300	6,828,000	647	1 9
1720	20	256,400	7,112,000	85	1 2
1749	20	581,600	8,671,000	1,011	1 1
1760	20	492,200	10,563,000	1,000	11
1780	20	411,100	13,000,000	1,230	11
1800	20	355,800	17,581,000	1,676	11
1810	10	177,800	8,912,000	647	1 3
1820	10	111,100	5,108,000	534	1 3
1830	10	142,200	1,606,000	190	1
1840	10	202,900	5,954,000		
1850	10	547,600	7,801,000		
1855		987,600	4,431,000		
1860		1,030,000	4,575,000		
1865		925,600	5,506,000		
1870		959,500	6,000		
1875		853,400	1,000	040	
76		171,700			
77		182,800			
78		187,700			
79	1	156,900			
1879		695,100			
1850	358	4,752,100	1		
1879	29	5,451,200	40		
1879	387	10,203,300	100,		

influential factor in the matter,[2] and look upon the
of money as increasing. The annual addition to the
of money has been estimated as £2,100,000 for the
d from 1545 to 1600. At this date the Brazilian
ly began. The course of distribution of these fresh
es of the precious metals is an interesting point,
h has been studied by Mr Cliffe Leslie.[3] The flow of
new supplies was first towards Spain and Portugal, and
thence they passed to the larger commercial centres
he other European countries, the effect being that
s were raised in and about the chief towns, while the
e of money in the country districts remained unaltered.
additions to the supply of both gold and silver during
wo centuries 1600-1800 continued to be very consider-
; but, if Adam Smith's view be correct, the full effect
rices was produced by 1640,[4] and the increased amount
oney was from that time counterbalanced by the wider
nsion of trade.[5] At the commencement of this cen-
the annual production of gold has been estimated
ing from £2,500,000 to £3,000,000. The year 1809
s to mark an epoch in the production of these metal
the outbreak of the revolts of the various Spanish

acob, i p. 311.

Adam Smith assumes 1570 as the date when prices were affected
gland, *Wealth of Nations*, p. 88. Humboldt estimated the total
uction (1492-1545) as being about £17,000,000; but see Table
hich contains Dr Soetbeer's estimates, based on the latest available

Essays in Pol. and Mor. Phil., Essay xv.

Wealth of Nations, p. 88

The total production is roughly computed at over £1,200,000,000
o two centuries 1600-1800; but see Table I. for more precise
ates.

dependencies in South America tended to check the
supply from those countries, and a marked increase
value of money was the consequence. During the
1809-1819 the value of gold and silver rose to about
and a half times their former level, notwithstanding
discoveries in Asiatic Russia.[6] The annual yield in 18
estimated at £8,000,000. The next important da
our present purpose is the year 1848, when the Cali
mines were opened, while in 18 of the Australian disco
took place. By these events an enormous mass o
was added to the world's supply. The most
estimates fix the addition during the years 1851-1
£500,000,000, or an amount nearly equal to the
stock in existence. The problems raised by this
menon have received the most careful study by s
distinguished economists,[7] to whose writings those de
more extensive information may be referred. The main feat
interest may be briefly summed up. (1) The addi
supply was almost entirely of *gold*, thus tending to p
a distinction between the two principal monetary
and an alteration in the currency of bimetallic cou
Under this influence France, from being a silver
became a gold using country. (2) The contem
poral development of the Continental railway sy
and the partial adoption of free trade, with th
expected facilities for free circulation of commodit
to the course of distribution being different from
of the 16th century. The more backward districts
metal equalizat
price combined with
ght elevation in value w
come. (3) The increased supply of gold tend
general currency to retain possible, and made the use of
monometallic standard appear tenable. The move
for currency reform, as will be seen, all arose after
discoveries. (4) The change in the value of money,
may for the period 1849-1869 be fixed at 20 per
enabled a general increase of wages to be carried on
improving the condition of the class living on
labour. It may be added that the difficulty of trac
effects of this great addition to the money stock is
triking proof of the complexity of modern ec
development. (5) The last point to be noticed is th
small influence exercised
value of silver by t
gold. Hardly had the
discoveries of 184
ceased to produce a decided
effect when new silver
of nominal fertility came into work. During the
immediately succeeding the gold discoveries the p
tion of silver remained at an annual amount o
£2,000,000 to £3,000,000. This amount sto
about 1870, increased to £4,000,000,[8] and rema
that amount for the next five years. More than
the supply came from new mines opened in N
This increased supply was accompanied by a
depreciation in the gold price of silver, though th
of commodities in countries having a silver stand
not rise. The result of the close investigations to
all aspects of the question were subjected was t
that the increased production of silver was only
sufficient to counteract the depreciation. The policy
various states of Germany and the Scand

The Report may be more important after 1873.

The following may be profitably consulted: Cliffe Leslie, *Essays in Political Economy* (Dublin, 1888); Cobden, Tooke, see Newmarch, *History of Prices*, vol. vi. pp. [illegible]; Evans, article "Precious Metals," *Encyclopaedia Britannica*, 9th ed.; J. E. Cairnes, *Essays on Political Economy* (London, 1873), pp. [illegible]; W. Stanley Jevons, *Investigations in Currency and Finance*, pp. [illegible]; W. [illegible], *Essays on Monetary Questions of the Day*.

The price of silver in London was 59d. per oz. in 1871, and 60d. per oz. in 1872, or 2½d. per oz. more than in 1873—that is, only 3 to 4 per cent.

See Report of Select Committee on the Silver Question, 1
for another estimate see Table I.

in adopting a single gold standard, (2) the
es composing the Latin Union in limiting the
of silver, (3) the Indian Government by
g a new method of drawing bills proved to be the
influential causes for the decline in the value of
compared with gold.[1]

of gold and
metals must be con-
three heads, viz. (1)
ry, (2) the export to
while at a comparable

ll hold with one conference that
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be then
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at pres
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ain of
ns remained most powerful in
ot, in other words, the
the technical features of the
may sometimes
the fact that
obtained
are of the
with the
exchange
Special Questions respecting Metallic Money

ere discussion of matters relating to currency, and
ral economists among the most advanced nations
d to the existing
per centralization of
ing that
to
ith those of the
ystem of any
exciting of a
The principal pu
ne questions with regard
netary systems. Each country
lightenment has directed it
n to its own monetary arrangements, and compared
hile the effect which the cur
ver on its neighbours leads
t monetary legisla
may be summed up under

for details, the Report
chot, *Papers on the I*
A Sotbeer in the
chen's Committee, 1876, and
ge Silber,
ke der Volkswirthsch., in.,

Ricardo, *Principles of Pol Econ*, p. 72 (ed. M'Culloch).

three heads: (1) The proper standard to use, the dis
of which in practice turns on the comparative mer
single standard of gold or silver and of a double st
of gold and silver at a fixed ratio; (2) the system
dividing the currency, which is generally discussed
the of proposals for decimal coinage; (3) pr
made in many quarters to assimilate the various c
systems of the world. These take one of two
it is either desired that a group of nations shall ass
their currencies, in which case the coinage may be ca
international one, or a wider view is taken, and
system is advocated for all states. This may be
universal coinage. The question of the proper st
may be deferred for the present, as it is of a more c
nature than the others. Before discussing even the
of the question it is desirable to state some elem
tacts involved in all such points. Every currency
must be based on a *standard unit of value* which
of a "fixed quantity of some concrete substance defi
reference to the units of weight or space." Th
English unit is the *pound*, which consists of a
quantity of gold (123·27447 grs. standard fineness)
the French unit is the *franc* (composed of 5 gran
silver 9/10ths fine). It is not, however, necessary th
standard unit shall be a coin. All that is needful
the current coins shall be multiples or submultiples
unit, or at all events easily reducible to it. The
centime is too small to be coined, and the pound o
which formed the unit of the early French and
currency was too large. Distinct from both the
coins and the unit of value is the *money of account*,
in practice it is usually identical with one of the
Russia in early times the *rouble* was an imaginary
of account not coined, while the copper *copeck* was t
of value. Another distinction must be pointed out,
that between *standard* and *token* money, the forme
of the same value as the metal it is made of, while th
is rated at a nominal value higher than that of its m
The silver and copper coins in England and the
silver coins in the Latin Union are merely tokens, b
the case of the English silver coins about 30 per cent
their nominal value. The French coins are of
fineness (835 per 1000). Token coins are only adm
in small payments, as otherwise — in accordance with
monetary principle to be presently explained — the s
coin would be driven out of circulation. The ma
amount in payment for which they are legal tend
England 40s. One of the functions of money b
afford a standard for estimating deferred payme
is generally used as the means of discharging obl
when they become due, and in this aspect is style
tender. The principal coinage of any country is lega
to an unlimited amount, and, when offered, dischar
pecuniary obligation. It is only the standard coinag
possesses this property, or rather the standard co
that which does possess it.

In discussing monetary questions it is also impo
remember that a metallic currency has to circulate
the most diverse classes of society, and must be s
the wants, and even to the prejudices, of the pop
ment. Many curious instances the preferen
community for some particul could be given
Austrian Maria Theresa dollar a special favourite
coast of Africa, and is still coined exactly as it was i
The inhabitants of California refused to accept th
backs issued during the American civil war, and
quently gold was always used in payments in tha
Many apparently well-advised reforms have mi

(p. 720, above

to the habits of the people not having been attended
ome writers have, however, misconceived the prin-
of currency and extended this influence to cases
it does not apply. Thus it has been sought to explain
option of gold as the principal English coinage after
y assuming that the English deliberately preferred
etal.[1] The fact of different nations possessing dif
currencies, as the prevalence of gold in England and
r in France during the 18th century, is to be other-
ccounted for. The great mass of a population, it is
ake and give money without particularly observing
is enough if the coin conforms to the usual type
exists, however, in all mercantile communities a class
lers in money[2] who make a profit by collecting the
oins for exportation, or, if two metals are in concurrent
e coins of that metal which is undervalued in the
tion fixed. The mode in which self-interest thus
es produces an effect which may be briefly formulated
ing that *bad money drives out good money*. It is
now called "Gresham's law," from a former master of
nglish mint,[3] who observed it. The illustration of
rking are numerous. Under its action the gold which
vervalued relatively to silver in England in 1696
e the main English coinage, as above stated. And
er to meet the want of silver coins, Sir I. Newton
ated, and secured, the reduction of the guinea from
d. to 21s. The exportation of metallic money when
er-issue of inconvertible paper takes place is another
f the theorem. By means of this principle we can
explain the tendency of currency to depreciation, for
once, either by wear or by the issue of inferior coins,
ency has become debased, no reformation is possible
the debased coins are removed from circulation, as
wise they will be preferred for payments by dealers,
ill not be melted down or exported. All demands for
n trade will be met from the best part of the coinage.
gument in favour of state coinage has been founded
reshain's law. It is argued that private coinage
lead to the issue of depreciated money.[4] It is,
ver, overlooked in this argument that the action of
w arises from the fact that the depreciated currency
l tender; were it not so, comes less than the proper
t would be at once rejected. It may be added that
monetary history bears out this view.[5]

ving disposed of these elementary questions, the
l groups into which all currency systems fall may now
ted. The simplest form of currency seems to be that
ich the state coins ingots of different metals, and
s them to circulate freely, without any ratio being
This, which is the lowest form of currency proper,[6]
risen in many countries through the introduction
of various other nations. Turkey is a European
le. Many of the South American republics possess
ency of this description. A theoretical form of this
n has been advocated in France. It is proposed to
coins of one, two, five, and ten grammes of gold, and
ow the present silver coins which are multiples of the
ne to circulate along with them. The difficulties of
lan are so obvious that there is no likelihood of its
adopted. The arguments in its favour are of little

force, since it is hardly correct to contend that it
natural system, when it has never been willingly adopt
any country. The next system to be noticed is tha
single metal being fixed as legal tender. This in
times is the really natural arrangement, and has
widely adopted. It is needless to recapitulate the ins
which have already been given in dealing with
matters. There is, however, a difficulty which soon
under this system. If the metal chosen is not
valuable, it is too cumbrous for large payments; if,
other hand, it possesses a high value, it is hard to
able. The even
would be too bulky for such payments as frequently
£100 in silver at its present value would weigh nea
lb, while it would be impossible to coin gold pie
the value of a penny or even a shilling. This system
naturally lead to the use of other metals beside
standard one, and when the state fixes the ratio be
the metals a new system has come into existence,
has been called the *multiple tender* system. In
ratios between the metals are fixed, either once for
until changed by state authority. This system w
force in England from 1257 (or rather 1344) to
the ratio between gold and silver being fixed from t
time by proclamation. France, too, adopted it duri
Revolution, the ratio of 15½ to 1 being that fixed be
gold and silver. The fluctuation of currencies ar
on this method, owing to the action of Gresham's la
led in England and Germany to a modified system,
seeks to combine any advantages of the multiple st
with the principle of the single standard. By this
one metal is fixed as the principal legal tender, wh
smaller coins are made of a less valuable materia
circulated at a nominal value somewhat above the
one, or, in other words, as token coins, but they ar
legal tender to a limited amount. This has been
the *composite legal tender* system.[7]

For further details reference may be made to Tables II a
and the notes appended. Every currency system requires th
existence of subsidiary coin, and, as stated before, this want is met
a less valuable metal, generally silver, and for smaller pa
copper or bronze. But apart from the question of the ma
the smaller coins, it is important to determine the legal ratio
them. The simplest of all would be the *[illegible]*. In it
would be the limit to the [illegible] and double the one
ounces below it. Notes, apparently a plainer or simpl
this [illegible] but the objection to it is the great number of co
would be required [illegible] the want of conformity w
[illegible]

[illegible]

[illegible]

a large series of coins to be formed.[1] The main reason, for the adoption of a duodecimal system appears to have preference for the number 12 so frequently shown by early , that among the Semitic races, the Jews were organized ribes , and in Italy the Etruscan league consisted of two ; and Rome In connexion with this it may be noted duodecimal system of currency prevailed south of the Apen At Rome the *as* was divided into 12 *uncia* The modern however, has been to adopt a decimal scale This method ion, which is found very widely in use among savage tribes, to be derived from the ten fingers of the human hands. the basis 10 is not so convenient as 12 it is firmly established nal system of counting, and is in process of extension to weighing and measuring.[2] For the purposes of currency this s is not very convenient, as 10 can be only resolved into two fac and 5), and one of these is a rather high number. This advantage has retarded the adoption of decimal coinage, and is base of the objections made to it. It has been contended that unsuitable for small purchases, and for such fractions as one-thi France adopted the decimal system of coinage in 1799, and it now extended over all the countries of the Latin Union (see T II.). It is also in use in Germany, Denmark, Sweden and Norw the Netherlands, and Finland, as well as in the United States none of these countries has a decimal coinage pure and simple.

(Mr Grasch in *Econ. Journ.* Dec. 1891, art. "Money," vol. xv. p. 444 et seq.)

[2] Tylor, *Anthropology*, pp. 311-312.

[3] Laing and M'Culloch, as quoted above. The former unfortunately phrases that "the decimal division never will come into general use in Fr or anywhere else."

TABLE II. *The Coinage Systems of Continental Europe, exhibiting the gold and silver coins, their weight, fineness, remedy, and approximate value in English and United States money.*

Coins	Remedy	Approximate Money Value	Coins	Remedy	Approximate Money Value
AUSTRIA-HUNGARY.[1]			**NETHERLANDS.**[2]		
100 Florins	Gold	£8 6 4	100 Guilder piece	Gold	£8 6 4
50 Florins	,,	£4 3 2	10 Guilder piece	,,	£0 16 6
20 Florins	,,	£1 14 10½	5 ,,	,,	£0 8 3
10 ,,	,,	£0 17 3	2½ ,,	Silver	£0 4 2
5 ,,	,,	£0 8 7	1 ,,	,,	£0 1 8
1 ,,	Silver	£0 1 7½	½ ,,	,,	£0 0 10
½ ,,	,,	£0 0 10	25 Cents	,,	£0 0 5
100 Kreutzer	,,	£0 0 4½	10 ,,	,,	£0 0 2
10 ,,	,,	£0 0 1	5 ,,	,,	£0 0 1
BELGIUM. See FRANCE.			**NORWAY.** See DENMARK.		
			PORTUGAL.[3]		
			1000 *Escudos* 1 Crown or $10·000	Gold	£1 15 10
			500 ,, Half Crown or $5·000	,,	£0 17 10½
			200 ,, One fifth Crown or $2·000	,,	£0 7 2
			100 ,, One tenth Crown or $1·000	,,	£0 3 6
			500 Reis	Silver	£0 2 3½
			200 ,,	,,	£0 0 10½
			100 ,,	,,	£0 0 5½
			50 ,,	,,	£0 0 2½
DENMARK. See FRANCE.			**ROUMANIA.** See FRANCE.		
FRANCE.			**RUSSIA.**[4]		
100 *Francs*	Gold	£3 19 2	100 *Copecks* Imperial or 10 Rouble piece	Gold	£7 1 8
50 ,,	,,	£1 19 7½	Half Imperial or 5 Rouble piece	,,	£3 12 10
20 ,,	,,	£0 15 10	3 ,,	,,	£2 7 6
10 ,,	,,	£0 7 11	1 ,,	Silver	£0 3 2
5 ,,	,,	£0 3 11½	½ ,,	,,	£0 1 7
2 ,,	Silver	£0 1 6	¼ ,,	,,	£0 0 9½
1 ,,	,,	£0 0 11½	20 Copecks	,,	£0 0 7½
50 Centimes	,,	£0 0 5½	10 ,,	,,	£0 0 3½
20 ,,	,,	£0 0 2	5 ,,	,,	£0 0 2
GERMANY.			**SERVIA.** See FRANCE.		
20 Mark piece	Gold	£0 19 5½	**SPAIN.** See FRANCE.		
10 ,,	,,	£0 9 9½	**SWEDEN.** See DENMARK.		
5 ,,	,,	£0 4 10½	**SWITZERLAND.** See FRANCE.		
2 ,,	Silver	£0 1 7½	**TURKEY.**[5]		
1 ,,	,,	£0 0 11½	100 *Piastres* Medjidie or Lira	Gold	£0 18 0
½ ,,	,,	£0 0 5½	½ ,,	,,	£0 9 0
			¼ ,,	,,	£0 4 6
			20 Piastres	Silver	£0 3 7
			10 ,,	,,	£0 1 9½
			5 ,,	,,	£0 0 10½
			2 ,,	,,	£0 0 4
			1 ,,	,,	£0 0 2

[1] Inconvertible paper currency.

[2] The Netherlands have adopted a system of [illegible] Guilder pieces coined at the rate of 20 to the [illegible], silver not freely coined. The Maria Theresa [illegible]

[3] The Portuguese coinage law (in force since Denmark, Sweden, and Norway) came into force 1st January 1875. It is a monometallic gold stan [illegible]

[4] The Russian coinage law came into force on 1st May 1769. It was extended to other countries composing the "Latin Union" (France, Belgium, [illegible] but has been adopted by Greece, Roumania, Servia and Spain. It is thus the most widely-extended syste [illegible] ... [illegible] ... [illegible] ...

te coins are introduced, *e.g.*, in France, 2 franc and 5-franc
In fact, most modern currencies are a combination of the
and binary systems, England alone adhering to a modified
nal scale. A decimal coinage has for the last sixty years
posed for England, and it is almost certain that if any one
ould be pointed out as much preferable to any other it
accepted. As it is, there are two or three proposals, each
ling some support, while many advocates of the decimal
prefer to wait till an international agreement for its adoption
can be obtained. One of the schemes advanced takes the
farthing as its base, then 10 *farthings* = 1 *dou* (2½d.); 10 *do*
florin (2s. 1d.); 10 *florins* = 1 *pound* 20s. 10d. The adva
of this plan are (1) that smaller coins now in use co
preserved (the penny being 4 farthings), (2) retail prices, which
the smaller articles estimated in pence, need not be alt[illegible]d,
need those which affect postage, tolls, and mileage charges. W
these may be set the loss of the unit of value, the pound,
should be raised to 20s. 10d., so that all accounts, and al

TABLE III. *Currencies of the more important non-European States*

Remarks	Approximate Money Value	Remarks	Approx Money
[illegible]	[illegible]	[illegible]	[illegible]

NORTH AMERICA.

DOMINIONS.[1]								
ts = 1 *Dollar*								
2.								
d.	16 Dollar piece	Gold						
	1 „	Silv						
	50 Cent piece	„						
	25 „	„						
STATES.[3]								
ts	20 Dollar piece							
Dollar.	(Double Eagle)	Gold	33·44	·900				
	10 Dollar piece (Eagle)	„	16·72	·900				
	5 Dollar piece	„						
	50 Cent piece		12·500	·900		0	0	[illegible]
	[illegible]		[illegible]	[illegible]		0	1	[illegible]
	[illegible]		[illegible]	[illegible]		0	0	[illegible]
	[illegible]		[illegible]	[illegible]		0	0	[illegible]
	[illegible]		[illegible]	[illegible]		0	0	[illegible]

SOUTH AMERICA.

ARGENTINE REPUBLIC.[4]								
Andes = 100 *Centesimos*	20 Peso piece	Gold	33·455	·900		4	1	
= 1 *Dollar*	10 „	„	16·666	·900		2	0	
(*Peso*)		„	8·333	·900		1	0	
	1	Silver	25·11	·900		0	1	
BOLIVIA.[5]								
Pesos = 100 *Milésimos*	20 Milesimo piece	Gold	17·92	·916				
Milésimo	10 „	„						
		Silver	25·500	·916·6				
		„	12·250	·916·6				
CHILE.[6]								
Centavos = 1 *Peso*	10 Peso piece (Condor)	Gold	15·25					
	5 Peso piece		5·04	·900				
	„ „	Silver	25·00	·900				
	50 Centavos piece	„	12·50	·900				
	20 „	„	5·00	·900				
			2·50	·900				
			1·25	·900				

ASIA.

INDIA (BRITISH).[9]								
3 *Pice* = 1 *Anna*	4 Rupee piece							
4 *Pice* = 1 *Sicca*	(Double Mohur)	Gold				30	0	
16 *Annas* = 1 *Rupee*	15 Rupee piece (Mohur)					15	0	
	10 Rupee piece					10	0	
	„ „					[illegible]	[illegible]	[illegible]
	[illegible]		[illegible]	[illegible]

otations, would have to be altered, while the new unit of the
would not be assimilated to any other unit. This plan has
no chance of acceptance. Another proposal starts from
ent *pound* as unit. It is to be divided into 10 *florins* (28·
ould contain 100 *mils* (or *farthings* reduced 4 per cent.
oin, 10 *centesimi*, 5d., would probably have to be introduced.
vantages of this plan are (1) the *pound* would be preserved
the *florin* and *shilling* would also be retained; the latt
accounts for large amounts need not be altered.
sections are such as follow. (1) The copper coins, which
most used by the poor, would all be changed, thus causing
inconvenience. (2) All charges expressed in pence would be altered
at one of the parties. Still, this scheme is much to be
l to the one first mentioned. A third plan is based on the
ss in English money is only 4l. more than 10 francs.
gard to this link between the English and French systems,
posed to coin a 10 *franc* piece in gold to serve as a token
If the penny were then reduced by 4 per cent. this piece
ontain 100 pence, and by common consent or temporary piece
a perfect decimal currency would be obtained. This
ment would involve the abolition of the *pound* as well as of
the present florin, &c. In fact, it is
ty to which all be determined
nce that can be hoped for from some pro
ent. All that can
ntroduction of the
o their tendency to
system to other co
as change the la
ons in force perhaps
time was an interna
different value
ng compare the denomi
that of the
The next currency whic
nomal we the frequently mentioned Carlo
ated the different European intermediate
ventional common coinage
ate deferred it over a great
nt circumstances appeared. The
our monetary system was thus left open
when means of facility for intercourse hav
international relation. And accordingly
ts, necessary and convenient was found in Eu
advocated this principle. In pursuance of
conferences and congresses were held on it
them in 1865. The
a series of important resolutions. It reported advocating the
convenience of a decimal system with a uniformity common to
the multiple and sub-multiple of 5000 to the unit of the higher coins
approved of, as well as the determination of the weight of coin
metric system. The first practical outcome of the movement
the monetary convention of 1865, which founded the Latin Union, by which France, Belgium, Italy, and Switzerland
came a single monetary region, with the franc as their common unit
sequent accessions to the Union are given in the note to the
coinage system (Table I.). In 1867 a monetary conference
d at the same time as the Exhibition of that year, when the
universal coinage was advocated, and three leading principles
down as necessary to that result, viz. (1) the universal
of a single gold standard, (2) the general use of the decimal
this coinage, (3) that all coinages should be co-ordinated
French system.[5] Owing to the accidents of historical
ment, certain points of connexion existed between the lead
open systems. Thus, the franc being regarded as a unit,
man thaler was as 2·47, the American gold dollar as 5·18,
English pound as 25·22. Very slight changes would bring
one into a ratio of 1 : 5 : 25, and it was proposed by the
of 1867 that, when this was effected, they should have inter
in all countries where any of the four unit-pie
Friendly nations were recommended to select whichever
most frequently used. The subsequent monetary changes
Europe have, however, ended rather in
of the existing systems without any tendency towards
establishment of a common one. Thus, of the three principles
down by the conference of 1867, two only have been adopted
the currency reforms. On the creation of United Germany
e Franco-German war of 1870-1871 it was the aim of the
of that country to develop as much as possible all outward
ons of that unity, and in accordance with that conception,
an currency was devised which was monometallic and decimal
ble II.), but which was not even to assimilate to the French
thus rejecting the third principle laid down by the Paris
ce, and rendering future progress more difficult. The
Scandinavian Union proceeded on very much the same lines
German reform, and was, in fact, mainly caused by it. The
Government, under the pressure of circumstances, have aban
the silver standard and coined some gold, but their position i
undecided. The Austrian Government have made a slight st
issuing a gold coins 8- and 4-gulden pieces, which are the sa
the 20- and 10-franc coins. In one part of the Russian domi
Finland, the French system has been introduced, the new
being equivalent to the franc. The main Russian system h
been changed, nor have any alterations been made by Eng
Turkey, or Portugal.[4] The question of universal coinag
become implicated with the question of the proper standard
the strong ground taken up in 1867 has certainly to some
been abandoned. It may, however, be considered that the p
systems of coinage are capable of being assimilated. A comp
of the amount of pure metal in English, French, German, U
States, and even Japanese coin shows how small is the differ
An recognition proposal was made in 1868 to the English comm
on the question, by which the sovereign would be made ide
with the French 25 franc piece (if that were coined). It was
on the fact that the sovereign contained only about 1 grain
of gold than the amount in 25 francs. It was proposed to
the small amount from the bullion brought for coinage as sei
age so that no change need be made. The advocates of this s
contended that price would not be affected by the alteration.
recommended itself to the commission. They ac
the view put forward by Newmarch, who argued that all
tracts would have to be altered to allow for the depreciation
by the change, and this portion seems impregnable, so l
metallic currency alone considered. Another ingenious pla
that of Bischof to assimilate the English and American syste
a step towards a wider change.[6] At the present moment the
monetary system of (1) France and her allies, (2) England a
larger part of her colonies, and (3) the United States are so
established in these several countries, and the advantages o
system are so equal, that it is hard to see which is to give
The wide area of the Latin Union, and the perfect decimal di
of its coinage, are arguments in favour of the franc; the g
value of the pound, and the immense extent of the E
colonial and English trade, are in favour of the British u
verse, while the dollar, from its convenient size and the pr
of the future growth of the United States, has claims to b
selected in the discussion. The most probable conclusion, ho
seems to be that the future unit will not be any of these coi
the result of a compromise, which will lead to a new system
established. The difficulties which arise when universal c
scheme are brought forward ought not to conceal from us th
advantages which such an institution would confer on the
The arguments urged in its favour are various, and are regar
being of different relative importance by their advocates.
may, however, all be stated as follows. (1) Increased faci
travelling. Though there is a tendency to under-estimat
element of the question, it seems impossible to doubt th
saving of trouble to travellers by any universal coinage
would be very great. The abolition even of the local curren
Germany and Italy, and their replacement by uniform m
systems, has been a great boon to tourists, but an arrang
which would obviate the necessity for procuring any di
money whatever would be a still greater advance. In the in
of peace, which is greatly promoted by extended interna
communication, it is very desirable to remove any obstacle
towards increased intercourse among persons of different cou
(2) Greater ease in adjusting the foreign exchanges. This arg
has been sometimes pushed too far. It has been apparentl
that, were a universal currency adopted, the problems of the f
exchange would no longer exist. There are, however, other
in the question, namely, those of time and place, which could
eliminated by the adoption of a single coinage system.[7] St
removal of even one complicating element would simplify exc
discussion. The question of mint pars would no longer aris
the specie points would be stated more simply. The friction
sometimes arises from the necessity of recoining the exporte
would also be removed, and the profits of those dealers who g

[4] Austria-Hungary and Turkey possess inconvertible paper cur
and various foreign coins circulate in the last-named country, the q
does not possess much importance for them. Portugal is closely co
with France and will probably follow her example. It may also be
that the gold coins of all these countries have a fineness of $\frac{11}{12}$ths.

[5] Sovereign = 7·32 gramme fine gold.

[6] See his pamphlet reprinted from the *Economist*. It is nearly the
the first proposal mentioned above, but it differs in contemplating the a
tion of American money, the 5 dollar piece being equivalent to the new

[7] See, for this, Goschen, *Foreign Exchanges*, p. 5, and the article Ex
(vol. viii. p. 784 *seq.*). A practical illustration is the case of Australia,
though the currency is identical with that of England, bills on Englan
a premium.

Attic, Eubœic, and Aginetan, s th, *Dict. Gr. and Rom. Ant.*, s.v.
na."
msen, *Hist. of Rome*, iii. p. 415.
de Parieu in *Journal des Econ* s (Feb. 1, 1878).

pecial knowledge would be saved to ordinary traders. (3) provement of the currencies of backward states. Many s still possess those mixed currencies which were once com- over Europe, and much confusion consequently arises. The cial coins have been introduced for international circulation,[1] nivetsal currency would perform their function more satis- y. (4) Greater facility in comparing price-lists, &c. This ge, which is reserved for the last, has been regarded by nt judges as the greatest.[2] It has a practical and a theo- nterest: the former, since trade with foreign countries would ered easier and safer, the latter, since statistical inquiries e very much facilitated. At present, it is quite impossible rdinary trader to understand a set of foreign price-lists, each expressed in terms of a different currency from the other. alty which is enhanced by the variations of gold and silver iod to add the case of an inconvertible paper currency. The e of a common monetary language would remove the second, and the premium on gold could be allowed for in the case erated paper. A much wider development of credit-trading ions would become possible, and would add to the wealth

Nor would the greater ease of statistical comparison be unim- ; the rates of wages in different countries and the prices ent transactions, would be readily compared, and the move- of labour and capital to the most advantageous points l more rapid. Against these great gains can be set only and a possible disadvantage, namely the [illegible] l in charge, which would, of course, for the time be con- e, but would soon be over, and the chance that some [illegible] same a depreciated currency, which would expel the other er coins. In the case of a universal coinage the [illegible] would arise, since there would be no field of employment for the oins, and they would consequently remain in circulation. whole currency would become depreciated. Proper arrange- ons, however, would obviate this danger, and could [illegible] ed. It may be said that the principal merit to one system for all civilized states is the advantage of [illegible] the standard to be employed. Till the debate on the is closed it is vain to expect monetary unification. The ment of a universal system based on gold coined quite to the conference of 1867, but doubtful to the end of 1878, which standard was the proposal discussed in 1881.

Considerations on the Questions arising from the Con- Standards. In the preceding section the various e monetary systems were set forth, but no discussion tered into with respect to their comparative merit. ree of these systems need be here examined, namely, *gle* standard system, the *multiple* standard system, stly, the *composite* system. Nor even is there any or examining the various possible single or multiple rds. The single silver standard is the only one of mer, as the double gold and silver standard is the e of the latter, which need be taken into account ne, historical inquiry has shown that the problem of oper proportion between two different metals when ogether presented itself to the Chinese with regard r iron and copper coinages; but the course of mone- olution, as discussed in section 3, has resulted in the on of the less valuable metals and in confining the al of the principal coins to silver and gold. The use r as a principal coinage was, as we have seen, widely d. The Hellenic coins were composed of that metal, eing afterwards introduced as a variable commercial ; and copper was brought in still later as a token cy. Though copper preceded silver as money in the latter, soon after its introduction, succeeded in eing it, the ratio first fixed being 1 to 250. A regular coinage did not exist at Rome till the empire, but n bars passed, the legal ratio being 1 to 1191. Still estions connected with the use of a double standard seem to have arisen.[3] The various European mon- s had silver as their principal money (see p. 726 *sq.*, , gold where it was used being, as in Greece, a

commercial money. The advance of gold to a p parallel to silver was commenced in the 13th and con in the 14th century, the method of regulating the gold and silver currencies being by proclamation, fixed the varying ratios from time to time. In E this course was followed from the first introduct gold coins (1257) to 1663.[4] From 1663 to 1717 was the standard, and the gold coins passed at the ket value. As the silver coins were very much de the gold guinea sometimes was deemed equivalent After the recoinage of 1696 the guinea passed at 2 At this ratio silver was undervalued, and was acc exported to Continental Europe and to India. The the silver coins arrested the public attention, and the was submitted to Sir I. Newton, whose answer was in his *Third Representation*. He proposed to redu guinea from 21 6d to 21s, as an experimental me The proper reduction for the object in view would been to 20 s. 8d. The silver coins, therefore, con and England came to have a gold currency. An op arrangement gave France a silver coinage. The fact of French monetary history, as well as those United States, illustrate the same condition of affair difficulty of constituting a double standard system become latent, thus made clear so far as it has re single country. For the continuance of the two me the currency depends on the market ratio and th ratio between gold and silver being the same. The h examination of the history of these metals will ho variable they have been. Without accepting the ex which regard silver as being more valuable than go well-attested variations of the precious metals hav very considerable. Thus, Herodotus estimates the 1 to 13, Plato 1 to 12, Menander 1 to 10, and in time the ratio was 1 to 9.[5] Table I. contains the tions since the discovery of America. In the 14th c the value of gold rose remarkably, and the gradua ment has ever since been toward an appreciation relatively to silver. Another point, previously not the tendency, as wealth increases, to adopt a more v form of currency. Greece, Rome, and England all illustrations of the movement. The experience of th of a mixed currency led the earlier writers on coi England to regard a single standard system as the be silver as the most suitable metal for the standard.[6] Petty, and Harris all advocated this view. The Italian writers proposed to combine gold and silv ratio of 1 to 12, which they conceived to be the actu portion. The theory of a composite system was, as mentioned, first given by Lord Liverpool.[7] This

[1] The [illegible] principal of these are—the Austrian Maria There a dollar, xican dollar, and the United States trade dollar, which is 7½ vier than the national coin of the same name. See also Tables III.

[2] [illegible]., Bagehot and Prof. Jevons. The former dwells on the com- aspect; the latter naturally places the scientific side first.

[3] Mommsen, *Hist. of Rome*, ii. p. 382 and iv. p. 553.

[4] The [illegible] may be calculated from the Tab in Adam *Money, &c.*; see also *Encyc. Brit.*, 8th e "Money." A [illegible] statement will be found in Lord La work, cit.

[5] Newton's report will be found in the *Select Tracts on Mone* by J. R. M'Culloch for the Political Economy Club (18 pp. [illegible] "The demand for exportation ar to [illegible] prices [illegible] other places than in England n [illegible] and notes therefore be diminished by low value of gold [illegible] silver. If gold in England or Portugal were [illegible] crowned so low as to bear the same proportion to silver as in both places, there would be here no demand for silver [illegible] gold to be exported to India. Ar were however easily [illegible] to have the same proportion to money in England which it hath to silver in the rest of there would be no *temptation to export silver out of this into other parts of Europe*" (p. 277). The italics are in the ori a [illegible], which has been much discussed in recent controversies.

[6] Del Mar, *Hist. of the Precious Metals*, p. 221. Acc this writer, the variation has been 200 degrees [illegible], from sil 10 times as valuable as gold, gold has come to be 20 tim valuable than silver.

[7] See Smith, *Dict. of Ant.*, s. v. "Argentum."

[8] See above, p. 731.

ulating the metallic currency was established in
l, as it were, accidentally, and deliberately adopted
1816. The practical good results which followed
ll English economists of that period warm advo-
of the composite system. Thus, M'Culloch and
ree in supporting the English system, as also does
dd.[1] On the Continent the weight of authority
as divided, and the existence of the French bi-
system gave support to the advocates of a double
d. The result of the gold discoveries in Australia
intorta was to greatly increase the supply of that
nd, under the action of Gresham's law, to change
ch currency from silver to gold, while Holland, to
he evil which were anticipated from the reduced
that metal, adopted silver as the standard. The
nts in favour of a universal currency described
combined with the course of event, brought the
l question into greater prominence. The proposal
Paris conference of 1867 for a single gold standard,
niversal coinage on that basis, raised the question
t prominence. Wolowski and Courcelle Seneuil
opposed the recommendation, the former predict
t a disastrous appreciation of gold would follow.
w seems borne out by the result, for, although a
l coinage was not created, yet Germany and the
candinavian Union both changed from a silver to a gold
d, while Holland and the United States both made
nts in the same direction by demonetizing silver
king preparations to adopt the gold. The Latin
at the same time directed their silver coinage, which
nly the same effect as the adoption of a gold standard.
The result of these extensive changes was to create
onfusion. The more ardent advocates of a double
d, too, attributed most of the continued trade de
n to this cause. The altered condition of opinion on
stion was seen at the monetary conference held at
1878, where the universal demonetization of silver
sidered to be dangerous. The "Bland Act" of the
States, which theoretically decreed the double
d (1878), was another instance of reaction. The
preciation of silver, which resulted mainly from it-
eased to be money over a large part of the civilized
severely affected the Indian finance, and thus the
ct a double standard were able to command more
n in England. The conference held in Paris in
flected these changed views. The supporters of
ble standard took the initiative and proposed a
sed on the double standard at a fixed ratio, but
lusion was arrived at. England, Germany, and the
candinavian Union upholding the gold standard.

ce has been the contributory of the bimetallic question
s become desirable to examine more closely the conflicting
s which recent shape these have taken. "Sensible Bimetallists
of the gold standard have found their best representatives
have regarded not Tooke. The former of these adopted the
t held by Petty, Locke, and Harris, that only one metal
a standard at a given time, but he held that the
ot be secured unless both selected gold as more suitable material
ver to be the principal money. He added that by law the
ver should be received to any the standard, and as a matter
he contrary would always be used practically at that time. 1850 the
standard to depreciation. These arguments were

i Ashburton was the only person of influence who advocate
le standard.

amounts of gold and silver coined each year were as follows:

	£
1874	16,000,000
1875	13,000,000
1876	12,000,000
1877	25,000,000
1878	9,000,000
1879	20,000,000

For Italy only

for a full discussion, W. Bagehot, *Depreciation of Silver*.

supported by a mass of historical examples.[4] Tooke, who dealt
the subject in his *History of Prices*, severely criticizes the d
standard. He points out that it would be impossible to keep
metals in circulation, and that it would be the inferior one w
would remain. He also indicates a more refined objection, namely
difficulty of constituting a bank reserve under the double stan
Thus, if silver were the more valuable, and the reserve cons
mainly of it, there would be an inducement to make a run o
reserve, so as to drain out the small quantity of gold and the
the more valuable silver.[5] The silver standard was preferr
Ricardo, who fully accepted the arguments against the d
standard as conclusive, his view was, that silver was steadi
value than gold, and was the standard money in other coun
while the objection to it on account of its greater bulk wa
thought, obviated by the use of paper money for circulation.
S. Mill pronounces no opinion as to the comparative merits of
and silver, but he objects to the double standard on the
ground that the cheaper metal is the only one used in paym
and that therefore the fluctuations are more frequent under a d
standard *cæteris paribus*. The advocates of the concurrent use of th
metals, prominent among whom were Wolowski on the Cont
and Seyd in England, contended that these objections wer
founded, for (1) the double standard, though it produced
admitting the assumption of their opponents) more frequent flu
tions, still did not vary so widely from the mean, since in each
it was the *cheaper* metal which determined the value,[6] and (2
action of Gresham's law would produce a compensatory a
Thus, if silver be undervalued in a double standard system, a
ats in to other countries where it is more valuable. The qua
of silver is thus reduced and its value raised, while gold is impo
it quantity increased, and its value lowered. Were gold the u
valued metal, the converse process would take place. The se
ce of the position is illustrated by the case of the great transfo
tion of the French currency (1849-1860). During the rapid inc
of the gold supplies the value of silver only rose about 3 per c
in fact the depreciation was spread over the two metals, and
continued to gold.[7] In addition to the above arguments, it
ged by Wolowski that any attempt to establish a universal
standard as contemplated by the Paris conference of 1867 w
cause a great appreciation of gold, which would be disastro
commercial interests, while silver would lose most of its value.
services which the double standard countries rendered by acti
intermediaries between gold and silver standard countries wa
dwelt on, the ease with which the mass of silver needed for exp
tion to the East was supplied from France during the years 18
being an instance in point. The monetary difficulties, as indi
above, which followed the adoption of gold by Germany an
Scandinavian Union, as well as the embarrassment of the I
Government, from the resulting depreciation of silver, revive
double standard advocates. Cernuschi and De Laveleye
forward as supporters of what the former called *bimetallism*, t
to secure the establishment of a universal, or at all events a
international currency, based on the concurrent circulation
two metals gold and silver at a fixed ratio. This plan has g
many supporters, though the tendency among English econo
seems to be to decline even to consider it; and not even yet
the question appear to have received that careful examinatio
bimetallists which would be desirable.[8]

The bimetallists start with a discussion as to the causes w
determine the value of money. They point out that there ar
two theories: one that the value of money depends on th
of the sovereign (the *fiat* theory); the other that the val
money is entirely independent of state control, and determine
economic conditions (the *free trade* theory). Neither of th
accepted by the bimetallists. They take up a middle ground
hold that by its power of deciding what substance shall be de
legal tender and discharge all obligations, the state is able to c
within limits, what substances shall be money and wha

[1] *Evidence of the Banks*, pp. 128-165.

[2] This objection to the double standard is also urged by Prof. Th
Rogers and by Bagehot. Actual instances of the difficulty occur
1860, and again in 1876, with the Bank of France.

[3] "Proposals for an Economical and Secure Currency," *Work*
Macmillan, p. 402.

[4] The superposition of two curves, each representing the varia
one metal, and the formation of a third curve representin
lowest concurrent point of each, will make this clear. See Je
Money, p. 155.

[5] See J. E. Cairnes, *Essays in Pol. Econ.*, pp. 140-143.

[6] Mr. A. J. Wilson has collected a series of articles on Recipr
Bimetallism, and Land Tenure Reform, and Prof. Bonamy Price
with Bimetallism and Fair Trade in his address to the Social S
Congress in 1884. But there is no fair reason for placing É. de Lav
Luzzatti, Cernuschi, Dana Horton, and other supporters of bimet
and we may add Prof. F. A. Walker, in the same category wi
advocates of (so-called) "Reciprocity."

of those substances shall be. They argue from history that
l metals have been successively demonetised that different
have been fixed between metals circulating together, that in
ctible paper currencies have been kept in circulation by the
the state.[1] The doctrine of cost of production as determining
lue of money is also assailed by them. They hold that the
antity of money which governs its value, and that cost of
ction has little or no influence on the matter. The next topic in
metallic argument is to contend that them proposed ratio for
o silver (1 to 15½) can be maintained by the Government con-
t effect. The common objection to bimetallism, that which-
metal was undervalued would be exported, they answer that
ne ratio existing over all, or a great part of, the world there
be no inducement to export either metal, and in support
n argument they appeal to the practical success gained
ost contemporaneously in the interests of modern bimetallism
ly, a greater stability as regards value is claimed for the two
s combined than for either used singly, for the depreciation
orted over a wide field, and, the condition of profit being
nd silver being somewhat differently affected by fluctuations in their
ne balanced each other. A fourth argument consists in the assertion
e which would follow the establishment of the
ve which learnt from the existence of good
e variations of relative
allic system to appear
advantages which
by the great abundance of
ed to any fall in gold which
production of gold. The new
ey is desirable, and that, in order
l consent practically impossible,
realised in no other way than by
he concurrent circulation of two
are controlled by the monometallists
ion is made the value of the
at a much smaller amount. The
ney is largely influenced by
on that cost of production
at any material reduction would
esent metal and that thus the world
different from the real
extreme case is referred to for the purpose. For
sk, to make the value of silver equal to that of gold
n it be possible to alter the market ratio on the bimetallic
? Is there not a great demand for the precious metals in the
trades? And would not the ratio of demand be affected
lxing of a new ratio? The argument of practical difficulty
y system would produce greater instability in the value of money
by the answer that there is no proof of it. It is quite
ie that a single metal may be steadier in value than two com-
and the evidence of history shows that silver is more stable
reciation than gold. The argument drawn from the disturb-
ce exchange transactions is to a slight extent admitted, but
inted out that the factors which affect the foreign exchanges
numerous, and are so rapidly eliminated in the course of
that a radical currency change need not be adopted for this
se. It is also shown that, even when no Europe
metallic, the fluctuations in the exchange price of silver took
and still more that, where it is the less valuable metal that
ourse of depreciation, bimetallism can afford no aid. The
ed tendency of the bimetallic system to produce a higher
f prices than would otherwise prevail is dwelt on by its opponents
as a proof of its inherently vicious character. The claim to
the world by adding to its stock of money places bimetal-
n the same class with the advocates of inconvertible paper
, and shows the absence of reason in their views. Their
n becomes the same as that of the Birmingham currency
The proposition that the quantity of money is of no con-
ce since prices vary in proportion to it, is one [illegible]
he contempt so frequently expressed for bimetallists is re
d for by their advocacy of the principle of the beneficial
of an increased amount of money. To the contention that
llism is the necessary condition for a universal coinage system
swers is, that the idea of universal coinage presupposes the
he *gradual* introduction of the gold standard [illegible]
ing the way for a future universal coinage based on gold
metallism. On the practical question as to the actual intro-
n of the system, the monometallists deny the possibility of

forming a universal bimetallic league which would not be
be broken up by war or impaired by some of the states-who
posed to issue inconvertible paper. On the other hand, the
international conventions for postal purposes, extradition
metrical measurement, and other matters of interest are co
by bimetallists as evidence of the feasibility of their plan.

The above summary gives the main arguments on
of the discussions as given by the advocates of the
principle. A short consideration will show that the con
may be suitably divided into three heads, viz. (1) the po
of constructing a universal bimetallic system which sha
accordance with the economic principle; (2), if the first
be answered in the affirmative, the comparative merits
system opposed to the present variety of systems or
universal gold standard system; and (3) the expedien
present circumstances of nations in general and England
other people in the proposed convention. Each of the
will be considered.[2] (1) The possibility of a bimetallic
can hardly be denied. Under all the difficulties attend
existence in a single country, it was assumed in practic
ing in France during the early part of the 19th century
a plan that a world-wide bimetallic league would afford a bet
basis than two. It is quite possible that international preference
metal or the ratio would be displaced, but the work
Under such circumstances the exchanges would be regulated by the
[illegible]
[illegible] Probably also
the Bank would [illegible] to the proportion of the two
An ounce of gold, divided into 20 shillings, would
demonetise [illegible] the standard, [illegible] the force
monetary [illegible] It is therefore impossible to answer
bimetallist [illegible] the question first proposed. (2) The consi
to be taken into account under the second head are very
ple, and do not admit of [illegible] attraction. The
currency system of England [illegible] sovereign [illegible]
based on the gold standard, [illegible] the great trad
to the inhabitants of the country [illegible] be beneficial
the Latin Union has been a permanent [illegible] attraction
maintained by the war
[illegible]
coined. Germany
crated silver and, were [illegible] tabl
not likely that any [illegible] would be [illegible]
silver countries [illegible] They have to receiv
of depreciated silver coin [illegible] bimetallic in exchang
their purchasing power is reduced owing to the greater
value of gold for silver. It would therefore be hardly advis
for Great Britain to take the first step to bring about the adopti
would be to raise the value of their money, and are there
necessary to export the quantity of silver to produce
adjustment. The natural consequence of the complete
[illegible] are not
The supply of silver might suffice for all want, and might
a better currency than the present silver. The pro
two separate monometallic systems, of gold for the more
countries of Europe and the United States, of silver for Ea
Indies would, when the superiority of gold had p
the East, present both difficulty after equilibrium was
The new ratio between silver and gold would become est
and their prices in silver using countries would be higher
[illegible] with the fall in the value of silver. It is therefore p
[illegible] would be reached under any
[illegible] It may therefore be concluded
comparative merits of the competing standards are not ca

[1] Dana Horton's paper on the *Position of Labour in the Doctrine of Mon*
ed to the monetary conference of 1878 (Appendix [illegible]
p. 79) above. The theory of money which has been stated and the objec
to the cost of production theory given. It is [illegible] to find Jevons
g (in common with Bagehot and Prof. Price) that the value of money
ely depends on cost of production, when by examination of that doc-
general is considered. Compare *Contemp. Rev.* (May 1878) with Jevons's
of Pol. Econ., p. 201 *sq.*

[2] Modern bimetallists freely admit that two different bimetallic systems
ving different ratios could not exist, for each would drain the other of

[3] It is assumed that the other factors which influence the exchange
(see p. 772 above) remain constant.

[4] Mr J. J. Murphy in *Dublin Statistical Journ.* vol. xxxvi. p. 28;
M. Wirth, *Zeitschr. für die ges. Staatswiss.* May 1881, "Die neue Methode
Bimetallismus."

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...ended [illegible] The immediate introduction of a ...gold [illegible] by the adoption of all parts [illegible] and that is the only settled point in the controversy ... of which the bimetallic question embodies ... a portion of pottery in a bimetallic locality with ... Mint. With regard to the aspect of the question ... England at least, ought to be a negative one. The ... monetary system has worked well. It is firmly ... British habit, and is not therefore to be lightly abandoned, the interest of England is principally opposed ... movement calculated to raise the value of silver relatively to ... the precise point in general. The threat of some bi-... that all nations will be ready to adopt a gold standard ... practical results in the English money market by the ... gold drain is of no weight, and does not. Every fresh gold will be paid for at a high price, and the simple expedient of ... bank rate will be found sufficient. Labour is needed in ... The interest of other countries is expected by ... ed. As to the Germans, to [illegible] one of depre... ...ver, as in other cases, to some bimetallic bait will ... to do other. The [illegible] of India and other ... countries have been discussed before. When all ... of the question have been [illegible] the most probable ... that the [illegible] of a bimetallic [illegible] to the same ... as very much as that [illegible] monetary evolution will ... rather be the cause of event, and the [illegible]

...ments, [illegible] by the Indian Government; and ... International Conference.

Bibliography.—The literature of the subject [illegible] ... is not extensive, and only a short [illegible] of it can be ... The principal [illegible] ... Ricardo's ... two pamphlets, *The High Price of Bullion* (1810), [illegible] ... of money and paper currency, [illegible] with great ... sophical discussion in his work *On the Influence of the Precious Metals*, dealt ... value of the precious [illegible] ... Thornton's view is perhaps ... The only [illegible] ... in English literature ... on Plan, which [illegible] ... and Peake, which [illegible] ... the [illegible] ... of the original money. [illegible] ... work deals chiefly with the collection of claims on the ... of money, which were [illegible] ... The ... ties principally on the general [illegible] ... would otherwise be [illegible], is [illegible] entitled *Remarks ... Scarcity, Exportation of Bullion*, &c., reprinted in 1804. Earl ... [illegible], and [illegible] ... The best work to ... is the *Inquiry into the Nature and Effects of the Paper Credit of Great Britain* [illegible] ... Bullion Report, and [illegible] ... Bullion question. It has been remarked that the ... of the economic [illegible] ... of the work to be noted is [illegible] ... monies, reprinted [illegible] ... At a later date Du Jardin's [illegible] ... prices, under the title *A Letter to Henry Hase*, [illegible] ... an anonymous work, [illegible] ... *Standard considered*, 1830. [illegible] ... *della Moneta* advocating [illegible] ... The problem ... vation of prices caused by the [illegible] ... several work, one of the most remarkable being the ... of William Stafford (1581).

Quotidiennes (1852). The recoinage of 1696 calle... Lowndes' *Essay on the Amendment of the Silver Coins*, and ... *Further Considerations concerning raising the Value of Mon...* the 18th century the *Reports* of Sir I. Newton, as Master of th... re valuable. Cantillon's *Essai* (Paris, 1755) contains in its ... 3d parts a good account of currency. Harris's *Essay on ... ome Ways* [illegible] ... An earlier tract by Rice V... *Discourse of Coin and Coinage* (1675) is brief, but correct ... ciple. Adam Smith's *Wealth of Nations* (London, 1776) d... the subject in Books I. and V., while sequence ... [illegible] in Book vi. The treatise, *The Coins of the ...* (London, 1805) by the first Lord Liverpool, elaborately d... the question of the proper standard and has powerfully in... monetary legislation in England and Germany. Ricardo ... pamphlet on the bullion question added to the knowledge of t... which regulated a depreciated currency. Senior, in his ... *on the Cost of Obtaining Money* (London, 1829), developed the ... of the net national distribution of the precious metals.

The 19th century has been a time of active discussion ... the monetary question. The gold discoveries, international ... [illegible] ... bimetallism, the resumption of spe... notes in countries where an inconvertible currency has ... each of the [illegible] having had its special literature. Some ... work have been mentioned when dealing with the special q... they refer to; [illegible] ... the return, refer to many others ... will [illegible] ... Economists in their sy... work (Mill, *Principles*, Book iii., chs. 10, 19, 21; Jevons, ... Book iv., ch. 10; Sidgwick, *Principles*, Book ii., chs. 1-3; ... Book iii., chs. 3, 4; Marshall, *Principles*, Book vi., chs. 1-3; ... Book iii., chs. 3, 4; Marshall, *Principles*, Book vi., chs. 1-3; ... chapters [illegible] ... the [illegible] ... of his *Course* ... [illegible] to the object with the title of "Le Monnaie." ... Professor W. S. Jevons's valuable work, *Money and the Mech... Exchange*, and Professor Irving Fisher's concise *Treatise on ... Purchasing Power* (London, 1892) are to be noted. More elabor... either of these is F. A. Walker's *Money*, the most complet... work on the subject in English, but earlier work, *Money ... Recent Inquiries into Economics*, is likewise very good. Wo... *Dictionary of Political Economy* contain much information, as does also ... *Statistical Atlas*. Dr Seyd's *Bullion and Foreign Exchanges* (Lon... 1868) [illegible] ... but the changes since its publication (1869) deprive it of ... its value. The various reports of Tates *Cambist* give t... accurate effect [illegible] often imperfect statements as to the ... currency. Jacob's work on *The Production and Consum... the Precious Metals* gives many interesting details, tho... conclusions are often [illegible] and the authorities [illegible] ... not worthy. The recent work of Del Mar, *History of the ... Metals* (London, 1880), furnishes a criticism and continu... Jacob, and applies many new details. His criticism ... "cost of production" theory as applied to gold and silver i... elsewhere. Some of his views on the moral aspects of the ... need qualification. Professor Sumner's *History of the A... Currency* may be relied upon for its facts. The *Reports* of the ... [illegible] supply abundant information on their specia...

Among the [illegible] may be mentioned the *Proceedings* of the P... Conference of 1867, 1878, and 1881, the *Decimal Coinage Com...* (1857), the French *Enquête Monétaire* (1870), and the *Repo... Committee of the House of Commons on the Depreciation o...* (1876). The *Reports of the* English *Mint* furnish information ... the coinage changes of each preceding year. (C. A.)

NEFERRATO or MONTEFERRAT, an ancient marquisate ... th Italy, in the valley of the Tanaro, the name of ... title survives in the Italian title Casale Monferrato) ... town of Casale. The princes of Monferrato were ... the most powerful Italian families of the Middle ... Among them were several famous crusa... I., prince of Tyre from 1187 to 1192, the valiant ... ht of Saladin; and Boniface, Duke of Thessalonica ... 1183 to 1207. In 1305, on the extinction of the ... the ex-province passed to Theodore Palaeologus ... h his mother, the empress Irene. The Palaeologi ... extinct in 1533. The duchy was subsequently ... ed to Mantua, and ultimately absorbed in Savoy in ... ming of last century.

NOË, GASPARD (1748-1815), French mathemati... the inventor of descriptive geometry, was born at ... on the 10th May 1746. He was educated first at ... lège of the Oratorians at Beaune and then in their ... at Lyons, where, at sixteen, the year after he had been learning physics, he was made a teacher ... Returning to Beaune for a vacation, he made, on ... cale, a plan of the town, inventing the methods of ... vation and constructing the necessary instrument ... plan was presented to the town, and preserved i... library. An officer of engineers seeing it wrote to ... mend Monge to the commandant of the military sc... Mézières, and he was received as draftsman and p... the practical school attached to that institutio... school itself was of too aristocratic a character to a... his admission to it. His manual skill was duly a... ated. "I was a thousand times tempted," he sa... afterwards, "to tear up my drawings in disgust ... esteem in which they were held, as if I had been g... nothing better." An opportunity, however, presente... being required to work out from data supplied to ... "defilement" of a proposed fortress (an operatio... only performed by a long arithmetical process), ... substituting for this a geometrical method, obtain...

so quickly that the commandant at first refused to
e it the time necessary for the work had not been
; but upon examination the value of the discovery
ognized, and the method was adopted. And Monge,
uing his researches, arrived at that general method
application of geometry to the arts of construc
hich is now called descriptive geometry. But such
e system in France before the Revolution that the
s instructed in the method were strictly forbidden
mmunicate it even to those engaged in other branches
public service; and it was not until many years after
that an account of it was published. The method
s, as is well known, in the use of the two bodies or
t of paper to represent say the plane of x and z
at angles to each other, and the construction
on of points, lines, and figures in space by means
r plan and elevation, placed in a determinate relation
n.

1768 Monge became professor of mathematics and
1 professor of physics, at Mezières, where he
d Madame Horbon, a young widow whom he had
sly defended in a very puffed memoir against an
ded charge, in 1780 he was appointed to a chair
mathematics at the Lycæum in Paris (held by him together
is appointment at Mezières), and was received a
er of the Academy, his intimate friendship with
llet began at this time. In 1783, quarrying Mezières
, on the death of Bezout, appointed examiner of
candidates. Although pressed by the minister to
e for them a complete course of mathematics he
d to do so, on the ground that it would deprive
e Bezout of her only income, arising from the sale
works of her late husband. He wrote, however
, his *Traité élémentaire de la Statique*.

nge contributed (1770–1790) to the *Memoirs* of the
my of Turin, the *Mémoires des Savants Etrangers* of
ademy of Paris, the *Mémoires* of the same Academy,
e *Annales de Chimie*, various mathematical and
al papers. Among these may be noticed the memoir
la théorie des déblais et des remblais (*Mem. de
de Paris*, 1781), which, while giving a remarkably
investigation in regard to the problem of earth
eferred to in the title, established in connexion with
capital discovery of the curves of curvature of a
. Euler, in his paper on curvature in the Berlin
rs for 1760, had considered, not the normals of the
, but the normals of the plane sections through a
lar normal, so that the question of the intersection
essive normals of the surface had never presented
o him. Monge's memoir just referred to gives the
y differential equation of the curves of curvature,
tablishes the general theory in a very satisfactory
r; but the application to the interesting particular
the ellipsoid was first made by him in a later paper
5. A memoir in the volume for 1785 relates to
duction of water by the combustion of hydrogen,
onge's results in this matter had been anticipated
tts and Cavendish.

792, on the creation by the Legislative Assembly
executive council, Monge accepted the office of
r of the marine, but retained it only until April
When the Committee of Public Safety made an
to the savants to assist in producing the *material*
ed for the defence of the republic, he applied himself
nolly to these operations, and distinguished himself
indefatigable activity therein; he wrote at this
is *Description de l'art de fabriquer les canons*, and
is aux ouvriers en fer sur la fabrication de l'acier.
ok a very active part in the measures for the
shment of the Normal School (which existed only
during the first four months of the year 1795)
the School for Public Works, afterwards the Polytechnic
School, and was at each of them professor for the
geometry, his method in that science were taken
lished in the form in which the shorthand writers
down his lectures given at the Normal School in 1795
again in 1798–99. In 1796 Monge was sent next
with Berthollet and some artists to receive the pictures
and statues levied from several Italian towns, and
there the acquaintance of General Bonaparte. Two
afterwards he was sent to Rome on a political mission
which terminated in the exile, becoming under Masséna
the headstrong Roman republic, and he thence joined
expedition to Egypt, taking part with his friend Berthollet
in the cross-operations of the war in the
labours of the Institute (in the interests of Science and
the Arts accompanied Bonaparte to Suez, and returned
him in 1799 to France. Monge was appointed president
of the Egyptian commission, and became associated
with the Institute school. His later mathematical
papers were published (1795–1810) in the *Journal de
l'École Polytechnique*. On the
tion of the Senate he was appointed a member
honour with an ample provision, and the title of
Péluse, but on the fall of Napoleon he was deprived
of his honours and exiled from the court
him of the pension granted by Louis. He died at Paris
the 28th of July 1818.

[illegible] Monge [illegible] to the heights
[illegible] between 21° 22′ and
N. lat., and 5° 10′ and 8° 30′ W. long., bounded
the N. by Bambuk, the E. by the Falémé river,
part of the S. by the Scarcies and Hia rivers,
on the W. by Cape Verga, Farim, and Bathomarah, with
an area of 39,200 square miles. The Gambia divides the
into two portions. The northern, intersected by the
Gambia and Upper Niger two important tributaries,
Gambia is always liable to inundation during the
season, and is so much that, except and the country,
to a large population. A considerable area
the banks and the basin of the great river is devoted
pasturage. Farmers cultivate on the
and the [illegible] butter made from the
forms an important article of export to Calcutta.
south of the Gambia the country is dry, much
and broken up by mountainous ranges. The
of part consists of varying proportion
of hills intersect the part of the district and
extreme south form a real portion of the
jungle, but of no great height. Irrigation is
throughout the section. Lying on the south of the Gambia

In 1872 the population of Monge [illegible] was 429,986
85,074 female 215,912. Hindus 1,015,540, Mohamm

82,269 the remainder consisting mainly of aboriginal tribes and
all race professing some form of faith. There are also a few
Buddhists and Christians. Seven towns contained upwards of
5000 inhabitants in 1872: Monghyr 33,698, Shaikhpura 11,536,
Jamalpur [illegible] 10,10[illegible], Surajgarha 7956, Barbighat
3623, and Lakhisarai 3499. Sixteen-twentieths of the area under
cultivation at the time the revenue survey was made, when it was
returned at 1,[illegible]05 acres, are known. However, that cultiva-
tion has since extended much further. The land is held principally
under the tenure known as *bhaoli*, by which the tenant pays
a certain share of the produce according to the custom of the
country. Rice is the staple crop, and most popular with the
natives. Mohuas, a species of forest, mango trees, sugar-cane,
vegetables, and most kinds of cereals and pulses are produced in
abundance, but no notice of them is called for in this article.
Coal is found in the Monghyr district, with good iron ore
in many places. The most important mineral product, however, is saltpetre, which is manufactured by means of large
vats, and under European supervision. The total area
under indigo cultivation is about 20,000 acres, with an average
out-turn of 2000 cwt. of dye. Mulberry trees are grown,
and silkworms are reared on a considerable scale. Opium is
the principal export, next to which come rice, sugar, and pulses.
Wheat, barley, maize, gram, and pulses are grown, and tobacco,
and the chief imports consist of European piece goods, salt, and
sugar. The value of the former in 1876-77 was £[illegible]50,000, and of the
latter £314,000. Education is making fair progress, and in 1[illegible]
there were 229 Government and aided schools attended by 6[illegible]
pupils. The climate is [illegible]. The temperature is high
in the hot weather, reaching 107° Fahr. in May; but the
weather is cool and pleasant. The average annual rainfall
is [illegible]. Malarial fever is comparatively uncommon, but epi-
demics of cholera occur frequently.

Monghyr was one of the principal centres of the Mohammedan administration in Bengal. In the early years of British rule Monghyr formed a part of Bhagalpur, and was not created a separate district until 1832.

Monghyr, chief town and administrative headquarters of the above district, is situated on the south bank of the Ganges (25° 23′ N. lat., 86° 30′ E. long.). The population in 1872 was 69,698, viz., Hindu, 44,900, Mohammedan, 14,346, Buddhist, 33, Christians, 305, "others,"

In 1196 Monghyr, a fortress of great natural strength, appears to have been taken by Muhammad Bakhtyar Khalji, the first Muhammedan conqueror of Bengal. Henceforth it is often mentioned in Muhammedan history. Being a place of military importance, it was frequently chosen as the seat of the local government. In 1590, when Akbar established his supremacy over the Afghan chief of Bengal, Monghyr was long the headquarters of his general Todar Mall, and it also figures prominently during the revolt of Sultan Shuja against his brother, Aurungzeb. In more modern times Nawab Mir Kasim, in his war with the English, selected it as his residence, and the centre of his military preparations. Some of Monghyr's ammunition is said to date from the arsenal he established. The town is now purely a civil station, and one of the most picturesque in Bengal.

MONGOLS

THE early history of the Mongol, like that of all central Asian tribes, is extremely obscure. Even the meaning of the name "Mongol" is a disputed point, though in general consent is now given to Schott's etymology of the word from "mong," meaning brave. From the earliest and very scanty notices we have of the Mongol in the history of the Tang dynasty of China (A.D. 619-907) and in works of later times, it appears that their original camping ground was along the course of the Kerulon, Upper Nonni, and Argun rivers. But in the absence of all historical particulars of their origin legend, real or mythical, has been busy with their early years. The Mongol historian Sanang Ssetsen gives currency to the myth that they proceed from a blue wolf, and the oldest story on record is that their ancestor Budantsar was miraculously conceived of a Mongol widow. By craft and violence Budantsar gained the chieftainship over a tribe living in the neighbourhood of his mother's tent, and that left a heritage to his race. Varying fortunes attended the descendants of Budantsar, but on the whole their power gradually increased, until Yesukai, the father of Jenghiz Khan, who was eighth in descent from Budantsar, made his authority felt over a considerable area. How this dominion was extended under the rule of Jenghiz Khan has already been shown (see GENGHIZ KHAN), and when that great conqueror died he left to his son in the valley of Kelon in 1227 he left to his empire which stretched from the China Sea to the banks of the Dnieper.

Over the whole of the vast region Jenghiz Khan set his second son, Ogdai, or Ochotai, or Ogdai Khakan, or chief khan, while to the family of his deceased eldest son Juchi he assigned the country from Kavalik and Kharezm to the borders of Bulgar and Saksin, where on the boots of Mongol horse-hair felt [illegible] to Jagatai his eldest surviving son, the territory from the borders of the Uigur country to Bokhara; while Tuli, the youngest, received charge of the home country of the Mongols, the care of the imperial encampment and family, and of the archives of the state. The appointment of Ogdai as his successor, being contrary to the usual Mongol custom of primogeniture, gave rise to some bitterness of feeling among the followers of Jagatai. But the command of Jenghiz Khan subdued these murmurs, and Ogdai was finally led to the throne by his dispossessed brother amid the plaudits of assembled Mongols. The ceremony was complete. Ogdai making three solemn genuflexions to the sun by the prince taking an oath by which they swore so long as there remained of his posterity a morsel of which thrown upon the grass would prevent the cows from eating, or which put in the fat would prevent the dogs from taking it, they would not place on the throne any of any other branch. In accordance with Mongol custom Ogdai signalized his accession to the throne by distributing among his comrades present from his father's treasure, and to his father's spirit he sacrificed forty maidens and one hundred horses. Once fairly on the throne, he set himself vigorously to follow up the conquests won by his father. At the head of a large army he marched southward into China to complete the ruin of the Kin dynasty, which already had been so rudely shaken, while at the same time his lieutenants advanced into the province of Honan from the side of Siberia. Against the combined attack the Kin troops made a gallant stand, but the skill and courage of the Mongols bore down every opposition, and over a hecatomb of slaughtered foes they captured Kai fung Foo, the capital of the empire. From Kai fung Foo the emperor fled to Jo Foo, whither the Mongols quickly followed. After sustaining a siege for some weeks, and enduring all the horrors of starvation the garrison submitted to the Mongols, and at the same time the emperor committed suicide by fire. Thus fell in 1234 the Kin or "Golden" dynasty which had ruled over the northern portion of China more than a century.

But though Ogdai's first care was to extend his empire in the rich and fertile provinces of China, he was forgetful of the obligation under which Jenghiz Khan's conquests in western Asia had laid him to maintain supremacy over the kingdom of Kharezm. This was more incumbent on him since Jelál al dín, who had been driven by Jenghiz into India, had returned, reinforced by the support of the sultan of Delhi, whose daughter he had married, and, having reconquered his hereditary dominions had advanced westward as far as Tiflis and Khelat. Furthermore to dispossess the young sultan, Ogdai sent an army of 300,000 men into Kharezm. With such amazing celerity did this army march in pursuit of its foe that

ced Mongol guards reached Amid (Diarbekr), whither l-dín had retreated, before that unfortunate sovereign y idea of their approach. Accompanied by a few ers, Jelal al-dín fled to the Kurdish mountains, where basely murdered by a peasant. The primary object Mongol invasion was thus accomplished, but, with stinct of their race, they made this conquest but a ng stone to another, and without a moment's delay l on still farther westward. Unchecked and almost osed, they overran the districts of Diarbekr, Meso a, Erbil, and Khelat, and then advanced upon jan. So great was the terror with which the arrions inspired the people of the province they d that single Mongols are said to have slain the tants of entire villages without a hand having been against them. In the following year (1230) they d Georgia and Great Armenia, committing frightful es, sparing neither man nor woman, young nor old, he exception of those whom they saved to minister ir wants or passions. Tiflis was among the cities d by assault, and Kars was surrendered at their ch in the vain hope that submission would earn cy from the victors. Meanwhile, in 1235, Ogdai troops were as numerous as their chief for conquest voured, despatched three armies in as many direc One was directed against Corea, one against the dynasty, which ruled over the provinces of China of the Yang-tse-Keang, and the third was sent west into eastern Europe. This last force was commanded u, the son of Juchi, Ogdai's deceased eldest brother, ook with him the celebrated Subutai Bahadur as his dviser. Bulgar, the capital city of the Bulgars, fell the force under Subutai, while Batu pushed on over lga. With irresistible vigour and a terrifying speed ongols made their way through the forests of Penza mboff, and appeared before the "beautiful city" of . For five days they discharged a deadly storm t from their balistæ, and, having made a breach in tences, carried the city by assault on the 21st of ber 1237. "The prince, with his mother, wife, he boyars, and the inhabitants, without regard to sex, were slaughtered with the axe in cruelty of l revenge; some were impaled, one shot at with for sport, others were flayed or had nails or plates d driven under their nails. Priests were roasted and nuns and maidens ravished in the churches their relatives. 'No eye remained open to weep e dead.'" Moscow, at this time a place of little ance, next fell into the hands of the invaders, who dvanced against Vladimir. After having held out veral days against the Mongol attacks, the city at succumbed, and the horrors of Riazan were repeated. mperial family, with a vast crowd of fugitives, sought in the cathedral, only to perish by the sword of the rors or by the flames which reduced it to ashes. It le, a more dire fate overtook the inhabitants of sk, near Kaluga, where, in revenge for a partial inflicted on a Mongol force, the followers of Batu so terrible a "carnival of death" that the city was ed by its captors Mobalig, "the city of woe." With le of victory thus strong in their favour the Mongol ed against Kieff, "the mother of cities," and carried assault. The inevitable massacre followed, and the as razed to the ground. While the scene of blood was at its height a catastrophe occurred which at ther time would have been considered of supreme . Under the weight of a vast crowd of fugitives t roof of the metropolitan church fell in, burying ung and old, in a vast hecatomb.

torious and always advancing, the Mongols, having desolated this portion of Russia, moved on in two divisions, one under Batu into Hungary, and the other under and Kaidu into Poland. Without a check, Batu marched to the neighbourhood of Pesth, where the whole force of the kingdom was arrayed to resist him. The Hungarian army was posted on the wide heath of Mohi, which bounded by "the vine-clad hills of Tokay," the mountains of Lommit, and the woods of Diosgyor. To an army hemmed in on all sides defeat meant ruin, and instantly recognized the direction in which the enemies had placed themselves. To add to his chances of success he determined to deliver his attack by night, while the careless Hungarians were sleeping before battle. Dismounting and leaving their tethered horses, they fell on all directions, followed by their men on foot. Two archbishops, three bishops, and many of nobility were among the dead, and the road for two leagues from the field of battle were strewn with The king, Bela IV., was saved by the fleetness of his horse, though closely pursued by a body of Mongols, followed at no great distance by the rest of the Mongol army, burning and destroying everything in their way. While Batu captured Pesth and on Christmas Day having crossed the Danube on the ice, Gran, Raab, and Wissegrad fell into the hands of the Mongols. At their approach the inhabitants of Cracow deserted their city, after having given it over to the flames. Disappointed at the loss of their expected spoil the Mongol advanced to Wahlstatt in the neighbourhood of Liegnitz, where Polish army under Duke Henry II. of Silesia awaited their onslaught. With savage impetuosity the troops of rushed to the attack, and completely defeated the Polish. No quarter was given. The massacre was total and Duke Henry himself was among the slain. It was a Mongol habit to cut off an ear from each of their slaughtered foes, and on this occasion it is said they filled nine sacks with the ghastly trophies. Following the example of the inhabitants of Cracow, those of Liegnitz left but the blackened walls of what had been the town a prey to the Mongols, who without delay pushed on into Moravia, and ravaged the country of Troppau. While leaving waste the country in the neighbourhood of their tower they received the announcement of the death of Ogdai, and at the same time a summons for Batu to return forthwith into Mongolia.

While his generals had been thus carrying havoc in all directions Ogdai had been giving himself up to ignoble ease and licentiousness. Like many Mongols he was much given to drink, and it was to a disease produced by this cause that he finally succumbed on the 11th December 1241. He was succeeded by his son Kuyuk, of whose character little is known, but it is noticeable that his two ministers to whom the entire control of affairs were entrusted were Christians, as also was his mother, and that a Christian chapel stood before his tent. This leaning toward Christianity, however, bore no peaceful fruit. On the contrary we find Kuyuk preparing to advance against the Sultan of Rum (Asia Minor), and despatching an expedition to Syria, by which that country was made tributary to the Great Mongol empire, of a threatened attack upon Corea and of another attack on the southern provinces of China. On the death of Kuyuk dissensions which had been for a long time smouldering between the house of Ogdai and Jagatai broke out into open war, and the most undisputed regions of Kaidu and Chapar, sons of Ogdai, the kingship passed away from the house of Ogdai for ever.

On the 1st of July 1251 Mangu, the eldest son of Tule, and nephew to Ogdai, was elected Great Khan.

perfect impartiality, Mangu allowed the light of his countenance to fall upon the Christians, Mohammedans, and Buddhists alike, although Shamanism was recognized as the State religion. Two years after his accession to the throne he was visited by Rubruquis and other Christian monks, who were hospitably received. The description given by Rubruquis of the Khakan's palace at Karakorum is very brief. How vast was the interval which separated him from the nomad, together with the life of his forefathers! It was surrounded by lofty walls. . . . Its architect, who had three doors. . . . The central hall was like a church and contained a throne and two tables, separated by a curtain. . . . Here the Great Khan sat on the first day of the year. In front of the throne was placed a silver tun, having at its four corners four golden lions, from whose mouths there poured mare's milk, or else wine, liquorice, honey-drink, and rice-wine. At the top of the tun there was a silver vessel provided with a trumpet, when the butler-in-chief wanted to replenish it he blew through the trumpet, whereupon the cup-bearers filled their flagons.' On his accession to the throne Mangu had to deal with a conspiracy which had been formed against him by his brother Kublai and his uncle Hulagu, who were held to be the cause of the disorder. Marching by Samarkand and Bokhara, Hulagu crossed the Oxus and advanced by way of Balkh into the province of Kohistan. The terror of the Mongol name induced Rukn al-din, the chief of the Assassins, to deprecate the wrath of Hulagu by offers of submission, and he was thus actually able to purchase a temporary immunity from invasion by the surrender of the principal fortresses in Kohistan. But when the country had thus been left at the mercy of the invaders, their instinct for the old system of 'Stone and Arrow' suspended their battle-axes, and, spurning neither man, woman, nor child, they exterminated the savage people. Hulagu then marched across the snowy table-land in the direction of Baghdad. On arriving before the city he demanded its surrender. This being refused, he encamped the walls on the east side. The Mongol forces amounted to 150,000 men, and the caliph was induced to believe that, if he would only open the gates to his enemy, Hulagu would be content with a large ransom and would withdraw. Instead of doing so, however, the Mongols entered the city, and, following their usual tactics, sacked the city. For forty days it was given up to pillage, fire, and the sword, and the number of killed was said to have reached the enormous total of 800,000. For the moment the caliph's life was spared, and he was allowed to carry away 100 wives out of 700 who had formed his harem, on being thrown upon whom 'neither the sun nor moon had shone.' But his fate soon exceeded his wildest imaginings. According to the current rumours of his death, one account was that he was sewn up in a sack and trodden to death by horses, another that he was starved to death. To the Moslem world his loss was a religious catastrophe, as it left Islam without a spiritual head. While at Baghdad Hulagu granted his astronomer, Nasir al-din, permission to build a great observatory. The town of Maragha was the site selected under the superintendence of Nasir al-din and nine assistant astronomers who were associated with him, a handsome observatory was built, and furnished with 'armillary spheres and astrolabes and with a beautifully executed terrestrial globe showing the five climates.' One terrible result of the Mongol invasion was a fearful famine which desolated the provinces of Dar Arabi, Mesopotamia, Syria and Rum. For, though the inhabitants starved, the Mongols had strength and energy left to continue their onward march into Syria. Aleppo was stormed and sacked, Damascus surrendered, and Hulagu was meditating the capture of Jerusalem with the object of restoring it to the Christians when he received the news of Mangu's death, and at once set out on his return to Mongolia, leaving Kitubuka in command of the Mongol forces in Syria. As a reward for his services, Hulagu received the investiture of his conquests, and established the empire of the Ilkhans.

While Hulagu was prosecuting these conquests in western Asia, Mangu and his next brother Kublai were pursuing a like course in southern China. Southward they had advanced into Tong king, and westward they carried their arms over the frontier into Tibet. But in one respect there was a vast difference between the two campaigns. Under the war-command of Kublai all indiscriminate massacres were forbidden, and probably for the first time in Mongol history the inhabitants and garrisons of captured towns were treated with humanity. While carrying on the war in the province of Szechuen Mangu was seized with a fatal form of dysentery, which proved fatal after a few days' illness. His body was carried into Mongolia on the backs of two camels, and, in pursuance of the custom of slaughtering every one encountered on the way, 20,000 persons were, according to Marco Polo, put to the sword.

At the Kuriltai, or assembly of notables, which was held at Shang-tu after the death of Mangu his brother Khubilai (see KUBLAI KHAN) was elected Khakan. His thirty-five years' reign on the Mongol throne, and his death in 1294, in his seventy-ninth year, he was succeeded by his son Timur Khan, or, as he was otherwise called, Oljeitu Khan. The reign of the sovereign was chiefly remarkable for the healing of the dissension which had for thirty years separated the families of Ogdai and Jagatai from that of the ruling Khakan. Oljeitu was succeeded by his nephew Khaishan. In accordance with the Mongol ceremony, on the election being announced four of the princes of the blood raised the new khakan aloft on a piece of white felt, two others supported him, while a fourth offered him the cup. 'Meanwhile, while Shaishan entered upon his prosperity and adopted the title of Kuluk Khan, carts full of gold pieces and of silver were brought out and distributed. So many pieces were spread on the ground that it resembled the sea-shore. The feast lasted a week, during each day of which 40,000 sheep were consumed. Libations of milk from 700 white cows and 7000 ewes were sprinkled on the ground.' With that tolerance which so markedly characterized the Mongols at this period, Kuluk worshipped indiscriminately at the temples of the Chinese Shamans and before the Buddhist shrines, while at the same time he lent a favourable countenance to John of Montecorvino, who, during the whole of his reign, was archbishop of Peking. Unfortunately the archbishop was not so tolerant as the Khakan, and carried on as fierce a dispute with the Nestorian Christians of his day as that which divided Dominicans and Jesuits in China three centuries later. After a short reign, and at the early age of thirty one, Kuluk was gathered to his fathers in February 1311. His nephew and successor, Buyantu, was a man of considerable ability and substantially patronized Chinese literature. Among other benefits which he conferred on letters, he restored the celebrated inscription-bearing "stone drums," which are commonly said to be of the Chow period (B.C. 255) from the decay and ruin to which they were left by the last emperor of the Kin dynasty, and placed them in the gateway of the temple of Confucius at Peking, where they now stand. After a reign of nine years Buyantu was succeeded by his son Gegen, who perished in 1323 by the knife of an assassin, the first occasion on which a reigning descendant of Jenghiz Khan thus met his fate. Yesun Timur, who was the next sovereign, devoted himself mainly to the administration of his empire. He divided China, which until that time had been apportioned into twelve provinces, into eighteen provinces, and rearranged

system of state granaries, which had fallen into disorder. His court was visited by Friar Odoric, who gives a minute description of the palace and its inhabitants. Speaking of the palace this writer says:

"Its basement was raised about two paces from the ground and within there were twenty four columns of gold, and all the walls were hung with skins of red leather, and so be it in the world. In the midst of the palace was a great jar more than two paces in height, made of a certain precious stone called nefrin (jade); its price exceeded the value of four large towns. Into this vessel drink was conducted by certain conduits from the court of the palace, and beside it were many golden cups from which those drank who feasted. When the Khakan sat to drink the queen was on his left hand, and a step lower sat the other of his wives, while at the bottom of the steps stood the other ladies of his family. All those who were married wore upon their head the skin of a marten as it were a cubit and a half in length, and at the top of the foot there were certain crane's feathers, the whole foot being set with great pearls, so that if there were in the whole world any fine and large pearls they were to be found on the decoration of those ladies."

The following years were years of great natural and political convulsions. Devastating floods swept over China, carrying death and ruin to thousands of homes; earthquakes made desolate whole districts, and in more than one part of the empire the banners of revolt were unfurled. The Khakans who now successively occupied the throne, instead of striving to stem the tide of discontent and disorder, gave themselves up to every kind of debauchery. As a natural consequence, the conduct of affairs fell entirely into the hands of their ministers, who but too often neglected the interests of their sovereigns. A comet which appeared in the reign of Toghon Timur Khan, and which was believed to be the precursor of fresh disasters to the reigning house, justified the prediction by being almost immediately followed by an earthquake, which overthrew the temple of the Imperial Ancestors, from the altars of which, as if to complete the misfortune, the silver tablets of the emperors were in the consequent confusion stolen. It was not long before the popular discontent found vent. In order to prevent the recurrence of the periodical inundations caused by the overflow of the Yellow river, the emperor ordered a levy of 70,000 men to excavate a new channel for the dangerous stream, and imposed a heavy tax to meet the necessary expenses. The oppressive edicts overtaxed the patience of the people, and they broke into open rebellion. Under various leaders the rebels captured a number of cities in the provinces of Kwangnan and Honan, and took possession of Hang-chow, the capital of the Sung emperors. At the same time pirates ravaged the coasts and swept the imperial vessels off the sea. While these combined disorders were disturbing the country, the emperor, under the guidance of Tibetan Lamas, was being initiated into the carnal enjoyments peculiar to the warmer climates of Asia.

In 1355 a Buddhist priest named Choo Yuen chang became so impressed with the misery of his countrymen that he threw off his vestments and enrolled himself in the rebel army. His military genius soon raised him to the position of a leader, and with extraordinary success he overcame with his rude levies the trained legions of the Mongol emperor. While unable to defeat or check the rebels in the central provinces Toghon Timur was also called upon to face a rebellion in Corea. Nor were his arms more fortunate in the north than in the south. An army which was sent to suppress the revolt was cut to pieces almost to a man. These events made a dream which the emperor dreamt about this time of easy interpretation. He saw in his sleep "a wild boar with iron tusks rush into the city and wound the people, who were driven hither and thither without finding shelter. Meanwhile the sun and the moon rushed together and perished." "This dream," said the diviner, "is a prophecy that the khakan will lose his empire." The fulfilment followed closely on the prophecy. By a subterfuge, the rebels, after having gained possession of most of the central provinces of the empire, captured Peking. But Toghon Timur, in a hasty flight escaped from his enemies, and sought safety on the shores of the Dolonor in Mongolia. For a time the western provinces of China continued to hold out against the rebels, but with the flight of Toghon Timur the Mongol troops lost heart, and in 1368 the ex Buddhist priest ascended the throne as the first sovereign of the Ming or "Bright" dynasty under the title of Hung-woo.

Thus ended the sovereignty of the house of Jenghiz Khan in China; nor need we look far to find the cause of its fall. Brave and hardy the Mongols have always shown themselves to be; but the capacity for consolidating the fruits of victory, for establishing a settled form of government, and for securing the allegiance of the conquered people, have invariably been wanting in them. In time their prowess and the exceptional ability of some of the first emperors of their line held the people of China in a bondage which was only outwardly peaceful; but when the hands which held the rein lost their nerve and power, and the troops, enervated by the softer climate of China, lost much of their hardihood, the long pent hatred of a foreign yoke broke out, and with gathered strength drove the invaders back to their Mongolian pasture-ground.

Not content with having recovered China, the emperor Hung-woo sent an army of 100,000 men into Mongolia in pursuit of the forces which yet remained to the Khakan. Even on their own ground the disheartened Mongols failed in their resistance to the Chinese, and at all points suffered disasters. Meanwhile Toghon Timur, who did not long survive his defeat, was succeeded in the Khakanate by Bilik Tu Khan who ascended in 1379, followed by Uskhai Khan. During the reign of this prince the Chinese again invaded Mongolia, and inflicted a crushing defeat on the Khan's forces in the neighbourhood of Lake Buyur. Beside the latter 2,000 officers and 77,000 soldiers are said to have been taken prisoners, with immense booty to have been secured. The defeat was the final ruin of the eastern branch of the Mongols, who from this time surrendered the supremacy to the western division of the tribe. At last the Keraits of Toregod, a tribe in the early days before Jenghiz Khan rose to power, exercised lordship over the eastern Mongols, but from these before long the supremacy passed to the Onjad who for fifty years treated them as vassals. Without finding their objection, however, the Keraits preserved the imperial line and Khakan after Khakan assumed the nominal sovereignty of the tribe while the real power rested with the descendants of Toghon, the Onjad chief who had originally attached them to his sceptre. Gradually, however, the Mongol tribes broke away from all controlling centres, and established separate and petty chiefs over the whole eastern Mongolia. The discredit of having finally dissolved the tribes originally attached to Jenghiz Khan's court belongs, in reference to his immediate successors, to have been enacted the Mongolian proverb "A second khakan disturbs the state, and a rat-bitten elephant overthrows his keeper."

At this time the Mongols, though scattered and isolated bodies, had recovered somewhat from the effects of the disaster which they suffered at the hand of the Ming sovereign of China. When first driven northwards they betook themselves to the banks of the Kerulon, whence they had originally started on their victorious career. But gradually as the Chinese power became weaker among the frontier tribes, they again pushed southwards

this time had established colonies in the Ordus, within the northern bend of the Yellow river ongol royal family and their immediate surroundings of the Chakhar country to the north-west of the territories, where they became eventually subjugated Manchus on the overthrow of the Mongol dynasty to the present rulers of China. Probably out of reverence for the royal descent of their chief, the emperors have invariably placed these Mongols a privileged position, and have incorporated the eight or military divisions of the Chakhars as one of the eight banners of the imperial Manchu army. The Mongol who submitted to the Manchus were into 24 banners, 19 representing all those on the east of the desert, and 86 the Khalkhas, whose stretched along the north of the desert from the neighbourhood of Barkul on the west to the Dalai the north-east. From and before this period the of the eastern Mongols has been that of all the tribes of central Asia, about which nothing can be certainly said than that that which appears most likely to happen, and that that which naturally be expected rarely occurs. Each tribe, fortune varied, either rose to power or sank into eance. At times the old vigour and strength and nerved the arm of Jenghiz Khan roused to the tribe, and we read of successful expeditions made by the Ordu Mongols into Tibet, and even of into China. The relations with Tibet thus ated brought about a rapid spread of Buddhism the Mongolians, and in the beginning of the 17th the honour of having a Dalai Lama born among vouchsafed to them. In 1652 Tsoba, one of the Ba-hukur Jonun Khan, went on a pilgrimage to ai Lama, and brought back with him a copy of the to be translated into Mongolian, as the Kanjur eady been. But though the power of the Ordu was still unsubdued, their mode of living was and rugged as the deposits and rocky hill which their territory. Their flocks and herds, on which entirely dependent for food and clothing, are not , and, like their masters, are neither well fed nor oured. But though living in the miserable condi princes yet keep up a certain amount of barbaric and the people have at least the reputation of being

Several of the tribes who had originally migrated those who finally settled in the Ordu territory, under ity to be so inhospitable, moved farther eastward per pasture. Among these were the Tumeds, one chiefs, Altan Khan, a famous in later Mongol his the power he acquired. For many years during the which he carried on a not altogether unsuccessful in China, and finally, when peace was made (1571), were fain to create him a prince of the empire conferred a golden seal of authority upon him. In these wars successful as in China but, as has observed in history, the physical conquerors became mental subjects of the conquered. Lamaism has had a great attraction in the eyes of the Mongols, on both the supernaturality of some Lamaist prisoners Altan brought back in his train, the religion spread time rapidly among the Tumeds. Altan himself ed the faith and received at his court the Bogda Gyamtso Khutukta, on whom he lavished every f honour. One immediate effect of the introduction dhism among the Tumeds was to put an end to the s which were commonly made at the grave of their ns. In 1584 Altan died, and was succeeded by his ge Dayancng Tumur. The rich territory occupied Tumed, together with the increased intercourse with China which sprang up after the wars of Altan, began effect a change in the manner of life of the people. degrees the pastoral habits of the inhabitants became agricultural, and at the present day, as in Manchuria, Chi immigrants have so stamped their mark on the fields market, on the towns and villages, that the country become to all intents and purposes part of China prop

Passing now from the inner division of the Mongols to say, the Chakhar and the 19 banners who live in southern and eastern portions of the desert we come to outer division, which is divided into 86 banners, occupies the territory to the north of the desert. Of t the chief are the Khalkha, who are divided into the W ern and Eastern Khalkhas. These people form the lin communication between Europe and eastern Asia. E m the 17th century the Russians sent an embassy to court of the Golden Khan with the object of persuading Mongol khan to acknowledge allegiance to the czar he did without much hesitation or inquiry, and he then despatched envoys to Moscow on the return of Russian embassy. But the allegiance thus lightly acknowledged was lightly thrown off, and in a quarrel which b out between the Khirghiz and the Russians the Khalk took the side of the former. The breach, however, soon healed over, and we find the Golden Khan send an envoy again to Moscow asking on behalf of his ma for presents of jewels, arms, a telescope, a clock, and monk who had been to Jerusalem that he might teach Khalkhas how the Christians prayed. Their submis to Russia on the north did not save them, however, t the Chinese attacks on the south. In central Asia the recent history of Russia in that part of the w shows, the depredations of a tribe on the property of ner tribesmen supply a ready cause of quarrel at any mom and the Chinese had no difficulty, therefore, in justify an invasion of the Khalkha territory. At that time present Manchu dynasty ruled in China, and to the t reigning sovereign the Khalkhas gave in their submiss For some time the Chinese yoke sat lightly on t conscience, but difficulties having arisen with the mind, they were ready enough to claim the protectio China. To cement the alliance the emperor Kang invited all the Khalkha chiefs to meet him at the p of Dolonor. This ceremony brought the separate his of the Khalkhas to a close, since from that time they h been enrolled in the Chinese empire.

Another important branch of the great Mongolian fa is the tribe of the Koshod or Eleuths. These claim their chieftains have maintained unbroken the direct des from Khoshar, a brother of Jenghiz Khan. Their h is in the neighbourhood of the Koko-nor, and in the cou to the north of the narrow strip of the Kansuh prov which separates that district from Mongolia proper. pasture in the territories thus indicated is rich and abu ant, and the Eleuths have therefore had fewer temptat to wander than most of their cognate tribes. Being t tationary and within a short distance of the Chinese f tier, they early fell under the dominion of that empire, in the year 1725 were incorporated into 29 imperial ban

During the Kin dynasty of China the Keraits, as been pointed out, were for a time supreme in Mongo and it was during that period that one of the ear recognized sovereigns, Merghus Buyuruk Khan, sat on throne. In an engagement with a neighbouring T tribe their Khan was captured and sent as a prop tory present to the Kin emperor, who put him to d by nailing him on a wooden ass. On the treache Tatar chief the widow determined to avenge herself, chose the occasion of a feast as a fitting opportun With well-disguised friendship she sent him a presen

ten oxen, a hundred sheep, and a hundred sacks of kumiss. These last, however, instead of being filled with skins of the liquor which Mongolians love so well, contained armed men, who, when the Tatar was feasted, rushed from their concealment and killed him. A grandson of Merghus was the celebrated Wang Khan, who was sometimes the ally and sometimes the enemy of Jenghiz Khan, and has also been identified as the Prester John of early Western writers. In war he was almost invariably unfortunate, and it was with no great difficulty, therefore, that his brother Ki Wang detached the greater part of the Kerait tribes from his banner, and

The Torgod.

founded the Torgod chieftainship, named probably from the country where they settled themselves. The mist peculiar to the dwellers in the Mongolian desert disturbed the Torgod as much as their neighbours. Their history for several centuries consists of nothing but a succession of wars with the tribes on either side of them, and it was not until 1672, when Ayuka Khan opened relations with the Russians, that the country obtained an even temporarily settled existence. Its position, indeed, at this time made it necessary that Ayuka should ally himself either with the Russians or with his southern neighbours the Turks, though at the same time it was obvious that his alliance with the one would bring him into collision with the other. His northern neighbours, the Cossacks of the Yaik and the Bashkirs, both subject to Russia, had the not uncommon propensity for invading his borders and harassing his subjects. This gave rise to complaints of the czar's government and a disposition to open friendly relations with the Krim khan. A rupture with Russia followed, and Ayuka carried his arms as far as Kasan, burning and laying waste the villages and towns on his route and carrying off prisoners and spoils. Satisfied with this vengeance, he advanced no farther, but made a peace with the Russians, which was confirmed in 1722 at an audience which Peter the Great gave him at Astrakhan. On Ayuka's death, shortly after this event, he was succeeded by his son Cheren Donduk, who received from the Dalai Lama a patent to the throne. But this spiritual support availed him little against the plots of his nephew Donduk Ombo, who so completely gained the suffrages of the people that Cheren Donduk fled before him to St Petersburg, where he died, leaving his nephew in possession. With consummate impartiality the Russians, when they found that Donduk Ombo had not only seized the throne but was governing the country with vigour and wisdom, formally invested him with the khanate. At his death he was succeeded by Donduk Taishi, who, we are told, went to Moscow to attend the coronation of the empress Elizabeth, and to swear fealty to the Russians. After a short reign he died, and his throne was occupied by his son Ubasha. The position of the Torgod at this time, hemmed in as they were between the Russians and Turks, was rapidly becoming unbearable, and the question of migrating "bag and baggage" was very generally mooted. In the war between his two powerful neighbours in 1769 and 1770, Ubasha gave valuable assistance to the Russians. His troops took part in the siege of Otchakoff, and gained a decided victory on the Kalans. Flushed with these successes, he was in no mood to listen patiently to the taunts of the governor of Astrakhan, who likened him to a "bear fastened to a chain," and he made up his mind to break away once and for all from a tutelage which was as galling as it was oppressive. He determined, therefore, to migrate eastward with his people, and on the 5th of January 1771 he began his march with 70,000 families. In vain the Russians attempted to recall the fugitives, who, in spite of infinite hardships, after a journey of eight months reached the province of Ili, where they were welcomed by the Chinese authorities. Food for a year's consumption was supplied to each family; and land, money, and cattle were freely distributed. [illegible] many lost their lives on the toilsome march it is impossible to say, but it is believed that 300,000 persons survived to receive the hospitality of the Chinese. The migration is interesting as illustrating the many displacements of tribes and peoples which have taken place on the continent of Asia at different periods of history. Some another migration occurred between four and five thousand years ago, when the Chinese crossed from western Asia into their present empire, such, again, was the movement which carried the Osmanli Turks from north-eastern Asia into Asia Minor, and eventually across the Bosphorus. By this desperate venture the Torgod escaped the re-imposition of the Russians, but they fell into the hands of other masters, who, if [illegible] equally determined to be supreme. The Chinese, flattered by the compliment implied by the transference of allegiance, settled them on lands in the province of Ili in the neighbourhood of the Altai Mountains, and to the west of the desert of Gobi. But the price they were made to pay for this liberality was adoption in the Chinese empire. Like the other Chinese-dubbed Mongols, the Torgod were divided into banners, and from that time forth they lost their individuality.

Among the Mongol chiefs who rose to fame during the rule of the Ming dynasty of China was Toobon, the Altuk Khan, who taking advantage of the state of confusion which reigned among the tribes of Mongolia, established for himself an empire in north-western Asia. Death carried him off in 1414, and his throne devolved upon his son Yesden, who was no degenerate offspring. Being without individual foes in Mongolia for the same reason that Nurhaci had no enemies [illegible] at he had killed them all, he turned his arms against China, which throughout history has been the happy hunting ground of the northern tribes, and had the unexampled good fortune to take prisoner the Chinese emperor Chingtung. But victory did not always decide in his favour, and, after having shattered reverses at the hand of the Chinese, he decided to open negotiations for the restoration of his imperial prisoner. This, after a captivity of seven years, Chingtung re-entered his [illegible] not altogether to [illegible] subject. On the death of Yesden [illegible] the Kalmuks lost much of their [illegible] but retained enough in other parts to assume the Khanate by virtue of their [illegible] and by constant acts of pillage and [illegible] were greatly restored [illegible] the united combination [illegible] the throne of his brother Seng[illegible]. Having been partly [illegible] at Ehcta he was well received by Arigh-pehtse-hoad, taking advantage of a quarrel between the Black and White Mountaineers of Kashgar overran Little Bokhara and left a viceroy to rule over the province with his capital at Yarkand. At the same time he opened relations with China, and exchanged presents with the emperor. Having thus secured his power southern and [illegible] to be thought, he turned his arms against the Khalkhas, whose chief ground of offence was their attachment to the cause of his brother. But his [illegible] and action created alarm at Peking, and the emperor Kanghi determined to protect the Khalkhas against the enemy. Great preparations were made for the campaign. The emperor, in person commanding one of the two forces, marched into Mongolia. After enduring incredible hardships during the march through the desert of Gobi the imperial army encountered the Kalmuks at Chromoto. The engagement was fiercely contested, but ended in the complete victory of the Chinese, who pursued the Kalmuks [illegible] 10 miles, and completely dispersed their forces. Immediately

were slain, among whom was Galdan's wife, and
housands surrendered themselves to the victors
with his son, daughter, and a few followers, fled
d and escaped, and thus collapsed a power which
ained at one time to overshadow the whole of Cen
a. For a time Galdan still maintained a semblance
truce to his powerful enemy, and death overtook
he yet in the field against the Chinese. The news
Galdan's death was received with great rejoicings at Pekin
Kang-hi held a special service of thanksgiving to Heaven
his ancestors were honoured, and ordered that the body
the enemy, whose body had been burned, should be
ought to the capital and there scattered to the four
winds. The fear which had been thus exorcised was no idle
one. Galdan was a man to be feared. The conqueror
Kashgar, Ili, Turfan, Karashar, Hami, and
numerous other towns, might well be considered a
formidable foe, and Heaven a merciful deliverer in ridding
the world of the cruel and dangerous Buddhist.

Although Galdan was dead the Chinese did not enjoy
complete immunity from war at the hand of his suc
cessors, but they had to deal with Arabtan's son, Amursana, who
had the shadow of his brother's and predecessor's
ambition without any of the Russian alliance which had
enabled his power in other directions. Little Bokhara
was said to be rich in gold mines, and therefore be
coveted region in the eyes of the Russian Under
Peter the Great an expedition
had been despatched to force a passage into the desired
land. To oppose the invasion the Kalmuks assembled
in force, and after a protracted and undecided engagement
the Russians were glad to agree to retire down the Irtish
and give up all further advance.

Arabtan's son, Amursana, succeeded Amursana's own
account he received from the Chinese emperor Kien-
Lung the nomination of Khan of the Kalmuks and
Prince Sungaria. But, though to the ear these titles
sounded as high-sounding as those of his predecessors, in
reality the power they represented was curtailed by the
presence of Chinese commissioners, in whose hands rested
the real authority. The galling weight of this state of
affairs soon drove Amursana before long into revolt. He
killed all the Chinese garrisons stationed in Ili, killed the
Chinese, and advanced his own forces as far as Pakhum on
the Ili. To punish this revolt, Kien-lung sent a large
force to the rebellious province. As on the previous occa
sion the Chinese were everywhere victorious, and Amursana
fled to Siberia, where he died of smallpox after a short
stay. The Chinese demanded his body, but the Russians
refused to give it up, though they allowed the Chinese
commissioners to identify it. On the death of Amursana,
Kien-lung determined to abolish the Khanate, and in place
of one nominated four Khans to rule over the Sungarians, the
Derbet, the Khoshod, and the Dorbod. But the divided
rule proved quite as unmanageable as that which had
been wielded by the Khan and the new rulers soon at
tempted to throw off the yoke imposed upon them from
without. Again a Chinese army marched into Ili, and this
time a severe measure of repression was meted out to the
Sungarians and their sympathizers. A general massacre of the
people was ordered, and was faithfully carried out. The
country which had been as a fruitful field was utterly
depopulated, and the place of the Sungarians was taken by exiled
Mongols from China.

While China was thus absorbing the Mongols within
her borders, Russia was gathering within her borders those
with whom she came into contact. Among these were
the Buriats, who occupied a large territory on both sides of
Lake Baikal Lake. As usual in such cases, disputes arose
over disturbances on the frontier, and were ended by
the Buriats and the neighbouring Mongol tribes becom
ing one and all tributary to Russia.

Of the Mongol tribes who became entirely subject
Russia the principal are those of the Crimea, of Kasan, an
of Astrakhan; of these the Tatars of Kasan are the tru
representatives of the Golden Horde or Kipchaks, wh
originally formed the subjects of Batu and Orda. Bat
whose victorious campaign in Russia has already bee
sketched, was finally awarded as his fief the vast steppe
which stretch from the Carpathian Mountains to th
Bolkai Hills. Over these vast plains the Mongols followe
their flocks and herds, while the more settled among the
established themselves along the banks of the rivers whic
flow through that region. Batu himself fixed his head
quarters on the Volga, and there set up his Golden Tent fro
which the horde acquired the name of the Golden Horde.
In 1256 Batu died and was succeeded by his brother Bereke
Khan. During the reign of this sovereign the exaction
which were demanded from the Russian Christians by th
Mongols aroused the Christian world against the barbaria
conquerors, and at the command of Pope Alexander IV.
a general crusade was preached against them. But thou
the rage of the Christians was great, they lacked the
united energy which might have availed them against the
enemy; and, while they were yet breathing out denuncia
tions, a Tatar host, led by Nogai and Talabugha, appeared
in Poland. After a rapid and triumphant march, the in
vaders took and destroyed Cracow, and from thence ad
vanced as far as Sythomir in Oppeln, from which point the
eventually retired, carrying with them a crowd of Christia
slaves. From this time the Mongols became for a season a
important factor in European politics. They corresponde
and treated with the European sovereigns, and intermarrie
with royal families. Hulagu, the famous general, marrie
a daughter of Michael Palaeologus; Toktu Khan took as h
wife Maria, the daughter of Andronicus II.; and to Nog
Michael betrothed his daughter Irene. But Bereke's in
fluence extended beyond Europe into Egypt, from whic
country, as well as from Constantinople, he secured th
services of artisans to build him dwellings of a mo
substantial nature than that of his Golden Tent. But t
widely extending intercourse with foreign nations brough
in its train a consequence which tended fatally to unde
mine the existence of the horde. His conversion to Isla
introduced a strongly disintegrating influence into the co
munity, and with it were sown the seeds of its final d
ruption. Bereke was succeeded on his death in 1265 by h
grandson Mangu Timur, who throughout his reign was co
stantly engaged in hostilities with the Russians and h
other European neighbours. The Genoese alone found und
his patronage a means of advancing their possessions. F
some time these people had held large colonies in southe
Russia, and in the Crimea had divided the trade with th
Venetians. By the support of Mangu Timur these la
were driven out of the field, and the Genoese were left
the enjoyment of a monopoly of the commerce. The reig
of the khans who succeeded Mangu Timur were no le
stormy than his had been; but even in these troublo
times the influences which surrounded the Mongols l
them onward in the path of civilization. Toktu, the ne
khan but one to Mangu Timur, is the first Mongol rul
whom we hear of as having struck coins. Those issu
during his reign bear the mint marks of Sarai, New Sara
Bulgar, Ukek, Kharezm, Krim, Jullad, and Madjarui, an
vary in date from 1291 to 1312.

The adoption of Islam by the rulers of the Golden Hor
had as one result the drawing closer of the relations
the Mongols with Constantinople and Egypt. Embassi
passed between the three courts, and so important was th
alliance with the Mongols deemed by the sultan Nás

ruler of Egypt, that he sent to demand in marriage a princess of the house of Jenghiz Khan. At first his request was refused by the proud Mongols, but the present of a million gold dinars, besides a number of horses and suits of armour, changed the refusal into an acquiescence, and in October 1319 the princess landed at Alexandria in regal state. Her reception at Cairo was accompanied with feasting and rejoicing, and the members of her escort were sent back laden with presents. With that religious toleration common to his race, Uzbeg Khan, having married one princess to Nasir, gave another in marriage to George the prince of Moscow, whose cause he espoused in a quarrel existing between that prince and his uncle the grand prince Michael. Nominally the attitude of a judge in the dispute, Uzbeg Khan summoned Michael to appear before him, and, having given his decision against Khan ordered his execution. The sentence was carried out with aggravated cruelty in sight of his nephew and successor. From this time Uzbeg's sympathies turned toward Christianity. He protected the Russian churches within his frontiers, and put his seal to his new religious views by marrying a daughter of the Greek emperor, Andronicus III. He died in 1340, after a reign of twenty-eight years. His coins were struck at Sarai, Kharezm, Mokshi, Bulgar, Azak, and Krim, and are dated from 1313 to 1340. His son and successor, Tinibeg Khan, after a reign of only a few months was murdered by his brother Janibeg Khan, who usurped his throne, and, according to the historian Ibn Hadjar, proved himself to be "just, God fearing, and the patron of the meritorious." These excellent qualities did not, however, prevent his making a raid into Poland, which was conducted in the usual Mongol manner, nor did they save his countrymen from being decimated by the black plague, which for the first time in 1345 swept over Asia and Europe from the confines of China to Paris and London. With all their love of war the Mongols had a keen eye to monetary advantage, and Janibeg, who was no exception to the rule, concluded treaties with the merchant princes of Venice and Genoa, in which the minute acquaintance displayed with shipping dues and customs charges shows how great were the advances the Mongols had made in their knowledge of European commerce since the days of Jenghiz Khan. The throne Janibeg had seized by violence was, in 1357, snatched from him by violence. As he lay ill on his return from a successful expedition against Persia he was murdered by his son Berdibeg, who in his turn was, after a short reign, murdered by *his* son Kulpa. With the death of Berdibeg the fortunes of the Golden Horde began rapidly to decline. As the Uzbeg proverb says, "The hump of the camel was cut off in the person of Berdibeg."

But while the power of the Golden Horde was dwindling away, the White Horde or Eastern Kipchak, which was the inheritance of the elder branch of the family of Juchi, remained prosperous and full of vitality. The descendants of Orda, Batu's elder brother, being far removed from the dangerous influences of European courts, maintained much of the simplicity and vigour of their nomad ancestors, and the throne descended from father to son with undiminished authority until the reign of Urus Khan (1360), when complications arose which changed the fortunes of the tribe. Like many other opponents of the Mongol rulers, Khan Tuli Khoja paid with his life for his temerity in opposing the political schemes of his connexion Urus Khan. Toktamish, the son of the murdered man, fled at the news of his father's death and sought refuge at the court of the famous Timur-i leng (Tamerlane), who received him with honour and at once agreed to espouse his cause. With this intention he despatched a force against Urus Khan, and gained some advantage over him, but, while fitting out another army to make a fresh attack, news reached him of the death of Urus. Only at Sighnak are coins known to have been struck during the reign of Urus, and these bear date from 1372 to 1375.

He was followed on the throne by his two sons, Tuk Toktakia and Timur Malik, each in turn; the first reigned but tamish for a few weeks, and the second was killed in a battle against Toktamish, the son of his father's enemy. Toktamish now seized the throne, not only of Eastern Kipchak but also of the Golden Horde, over which his arms had at the same time proved victorious. His demands for tribute from the Russian princes met with evasion from men who had grown accustomed to the diminished power of the later rulers of the Golden Horde and Toktamish therefore at once directed an army into Russia. Having captured Serpukhoff, he advanced on Moscow. On the 23rd August 1382 his troops appeared before the doomed city. For one day the inhabitants bravely withstood the constant attacks on the walls but failed in their resistance to the treacherous stratagem which was so common a practice in Mongolian warfare. Within a few hours of their opening the gates to the Mongols who declared themselves the enemies of the grand prince alone and not of the people the usual result followed. The Russian general who was invited to Toktamish's tent was there slain, and at the same time the signal was given for a general butchery. Without discriminating age or sex the Mongol troops butchered the wretched inhabitants without mercy, and, having made the streets desolate and the houses tenantless, they first plundered the city and then gave it over to the flames. The same pitiless fate overtook Vladimir, Zvenigorod, Yuriefi, Mozhaisk, and Dimitroff. With better fortune, the inhabitants of Pereslavl and Kolomna escaped with their lives from the troops of Toktamish, but at the expense of their cities which were burned to the ground. Satisfied with his conquests, the Khan returned homeward, traversing and plundering the principality of Riazan on his way. Flushed with success Toktamish demanded from his patron Timur the restoration of Kharezm, which had fallen into the hands of the latter at a period when disorder reigned in the Golden Horde. Such a request was not likely to be well received by Timur, and, in answer to his positive refusal to yield the city Toktamish marched an army of 90,000 men against Tabriz. After a siege of eight days the city was taken by assault and ruthlessly ravaged. Meanwhile Timur was collecting forces to punish his rebellious *protégé*. When his plans were fully matured, he advanced upon Old Urgenj and captured it. More merciful than Toktamish, he transported the inhabitants to Samarkand, but in order to mark his anger against the rebellious city he levelled it with the ground and sowed barley on the site where it had stood. On the banks of the Oxus he encountered his enemy, and after a bloody battle completely routed the Kipchaks, who fled in confusion. A lull followed the victory, but in 1390 Timur again took the field. To each man was given "a bow, with thirty arrows, a quiver and a buckler. The army was mounted, and a spare horse was supplied to every two men, while a tent was furnished for every ten, and with this were two spades, a pickaxe, a sickle, a saw, an axe, an awl, a hundred bowstrings, a bow-cord, an ox's hide, and a strong pin." Thus equipped the army set forth on its march. After a considerable delay owing to an illness which overtook Timur his troops arrived at Kara Saman. Here envoys arrived from Toktamish bearing presents and a message asking pardon for his past conduct; but Timur was inexorable, and, though he treated the messengers with consideration, he paid no attention to their prayer. In face of innumerable difficulties, as well as of cold, hunger, and weariness, Timur marched forward month after month through the Kipchak country in pursuit of Toktamish. At

ruler of Egypt, that he sent to demand in marriage a princess of the house of Jenghiz Khan. At first his request was refused by the proud Mongols, but the present of a million gold dinars, besides a number of horses and suits of armour, changed the refusal into an acquiescence, and in October 1319 the princess landed at Alexandria in regal state. Her reception at Cairo was accompanied with feasting and rejoicing, and the members of her escort were sent back laden with presents. With that religious toleration common to his race, Uzbeg Khan, having married one princess to Nasir, gave another in marriage to George the prince of Moscow, whose cause he espoused in a quarrel existing between that prince and his [illegible] prince Michael. Assuming the attitude of a judge in the dispute, Uzbeg Khan summoned Michael to [illegible] him, and, having given his decision against him, ordered his execution. The sentence was carried out with aggravated cruelty in sight of his nephew and successor. From this time Uzbeg's sympathies turned towards Christianity. He protected the Russian churches within his frontiers, and put his seal to his new religious views by marrying a daughter of the Greek emperor, Andronicus III. He died in 1340, after a reign of twenty-eight years. His coins were struck at Sarai, Kharezm, Mokshi, Bulgar, Vesh, and Krim, and are dated from 1313 to 1340. His son and successor, Tinibeg Khan, after a reign of only a few months was murdered by his brother Janibeg Khan, who usurped his throne, and, according to the historian Ibn Hordal, proved himself to be "just, God fearing, and the patron of the meritorious." These excellent qualities did not, however, prevent his making a raid into Poland, which was conducted in the usual Mongol manner, nor did they save his countrymen from being decimated by the black plague, which for the first time in 1345 swept over Asia and Europe from the confines of China to Paris and London. With all their love of war the Mongols had a keen eye to monetary advantage, and Janibeg, who was no exception to the rule, concluded treaties with the merchant princes of Venice and Genoa, in which the minute acquaintance displayed with shipping dues and customs charges shows how great were the advances the Mongols had made in their knowledge of European commerce since the days of Jenghiz Khan. The throne Janibeg had seized by violence was, in 1357, snatched from him by violence. As he lay ill on his return from a successful expedition against Persia he was murdered by his son Berdibeg, who in his turn was, after a short reign, murdered by *his* son Kulpa. With the death of Berdibeg the fortunes of the Golden Horde began rapidly to decline. As the Uzbeg proverb says, "The hump of the camel was cut off in the person of Berdibeg."

But while the power of the Golden Horde was dwindling away, the White Horde or Eastern Kipchak, which was the inheritance of the elder branch of the family of Juchi, remained prosperous and full of vitality. The descendants of Orda, Batu's elder brother, being far removed from the dangerous influences of European courts, maintained much of the simplicity and vigour of their nomad ancestors, and the throne descended from father to son with undiminished authority until the reign of Urus Khan (1360), when complications arose which changed the fortunes of the tribe. Like many other opponents of the Mongol rulers, Khan Tuli Khoja paid with his life for his temerity in opposing the political schemes of his connexion Urus Khan. Toktamish, the son of the murdered man, fled at the news of his father's death and sought refuge at the court of the famous Timur-i leng (Tamerlane), who received him with honour and at once agreed to espouse his cause. With this intention he despatched a force against Urus Khan, and gained some advantage over him, but, while fitting out another army to make a fresh attack, news reached him of the death of Urus. Only at Sighnak are coins known to have been struck during the reign of Urus, and these bear date from 1372 to 1375.

He was followed on the throne by his two sons, Toktakia and Timur Malik, each in turn; the former reigned for a few weeks, and the second was killed in a battle against Toktamish, the son of his father's enemy. Toktamish now seized the throne, not only of Eastern Kipchak but also of the Golden Horde, over which his arms at the same time proved victorious. His demands for tribute from the Russian princes met with evasion from those who had once been forced to the diminished power of the intermediaries of the Golden Horde and Toktamish therefore at once directed an army into Russia. Having captured Serpukhoff, [illegible] 1382 his troops were [illegible] the doomed city [illegible] obstinately withstood the combined attack [illegible] still but failed in their resistance to [illegible] were [illegible] common a phrase in Mongol warfare. When [illegible] room for credulity they opened the gates to the Mongols, who declared themselves the enemies of the grand prince alone and not of the people. The ruse succeeded. The Russian general who was invited to visit Toktamish was there [illegible], and at the same time [illegible] for a general slaughter. Without any criminal [illegible] of the Mongol troops butchered the wretched inhabitants without mercy, and, having set the streets [illegible] and the houses [illegible], they plundered the city and then gave it over to the flames. The same pitiless fate overtook Vladimir, Zvenigorod, Yuriefl, Mozhaisk, and Dimitroff. With better fortune the inhabitants of Pereslavl and Kolomna escaped with their lives from the troops of Toktamish, but at the expense of their cities, which were burned to the ground. Satisfied with his conquests, the khan returned homeward, travelling and plundering the principality of Riazan on his way. Flushed with success Toktamish demanded from his patron Timur the restoration of Khorezm, which had fallen into the hands of the latter at a period when disorder reigned in the Golden Horde. Such a request was not likely to be well received by Timur, and, to answer to his positive refusal to yield the city Toktamish marched an army of 90,000 men against Tabriz. After a siege of eight days the city was taken by assault and ruthlessly ravaged. Meanwhile Timur was collecting forces to punish the rebellious vassal. When his plans were fully matured he advanced upon Old Urgenj and captured it. More merciful than Toktamish, he transported the inhabitants to Samarkand, but in order to mark his anger against the rebellious city he levelled it with the ground and sowed barley on the site where it had stood. On the banks of the Oxus he encountered his enemy, and after a bloody battle completely routed the Kipchaks, who fled in confusion. A lull followed the victory, but in 1390 Timur again took the field. To each man was given "a bow with thirty arrows, a quiver and a buckler. The army was mounted, and a spare horse was supplied to every two men, while a tent was furnished for every ten, and with each were two spades, a pickaxe, a sickle, a saw, an axe, and a hundred [illegible] cord, an ox's hide, and a [illegible] pin." Thus equipped the army set forth on its march. After a considerable delay owing to an illness which overtook Timur his troops arrived at Kara Saman. Envoys arrived from Toktamish bearing presents and a message asking pardon for his past conduct; but Timur was inexorable, and, though he treated the messengers with consideration, he paid no attention to their prayer. In the face of innumerable difficulties, as well as of cold, hunger and weariness, Timur marched forward month after month through the Kipchak country in pursuit of Toktamish.

t, on the 18th of June, he overtook him at Kandurcha, the country of the Bulgars, and at once forced him to an gagement For three days the battle lasted, and atter lining now to thi side and now to that victory finally de ed in favour of Timur. The Kipchaks were completely ted and fled in all directions, while it is said as many 100,000 corpses testified to the severity of the fighting. mur pursued his flying enemy as far as the Volga, ghtering all who fell into his hands, and ravaged and royed the towns of Sarai, Saraichuk, and Astrakhan. ving inflicted this terrible blow on the Golden Horde, mur distributed rewards to his chieftains and presided a series of banquets in celebration of his victory. These ings over, he returned to Samarkand laden with spoils trophies. But Toktamish, though defeated, was not dued, and in 1395 Timur found it necessary again to ertake a campaign against him. This time the armies upon the Terek, and after a fiercely-contested battle Kipchaks again fled in confusion When the victory gained, Timur, we are told, knelt down on the field returned thanks to Heaven for his success. The pur- along the Volga was vigorously undertaken, and th ghter among the fugitive was terrible. The hurried ance of T horsemen threw the Russians into a e of wild alarm, and the grand prince Moscow red that an ancient image of the Virgin which was ved to possess miraculous power should be taken to scow to save that city from the destroyer. Success eared to attend this measure, for Timur, threatened by advancing autumn, gave up all further pursuit, and red with a vast booty of gold trinkets, silver bars, pieces of broch linen and of the embroidered cloth of Russia, &c. his homeward march southwards he arrived before k, which was then the entrepôt where the merchants the east and west exchanged their wares. In vain the ves, with the Egyptian, Venetian, Genoese, Catalan, Basque inhabitants, besought him to spare the city answer was a command to the Moslems to separate nselves from the rest of the people whom he put to sword, and then gave the city over to the flames. ussia and Georgia next felt his iron heel, and the nesses of the central Caucasus were one and all oyed. After these successes Timur gave himself up a time to feasting and rejoicing, accompanied by every nite display of Oriental luxury. The tent or audience hung with silk, its poles were golden, or probably ed with golden plates, the nails being silver, its pe was of gold, enriched with precious stones, the illed with water. But his own

not satisfied, and, having refreshed his troops by this , he marched northwards against Astrakhan, which he ly destroyed. The inhabitants were driven out into country to perish with the cold, while the commander he city was killed by being forced beneath the ice of Volga. Sarai next shared the same fate, and Timur, ing thus crushed for the second time the empire of ingis Khan, on his return home by way of Derbend Azerbijan. The defeated khan succeeded shortly rwards in re-capturing Sarai, but, being again driven he retired in 1398 to Kiefl, a fugitive from his king n. During his reign, which lasted for twenty-four years, struck coins at Kharezm, Krim, New Krim, Azak, a, New Sarai, Saraichuk, and Astrakhan. The power he hands of the successors of Toktamish never revived the last campaign of Timur. They were constantly aged in wars with the Russians and the Krim Tatars, whom the Russians had allied themselves, and by es their empire decayed, until, on the seizure and th of Ahmed Khan at the beginning of the 16th cen- , the domination of the Golden Horde came to an end.

One solitary fragment of the Golden Horde, the Khan of Astrakhan, maintained for a time an existence after fall of the central power. But even this last remna ceased to be a Mongol apanage in 1554, when it w captured by the Russians and converted into a Russ province. The fate which thus overtook the Golden Ho was destined to be shared by all the western branches the great Mongol family. The khans of Kasan a Kasimoff had already in 1552 succumbed to the growi power of Russia, and the Krim Tatars were next fall under the same yoke. In the 15th century, wh the Krim Tatars first appear as an independent pow they attempted to strengthen their position by ally themselves with the Russians, to whom they looked help against the attacks of the Golden Horde. But wh they were in this state of dependence another power ar in eastern Asia which modified the political events of t region. In 1453 Constantinople was taken by Osmanli Turks, who, having quarrelled with the Geno merchants who monopolized the trade on the Euxine, s an expedition into the Crimea to punish the presumptu traders. The power which had captured Constantino was not likely to be held in check by any forces at t disposal of the Genoese, and without any serious oppo tion Kaffa, Sudak, Balaclava, and Inkerman fell before troops of the sultan Mohammed. It was plain th situated as the Crimea was between the two great pow Russia and Turkey, it must of necessity fall under direction of one of them. Which it should be w decided by the invasion of the Turks, who restored Men Girai, the deposed khan, to the throne, and virtua converted the khanate into a dependency of Constan nople. But though under the tutelage of Turkey, Men Girai, whose leading policy seems to have been the des to strengthen himself against the khans of the Gold Horde, formed a close alliance with the grand prince Iv of Russia. One result of this friendship was that Mongols were enabled, and encouraged, to indulge th predatory habits at the expense of the enemies of Russ and in this way both Lithuania and Poland suffer terribly from their incursions. It was destined, howev that in their turn the Russians should not escape fr the marauding tendencies of their allies, for, on pret of a quarrel with reference to the succession to the Kas throne, Mohammed Girai Khan in 1521 marched an ar northwards until, after having devastated the count massacred the people, and desecrated the churches on route, he arrived at the heights of Vorobieff overlooki Moscow. The terror of the unfortunate inhabitants the sight once again of the dreaded Mongols was extrem but the horrors which had accompanied similar p vastations were happily averted by a treaty, by wh the grand prince Vasili undertook to pay a perpetual tr ute to the Krim khans. This, however, proved but a tru It was impossible that an aggressive state like Russia shou live in friendship with a marauding power like that of t Krim Tatars. The primary cause of contention was t khanate of Kasan, which was recovered by the Mongo and lost again to Russia with that of Astrakhan in 15 The sultan, however, declined to accept this condition these as final, and instigated Devlet Girai, the Kr khan, to attempt their recovery. With this object t latter marched an army northwards, where, finding the ro to Moscow unprotected, he pushed on in the direction that ill-starred city. On arriving before its walls he fou a large Russian force occupying the suburbs. With the however, he was saved from an encounter, for just as foremost men approached the town a fire broke o which, in consequence of the high wind blowing at t time, spread with frightful rapidity, and in the spa

hours destroyed all the churches, palaces, and with the exception of the Kremlin, within a s of 30 miles. Thousands of the inhabitants d in the flames. "The river and ditches about y," says Horsey, "were stopped and filled with the ades of people, laden with gold, silver, jewels, ear-rings, and treasures. So many thousands were ourned and drowned that the river could not be for twelve months afterwards." Satisfied with struction he had indirectly caused, and unwilling to the Kremlin, the khan withdrew to the Crimea, ng the country as he went. Another invasion of , a few years later (1572), was not so fortunate for ongols, who suffered a severe defeat near Molodly, ts from Moscow. A campaign against Persia made ersion in the wars which were constantly waged n the Krim khan and the Russians, Cossacks, and So hardly were these last pressed by their pe ns enemies in 1619 that they bound themselves ty to pay an annual subsidy to the khan. But rtunes of war were not always on the side of the and with the advent of Peter the Great to the n throne the power of the Krim Mongols began to . In 1696 the czar, supported by a large Cossack nder Mazeppa, took the field against Selim Gerai and gained such successes that the latter was led to cede Azoff to him. By a turn of the wheel tune the khan had the satisfaction in 1710 of it restored to him by treaty; but this was the last ccess that attended the Tatar arms. In 1736 the ns in their turn invaded the Crimea, captured the ted lines of Perekop, and ravaged Bakchi Serai, ital. The inevitable fate which was hanging over rim Tatars was now being rapidly accomplished. 83 the Krim, together with the eastern portion of d of the Nogais, became absorbed into the Russian e of Taurida.

ther branch of the Mongol family which represents n is that of the Kazaks (see KIRGHIZ, vol. xvi. pp.), whose ancient capital was Sighnak, which, as we ren, passed into the hands of the great Timur. It ow only be necessary to refer briefly to the Uzbegs, n the destruction of the Golden Horde, assumed an ant position on the east of the Caspian Sea. The r of their greatness was the khan Abulkhair who d in the 15th century, and who, like another Jenghiz consolidated a power out of a number of small clans, lded lustre to it by his successful wars. Sheibani, his grandson, proved himself a worthy successor and ghty antagonist of the great Moghul emperor Babur. 00 he inflicted a severe defeat on Babur's forces, and ed Samarkand, Herat, and Kandahar. By these and conquests he became possessed of all the country between the Oxus and the Jaxartes, of Ferghana, Kharatissar, as well as of the territory of Tashkend from ar to the frontiers of China. In the following year, ushing exploit, Babur recovered Samarkand, but only it again a few months later. During several succeeding ars Sheibani's arms proved victorious in many fields tle, and but for an indiscreet outrage on the sister of the shah of Persia he might have left behind him erful empire. The anger, however, of Shah Ismael against him a force before which he was destined . The two armies met in the neighbourhood of where, after a desperate encounter, the Uzbegs completely defeated. Sheibani, with a few followers refuge in a cattle pound. But, finding no exit on rther side, the refugees tried to leap their horses the wall. In this attempt Sheibani was killed, his body was recognized by his exultant enemies they cut off the head and presented it to the sha caused the skull to be mounted in gold and to be con into a drinking cup. After this defeat the Uzbegs wit across the Oxus and abandoned Khorasan. Further news aroused Babur to renewed activity, and before he reoccupied Samarkand and the province "Beyon River," which had been dominated by the Uzbegs fo years. But though the Uzbegs were defeated, they w no means crushed, and ere long we find their khan re now at Samarkand and now at Balkh. A time and European power began to encroach more and nate Asia the history of the Khanate ceases to be c to the interneeine struggle of rival khans. Even Ba was not beyond the reach of Russian ambition and I diplomacy. Several European envoys found their further during the first half of the present century the murder of Stoddart and Conolly in 1842 fo melancholy episode in British relations with that ba capital. With the absorption of the khanate of Bo and the capture of Khiva by the Russians the indi history of the Mongol tribes in Central Asia comes

[illegible]

[illegible]

[illegible]

...nheation of the name *Oelet*, in the East Monggolian *Oeghet*, ...most widely spread among the tribes living in China, ...very decidedly. Some assert that "Oelet" is nothing but ...ese transcription of Oirad, as the ordinary Chinese language ...possesses the sound *r*. We have, however, to bear in mind ...have a Mongolian root *oelekha*, with the sense "to be in- ...cited, stirred, ill will, &c. The main population of the ... ...ther drag out, their existence after the naval ...Songaria, in the eastern part of the Thian ...

...e south border of the Gobi, or Lob-nor, and in the ...d Koko-nor. Many are under the Chinese Govern- ...ment; however, of the extension of the Ba... ...tion and Vassalage many have become Free from ... ...According to an approximate account we have ... ...ation within the limits of the Russian Empire ... ...but, the nomad population amounts to about ... ...the Kirghis and a number of Turkish peoples ... ...the road of the Volga to Astrakhan. Even in ... ...entirely the Mongolian character.

...and the Ob. Between the Yenisei and the ...ttled in Tuva, the Soyot, a people of the Yeni... ...pe... ...ng of the Oirad, to the Dorbet, and in 1674 to the ... ...a considerable number returned to the Chinese ...

...ce they have not unimportant populations ...ccupied the Irtish, which flows between the ... ...Volga on the east and the Don in the west, and ... ...steppes in the north of the Kirghis and the Ma... ...n. According to modern statistics, their popu... ...amounts to [illegible]. To the west have to add 4,000 nomads ...ts of the Government of the Don, and 1,229 in the ...provinces of Orenburg and Astrakhan. The same total of ...bled Volga Kalmuks (Derbet) amounts to 169,531.

...the southern part of the Russian province of Irkutsk ...ccle round the Baikal Lake in the heirloom property ...ets, who in the year 1731 (the Holy Seal of the country ...e taken communes, freed from burthen. Their country ...ly extends from the Chinese frontier on the south stream ...alled lines to the north, to the town Lake Kosogol. Here, ...the Onon in the west to the Oka and the valley of the Argun, ...t, and till the Tschikoi were also reckoned. Nearer Dahuria they ...numerous beyond the Baikal Lake, in the valleys of ...the Onon, and the Schilka and on Nertschinsk. ...ak-thate Buriats came to Russian part only towards the end ...th century from the Khalkha. While Mongol not Kal... ...nerally continue to live after the manner of nomads, ...re agricultural parts, possibly however, the nomadic ...n influence. The transition is gradual. The ...t of the Buriats amounts at present to about 250,000 ...r tribes separated from the rest of the Mongols by the ...ers the Ikeserat (Ikeserten) and the Kori Arghalei, ...sh about a hundred men in Alghamun Gol, between Hami and ...n external character to the Buriat Mongols, still ...ly they are the remains of a tribe from the ...dvance. Their language, which has lost of course ...es to unity Mongolian, more particularly West Mongolian, ...

...Kalmuk has proved by H. C. von der Gabelentz ...hly with the threefold division of the Mongol ...threefold division of their people. The ... ...n or Mongolian people, (2) West Mongolian or Kalmuk ...te ...

...ect mentioned are found to be in close relation to ...ect mean their root-syllables and connected ... ...the verb.

...ther type of Pronoun and kind of Pronoun is a ...n affix the [illegible] of vowel which are ... ...the root-syllable, and the other, ...which are in the suffix. All vowels of the same word ...ently harmonize, so that the nature of the ...oot-vowel, whether the [illegible] of the other or inflexion-vowel ...now and then a kind of [illegible] harmony takes place ...a later vowel determined by the nature of the former. The ...t pronominal vowel are [illegible] under their influence ...n certain cases, which in a slightly altered form re... ...e among the [illegible] expedientially from ...nward, and the same follow from left to right, the alpha... ...*a*, *e*, *u*, *o*, *ö*, *ü*, and diphthongs ...*ai*, *ui*, and for seventeen con... ...*n*, *b*, *kh*, *ch*, *k*, *g*, *n*, *l* [illegible] *t*, *d*, *n*, *s* (*sh*), *ts*, ... All these are modified in [illegible] due to their position, ...eginning, middle, or end of a word, and also by certain ...phic rules. In Mongolian and Manchu writing the syllable ...con... ...mant together with the vowel is considered as a unit, ...

...ee, "Ueber die Sprache der Dschurdschen und Anuchen," in the *Zeit- ...chrift für die Kunde des Morgenlandes*, vol. [illegible] pp. [illegible]

...in other words a syllabarium rather than an alphabet. The ...ing characters are lineal descendants of the original Uigurian le... ...which were themselves derived from the Syriac, having been br... ...to the Uigurs by Nestorian missionaries. An Indian and Ti... ...influence may also be noticed, while the arrangement of the ...acters in perpendicular lines is common to the Chinese. The ...ing was brought into its present shape by the learned Lama ...skya Pandita, Phags-pa Lama, and Ishoni-hi Odser in the ...century, but is exceedingly imperfect. To express the freque... ...occurring letters borrowed from Sanskrit and Tibetan, whic... ...warming in the Mongol alphabet, a special alphabet called ... ...is employed. Every one who has tried to read Mongolian k... ...has many difficulties have to be overcome, arising from the ... ...rity of certain letters, or from the fact that the same sign ...be pronounced differently according to its position in the ... ...Thus there are no means to distinguish the *a* and *e*, *a* a... ...the consonant *q* and *ch*, *l* and *d*, *q* and *s* (*sh*), *l* and *s* (*t*) ... *o*, *ö* and *u*, *ü* and *kh* (*dz* and *ts*), are liable to be mi... ...for each other. Other clumsiness will be noticed and avoide... ...of a real defect. But a great defect that such common ... *a*, *e*, *i*, *o*, *u*, and *ai*, here, *ui* (*ö*, *ü*) and *ui* (*ö*, *ü*) ... ...*ai* (*ö*, *ü

endings in singular and plural. Gender is not indicated. djective is unaffected both as attribute and as predicate, s no comparative form, this idea being expressed by the con- on or by the use of certain particles. The personal pronoun- I; *tchi*, thou; *bida*, we; *ta*, ye; their genitive serve as pos- es. The demonstratives are *ene*, *ere* (this, that), plural *ede*, interrogative *hen*, who? The relative is lacking, and its place plied by circumlocution. The numerals are 1, *negen*; 2, r, 3, *gurban*; 4, *durben*; 5, *tabun*; 6, *jirgaghan*; 7, *dologan*, *nan*, 9, 10, *arban*, 100, *dsagan*, 1000, *mingan*. edinals are formed by appending *tegus*, *tugar*. Fix them of ch is seen in the imperative *a-tsa*, *ea-ya*. The n forms for tense and mood but periphrastic modes are well ception are provided. Th nt is formed from the theme ing *mandar-mand*, the pr by *mand* or *mand* (*mandsa-mandsa*, *bi* th future by *mandsa* or *mandsa* (*mandsa-mandsa*, *bi* The pret me in the third per on the termination *-ba* and *-ba*, th has in the third per on *-ba* and in the be *-ba*. The con l end- n the pre t m *-ba-mand*, otential in *-ba-mandsa*, the imperfect pret n *-ba* me l in the present in *-d* (*-dar*, *-der*, *-dor*, *-dur*, *-bar*, *-ber*, *-bor*, *-bur*, *-dsar*, *-dser*, *-dsor*, *-dsur*), in the preterite in *-ba* (*-bar*, *-ber*, *-bor*, *-bur*), and the present part has *-kchi* (*mandakchi* = pr t per *thereseen*); the supine ends in *-ra*, the conjunctive in *-ra*, or when used substantively *-rakchi*. There are four regular conjugation and derivative form derived from me by suffixes, are computed on the same scheme. Gram sive has suffixed *-ta* or *-tda* (*bar-tdakhu*, to be ca peth); ve *-gul* (*mandagulkhu*, to cause to carry); the cooperative ve *-ldsa* or *-ldsa* (*bar-ldsakhu*, to carry together). re are no prepositions, only post-positions. Adverbs are also e particles (affirmative, negative, interrogative, modal, etc.) formed by suffixes from other part of speech. There are few conjunctions, the relations of clauses and sentences are y indicated by the verbal forms (part., cup., conditional, etc.) v by the gerund).

e order of words and sentences in construction is pretty much pposite of that which we follow. In a simple sentence the ation of time and place, whether given by an adverb or a nou ve with a post-position, always comes first; then comes the t, always preceded by its adjective or genitive, then the object ther cases depending on the verb, last of all the verb itself ded by any adverbs that belong to it. So in the structure of od all causal, hypothetical, concessive clauses which can be ived as preceding the main predication in point of time, so as contemporary with it, or as in any way modifying it, must first, the finite verb appears only at the end of the main ation or apodosis. The periods are longer than in other uages; a single one may fill several pag

ammars and dictionaries may be divided according to the Buria dialect st Mongolian, I. J. Schmidt gave the first grammar (Det rsb 1 II), and golian-German-Russian dictionary (Peterb., 1835). Next to know how it hed in Russia are a Mongolian grammar (Kazan, 1) and a Buriat-Mongolian-Russian dictionary (Kazan, 1846–47), and in great *Dictionnaire mongol-français* (Paris, 1844, 1846, 1850). We name also R. Vasili, *Sur la Mongolie et les Mongols* (Mongolian), xylographed at the mission press at Peking in 1838, and A. Bobrownikow's Russian *Grammar of the Mongol-Buriat* (Kazan, 1849) is also very good. An abridgment of Schmidt's Pallas, *Elements della grammatica mongolica* (Florence, 1), A. Popow's *Vom Ober-Tanguthischen* appeared in Vienna at Kazan (1858). For the Kalmuk e grammars by Popow (Kazan, 1847), Bobrownikow (Kazan, 1849), as *Lehrb.*, autographed at Donaueschingen (1849), Zwick (also autographed k and German dictionary with a printed German key appeared n 1852, B. Jülg's edition of the fable of Siddhi-kur (Leipzig, 1) plete glossary to the stories. There are small but excellent ulaties by P. Smirnow (Kazan, 1857) and C. Goldmann (St Petersb., 1869).

For the Buriatic we have Castrén, *Versuch einer Buriatischen Sp* edited by Schiefner (1857) and A. Orlow's Russian grammar of the Mon ate colloquial language (Kazan, 1875).

Literature. A clear distinction must be drawn be written or book language and the comm day life. The difference between the fairly compared to that between the Modern High German boo the different dialects. All grammars and dictionaries as yet pu nly of the book language, and so far with a few exceptions the literary documents are wr ept *Ö-ts-khaas*, and the *south* Gobi and Ala. The population ar on the b lived in wigwams by A. Pozdn Russian ser of the l who b certain rights to land in the form of hereditary fiefs. The literature I have at present access to [illegible] Tibetan, the Buddhist sacred language of Buriatia, is still the lan guage of the Buriat Lamaist priesthood. The Tibetan letters (*Uchen*) are used in the hom e-books, such as Mongol [illegible] Lamaist services, but the Buriats themselves [illegible] the Tibetan (*Uchen*) the Buriat-Mongol [illegible] ers, for instance with the fable of Siddhi-kur. Many blocks have been [illegible] at Tsongol-Datsan. Many [illegible] have also been [illegible] pleted [illegible] Datsan [illegible] for the [illegible] perhaps [illegible] [illegible] [illegible]

congenial employment, and in February 1641 he
at Dublin as colonel of Lord Leicester's regiment.
greatly increased his reputation. Under the most
circumstances he was ever cool, patient, vigorous
disciplinarian, he was always attentive to the wants
men, and completely won their confidence and affec-
All the qualities for which he was noted through
calculating selfishness, which kept him ever on
money side and by which he accomplished his great
successes, the imperturbable temper and impene-
secrecy, were fully displayed in this employment.
but one interest, that of George Monk, and to
that interest he laboured, while retaining his free-
from party ties, to make himself indispensable as a
The government of Dublin was vacant, and Monk
pointed by Leicester. But Charles I. overruled the
ment in favour of Lord Lambert, and Monk, with
brave words, gave up his claim. Ormond, however,
ewed him with suspicion as one of the two officers
used the oath to support the royal cause in Eng-
ent him under guard to Bristol. He now deemed
t to affect Royalist views. His value caused him
received at once into Charles's confidence, he was
ed major-general of the Irish brigades, and served
Byron at the siege of Nantwich. Here he was
ner-owned by Fairfax, on 25th January 1644 in one
most skilful operations of the war. After a short
y in Hull he was placed in the Tower, where he
d for three years, during which his father died,
ng his time partly in writing his *Observations*
ary and Policy of Wars.
ing the war Monk could not be released,
, however, became a prisoner, the troubles in
made the parliament anxious to secure Monk's
, and he was told that if he would take the Cove-
might have an important command. With some
hesitation the terms were accepted, and, after a
of two months in Lord Leven's abortive expedition,
was placed in command of the Parliamentary forces in the
f Ireland. Compelled in 1643 to conclude a pacifi
with the rebel O'Neill, he returned to England after
g's execution. In the next year he succeeded, by
brother's death, to the Devonshire estates. He remained
out a short while. Cromwell gave him a regiment
command of the ordnance in the Scotch war of
nd after the battle of Dunbar, in which he left the
he was left with 6000 men to "settle the country,"
after taking Edinburgh, Tantallon, and Stirling
he did most completely in a few weeks. In 1651
sted with fever, but recovered at Bath and in
e year was appointed on the commission for pro-
the Union. In 1653, with Admiral Penn, he
anded the British fleet against the Dutch, and on
3d June and 29th July fought two of the most
ary naval battles on record, in which both Blake
and Van Tromp were slain. A peace on very
favourable to the Dutch was concluded, but politi-
ly Cromwell's fellow-soldiers considered, a course
on which Monk heartily concurred. On his
he married Anne Clarges, a woman of
e Covenanting chaplain honestly dowdy, "as
who, like other writers who mention her, is unduly
s complaisance. Monk was now sent to quell the
headed by Middleton in Scotland, and, when this
was over, settled down to a steady government of
ntry for the next five years. For fanaticism in any
e had no sympathy, and he set himself to diminish
uence of the Presbyterian clergy. Cromwell's chief
nts, taking from them the power of excommuni
and their general assemblies, but allowing them to
retain their presbyteries. Equal repression was ex
against the nobility and gentry. The timely discov
plot fomented by Overton for killing Monk on New
Day gave him an excuse for thoroughly purging h
of all Anabaptists, Fifth Monarchy men, and other
ous enthusiasts. It is doubtful whether at this tim
had proposed to himself the restoration of the kin
probably had it always in his mind as a possibility,
would run no risks. His very reticence, however,
alarm on one side and hope on the other. In
received a letter from Charles II., a copy of which
once sent to Cromwell, whom, however, we find wr
him in 1657 in the following terms: "There be s
me that there is a certain cunning fellow in Scotland
George Monk, who is said to lye in wait there to in
Charles Stuart; I pray you, use your diligence to
hend him, and send him up to me."

During the confusion which followed Cromwell's
Monk remained silent and watchful at Edinburgh,
only to secure his hold on his troops. In July
direct and tempting proposals were again made
by the king. His brother Nicholas, a clergyman, w
ployed by Sir J. Grenvil to bring to him the subst
Charles's letter. No bribe, however, could induce
act one moment before the right time. He h
brother go back to his books, and refused to entert
proposal. But when Booth rose in Cheshire for th
so tempting did the opportunity seem that he
the point of joining forces with him; and a lett
written to the Rump parliament threatening ton
did not at once fill up its numbers. His habitual c
however, induced him to wait until the next pos
England, and the next post brought news of
defeat. On 17th October he heard of Lambert's
defeat. From that moment his plan of action se
have been settled. In most vehement language
derided the idea of restoring Charles, and, with ad
perception of the state of English feeling, took
principles that in all cases the army must obey t
government, and that the civil government re
parliamentary. At present the Rump was crushed
military party; the first thing, therefore, to be done
free it. His army underwent a second purging
affection and he then issued a declaration embody
principles mentioned above, and wrote to Lenth
speaker, and to the military party to the same
In a treaty with the Committee of Safety his commis
who were to treat only on the basis of the restora
parliament, were outwitted. Monk at once refu
to accept the terms proposed, and marched to Berwick,
received an offer from Fairfax of assistance if he
promise that the secluded members should be re
Meanwhile Lambert had marched northwards to
his advance.

Monk's action gave fresh heart to the adherents
parliament. The old council of state met, and
him general of all the forces; the fleet and th
army hitherto hostile, came round to his side, and
Whetham at Portsmouth. Monk now, in the de
winter crossed the Tweed at Coldstream and marc
Morpeth to Newcastle, receiving letters on his wa
the lord mayor and corporation of London urging
declare for a free parliament. On his approach La
army fell away from their general, and no obsta
marched on the path to London. At York, when u
Fairfax, he refused to declare for the king, and is
have caned an officer who affirmed that such w
design. The parliament now ordered him to c
London. Fleetwood's army which occupied the ci
however, a great obstacle; and it was not until the

BRECKNOCK

HEREFORD

Abergavenny

MONMOUTH

Pontypool

Carleon

Caerleon

Chepstow

NEWPORT

Christchurch

Portishead

Clevedon

SOMERSE

BRIDGEWATER BAY

MOUTH OF THE SEVERN

accordance with his desire, had arranged for its
n that he would enter with his troops. Even
intentions were strictly concealed, the spies set
m by the various anxious parties were baffled by
netrable reserve. He was careful to appear only
ervant of parliament, but when he was desired to
oath of abjuration he skilfully evaded the request
, always jealous of the Rump, now refused to pay
xcept at the orders of a free parliament. Monk,
equence, was ordered to march his troops into the
ke down the chains and posts, and imprisoned the
He obeyed these unpleasant orders to the letter on
ebruary, thus permitting the hatred against the
rise to the height, while he showed how unwilling
ument of its will he was. On the 11th, however,
w off the mask, and wrote to the Rump, peremp
dering them to admit the secluded members, and
ge for the dissolution of parliament by 6th May.
t February he conducted the secluded members
seats. At the same time he refused to restore
ds, and issued an order disowning Charles Stuart
fficers commanding garrisons. Every day brought
sh opportunities for tact or evasion. His partisans
im to take the protectorate himself; another party
upon him to accomplish the restoration by the
one, a body of his officers sent him a declaration
ing their fears that his action would lead to the
ion of monarchy; the parliament tried to make
eir own by the offer of Hampton Court. His
habits of dissimulation and evasion, assisted now
ain by downright lying, carried him triumphantly
all these dangers, and at length the dissolution of
ent on 17th March removed his greatest difficulties.
as now that, with the utmost secrecy, he gave an
w for the first time to the king's agent Grenvil,
him sent to Charles the condition of his restoration,
rds embodied in the Declaration of Breda. For
at present he would accept nothing but a royal
sion as captain-general, which he carefully kept
elf. All parties were anxious to gain the credit of
v certain restoration. The Presbyterians in parti-
fearful of the king being restored without terms,
ir best to discredit Monk and to impose the old hard
t conditions; but in vain. The new parliament was
and the House of Lords restored, an insurrection
bert, who had escaped from the Tower, was quelled
k's prompt measures, and on the 25th of April he
l the solemn thanks of both Houses, and the title of
general of the land forces. Even yet the fabric
pt up. Monk received with feigned surprise the
official letter from Grenvil, denied all knowledge
ontents, and handed it over sealed to the council
cided to defer opening it until the meeting of
ent on the 1st of May.

the Restoration the historic interest of Monk's career
The rude soldier of fortune had played the game
comparable dexterity, and had won the stakes. He
ade gentleman of the bedchamber, knight of the
master of the horse, commander-in-chief and duke of
arle, and had a pension of £7000 a year allotted him
most desires were satisfied, and he made no attempt to
e further in a society in which neither he nor his
wife could ever be at home, and which he heartily
d. As long as the army existed of which he was
l, and of which the last service was to suppress
's revolt, he was a person not to be displeased
entirely concurred in the measure for disbanding
thenceforward his influence was small, though men's
rned naturally to him in emergency. In the trial
regicides he was on the side of moderation, and his
interposition saved Hazelrig's life; but his action at the
time of Argyll's trial will always be regarded as the most
dishonourable episode in his career. In 1664 he had
charge of the admiralty when James was in command of
the fleet, and when in 1665 London was deserted on
account of the plague, Monk, with all the readiness of a
man accustomed to obey without thinking of risk, remained
in charge of the government of the city. Once more, at
the end of this year, he was called upon to fight, having a
joint commission with Prince Rupert against the Dutch.
The whole burden of the preparations fell upon him. On
23d April 1666 the admirals joined the fleet, and on the 1st
of June began a battle near Dunkirk which lasted four days,
followed by another on 25th July, in which Monk showed
all his old coolness and skill, and a reckless daring which
had seemed hitherto foreign to his character. His last
service was in 1667, when the Dutch fleet sailed up the
Thames, and Monk, ill as he was, hastened to Chatham to
oppose their further progress. From that time he lived
much in privacy, and died of dropsy on the 3d of December
1669.

See the *Life of Monk* by Dr Gumble his chaplain (London, 1671)
and Dr Skinner (London, 1724), and *Clarendon's Life*, which contain
all the contemporary information concerning him up to the Restoration.
The numerous and more scattered notices of him in the court of Charles
II. Pepys's *Diary* should also be consulted. (O. A.)

MONKLY. See Ayr.

MONMOUTH, a maritime county of England, is bounded
E by Gloucester, N.E. by Hereford, N.W. by Brecknock,
W. and S.W. by Glamorgan, and S. by the Bristol Channel.
Its greatest length from north to south is about 35 miles,
and its greatest breadth about 27 miles. The area is
368,399 acres, or about 575 square miles.

The surface of Monmouth is very varied, and in many
districts picturesque, especially along the valley of the
Wye, and between that river and the Usk. In the west
and north the hills rise to a considerable height, and the
mountain region consists chiefly of finely undulating country.
The highest summits are Sugar Loaf (1954 feet), Blorenge
(1908), and Skyrrid Vawr (1595). Along the shore on
both sides of the Usk are two extensive tracts of marsh
land, called the Caldicot and Wentlooge levels, stretching
from Cardiff to Goldcliff and protected from inunda-
tions by [illegible]

The principal rivers [illegible] the Wye, which forms the
eastern boundary of the county with Gloucester, and falls
into the Severn. Monnow, which forms a portion of its
boundary with Hereford, and falls into the Wye at
town of Monmouth; the Usk, which rises in Brecknock
and flows [illegible] through the centre of the county to the
Bristol Channel below Newport; the Ebbw, which rises in the north-west
and enters the estuary of the Usk at Newport; and the
Rhymney, which rises near Brecknock, and, after forming the
boundary between Monmouth and Glamorgan, enters the
Bristol Channel a little to the east of Cardiff. Salmon
abound in the Wye and the Usk, and trout are
plentiful in all the streams. The Monmouthshire canal
extends from Newport to Pontypool, where it is joined by
the Brecknock-and-Abergavenny canal, which enters the county near
Abergavenny. The Crumlin canal also joins it a little
to the east.

[illegible] The [illegible] mation is principally
old Red Sandstone and Carboniferous, the Old Red forming the
lower and eastern half of the county, from a line drawn between
Abergavenny and Newport, and varying in its lines from between
one and 10,000 feet in the north to about 4000 feet in the south.
In the centre of the county, about the Usk, there is an outcrop
of Silurian rocks extending to a distance of about 8 miles north
and south and 4 miles east and west with a thickness of 1500 feet.
Toward the east the Old Sandstone rocks dip beneath the Mon-
tian Limestone, which enters the county from the Forest of Dean
coal-field, and gives its peculiar character to the fine scenery along
the banks of the Wye. The formation varies in thickness from

00 feet. The Carboniferous rocks connected with the great
l of South Wales, which occupy the western half of the
include the Carmarthen, consisting of shale and
es, sandstone and [illegible], of which there are about
ive beds, more than feet thick; total thickness of the
1,600 feet. Millstone Grit, thickness 330 feet, C
rous Limestone surrounding the coal field, thickness
t; Old Red Sandstone, thickness 600 feet, and co
beds consisting of red and brown sandstone, marls, &c
above 6000 feet. The coal field of Monmouthshire and eastern
covers [illegible]. The beds are very rich and easily wrought,
extensive way of collieries there have been carrying pro-
rious of the kind; most of the pits are [illegible] half
ber of collieries in operation in [illegible], and the
of coal obtained [illegible]. The iron stone of Mon-
[illegible] beds, varied and nearly [illegible] the total
ounts to [illegible] per cent. The ore is [illegible] co
ing the iron [illegible] was produced [illegible] tons of Pont
ory, [illegible] Blaenavon, [illegible]
tv. [illegible] which [illegible] tons [illegible]
Clydach [illegible]
pidity. In [illegible] the num[illegible] furnaces [illegible] were
n [illegible] were in operation. The [illegible] of pig iron made was
ton. The work[illegible] in the [illegible] the [illegible]
pool, and occupy the [illegible] mile on the east bank of
Lydd[illegible] Glamorgan, but [illegible] the Mon
ale, Victoria, Blaenavon, [illegible]
Rhymney, and Tredegar [illegible]
and 12 collieries and mines at [illegible]
ively carried on the number [illegible] the Monmou
t district in 1881 by the inspectors of mines [illegible]
th. Excluding [illegible] 57 persons were employed

and Inhabitants.—About one-eighth of the surface of the
nd about one-third of the [illegible] Lowlands
nd is that running on Red Sandstone, principally along
the Usk, where wheat is raised of very fine quality. In
mountainous [illegible] there is very little land [illegible]
ultivation, the soil being [illegible] and peaty. More
is [illegible] to raising than to the rearing of crops. There
erable number of dairy farms, but more [illegible] is
gely followed. Of the [illegible] in 1881 [illegible] were
ar in regard to which [illegible] returns were [illegible]
, 1521 between 250 and 500 [illegible] and 91 above 500.
According to the returns [illegible] for [illegible] there
acres, or about [illegible] were under crops or grass
on. Of this, 176,137 acres were [illegible] and
ivation [illegible]. Of the [illegible] were under wheat, 5596 under barley
e under oats, 5590 under turnips or rape, and 571 under other
occupied 4486 acres, and potatoes [illegible]. The area
oods was 29,848 acres, and under [illegible] 3023. The total [illegible]
ses in 1887 was 13,631, of which the number [illegible]
ultural purposes was 6119. Of the [illegible]
sand heifers in milk or in calf [illegible]
[illegible] Poland [illegible]
the Mon[illegible]
were the M[illegible]

History and Antiquities.—At the time of the Romans
monthshire formed part of the territory of the Silures, whose
pal seat was at Caerwent, and who were finally subdued by
Frontinus in the year 78. The old Roman road, the *Via*
leading from the mouth of the Severn to Caerwent, Caerle
onwards to Neath in Glamorgan, can still be traced. The
made Caerwent, under the name of *Venta Silurum*, one
principal stations. Tessellated pavements, pottery, coins,
remains of a Roman villa, have been found, and portions
walls still [illegible] at station of the Romans was, h
Isca Silurum now Caerleon (Caerleon), so called from
that it was the headquarters of the second imperial legi
Inchtuil of Ptolemy terms it called a colonia, being the only
of that dignity in Wales. The mound of the old fortress still r
s with a portion of an amphitheatre. Other less im
stations were those of *Gobannium* (Abergavenny), *Blestium*
mouth), and *Burrium* (probably Usk). Monmouthshire is
associated with Arthurian legends. In one of the Wel
Arthur is represented as holding his court at Caerleon during
and Leatherbed, an oval bank near the town, is pointed
Arthur's Round Table. When Wales was subdivided into thi
dom on the death of Rhodri the Great, Monmouth and Gl
were placed under a separate government distinct from
there. In the 9th and 10th centuries Monmouth was fre
ueled by the Danes. Edward the Confessor, after vari
tions in Wales, is said to have established a palace at Porth
Portskewett, [illegible] the Norman Conquest the district was
over to certain Norman nobles called the "Lords of the M
who held the land which they conquered *par bravoure*, w
rights of jurisdiction were frequent contests took plac
the lords of the marches and the Welsh princes until, in
latter portion of the power of the marches was abolished by
VIII., and Monmouth was included among the English c
Monmouthwere the scene of frequent contests during the Cr

Of Norman fortresses in Monmouth, either built or taken po
of by the lords of the marches, there are remains of no le
twenty-two. The more interesting and important are Cald
[illegible] of the De Bohuns, still entire, Chepstow, one of th
[illegible] model of the old Norman fortresses, certainly built by Fitz O
the 11th century, in an impregnable situation on a cliff above th
Newport, now used as a brewery; Abergavenny, now part
used as a private house; the gateway and hall of Grosmont,
residence of the duke of Lancaster; and Usk Castle, rebuil
[illegible] in the time of Edward IV. Raglan Castle, begun
reign of Henry V., is a very extensive ruin, still in good
[illegible] and contains examples of several styles of archi
Charles I. resided [illegible] after the battle of Naseby. In 164
[illegible] surrendered up to the parliament.

At the Reformation there were in Monmouth two hospi
[illegible] other religious houses, but of these there are now in
remains of only two. Llanthony Abbey and Tintern Abbey.
Llanthony Abbey in the Black mountains was founded by Wi
Lacy for Canons regular in 1103, and is one of the earliest exa
[illegible] of the Pointed style. The ruins consist of portion
nave, transept, central tower, and choir. Tintern Abbey,
[illegible] to the same order, and founded by Walter de Clare
[illegible] a portion of great beauty on the Wye. The
[illegible] Early English to Decorated, is almost entire, w
[illegible] roof and may be ranked as among the fine
[illegible] in England. Of the churches, those chiefly
[illegible] are Usk, formerly belonging to a benedictine pri
[illegible] a number of old tombs; Chepstow, partly Norm
[illegible] richly moulded doorway; St Woolos church, N
[illegible] Norman; the Norman church of St Thomas, Monmouth
Church principally Norman, Matherne, Early English, with
[illegible] Edward, king of Gwent, and Usk, formerly attached to
[illegible] priory.

Monmouth (Welsh *Mynwy*), a parliamentary and
[illegible] borough of England, and the county town o
mouthshire, a picturesquely situated at the conflu
the Wye and Monnow, in a valley almost surroun
hills, 18 miles south of Hereford, and 128 west of L
By means of the Wye it has water communicatio
Bristol and with Hereford, but the former trade by
[illegible] now ceased. Portions of the old walls and of t
gates still remain; but there are only insignificant r
the old castle in which Henry V. was born, and wh
originally a Saxon fortress. After the Norman C
it was placed in the hands of William Fitz Osborn
[illegible] dependent, John lord of Monmouth, rebuilt it on
extensive scale. Subsequently it came into the po
of John of Gaunt, and thus became attached to th
of Lancaster. In 1646 it was taken by the parlia

17,624. According to the [illegible] there were [illegible]
or persons, [illegible] 2,096,971 were [illegible] resident
1. Of the owners, 1976 or 63 per [illegible] had [illegible]
7 persons of between 1000 and [illegible] and 16 between
5000. The following [illegible] possessed [illegible] each
h Lady Llanover, 6312, the [illegible] H. [illegible]
Lord Tredegar, 5723; and the [illegible] Robert [illegible]
[illegible]. The South Wales Railway passes [illegible]
[illegible] The county returns [illegible]
[illegible] are connected either with the Great Western
or with the London and North Western
[illegible] Monmouth comprises [illegible]
of the municipal boroughs of Monmouth and [illegible] Newport
In addition to the [illegible] boroughs there are the [illegible]
[illegible] Abergavenny [illegible]
[illegible] Chepstow
Chirk [illegible] Lanvrechva
Pontnewydd [illegible]
Tredegar [illegible] With the exception of
enny, Caerleon, Chepstow, Pontypool and Usk, the towns
of modern growth, and owe their rise chiefly to the iron
ture, some, however, [illegible] partly dependent on that of
The county returns two members to parliament, and
th, Newport, and Usk each a united population in 1881
3, constitute the Monmouth district of boroughs, which
one member. The county is the seat of quarter sessions,
ided into twelve petty sessional divisions. It is within
ese of Llandaff, and contains [illegible] civil parishes, townships,
The population, which in [illegible] was [illegible],
to 134,368, in 1871 to [illegible] and in [illegible] to 211,267 (of
98,262 were males, and 103,005 females).

MONMOUTH

Besides the churches -the new church of St Mary, ted in 1882, and the church of St Thomas, an Old n structure the principal public buildings are the house, the town hall, and Jones's free grammar in the Tudor style, which dates from 1614. The actures of the town are unimportant The fine y of the Wye attracts a large number of tourists.

nouth was one of the stronchold of the Saxons and under ne of Bleatum formed one of the staxon of the borough ncorporated by Edward VI, and received additional privileges een Mary, James I, and Charles II It has continuously nment since the 27th of Henry VIII, and, along with New d Usk, forms the Monmouth district of boroughs. The prin cipal and parliamentary borough has been with a ion since 1867 and in 1st of 6 III

NMOUTH, a manufacturing city of the l States, in Warren county, Illinois, 170 miles west f Chicago by the main line of the Chicago Burlington nd Quincy Railroad, and 182 miles south of St by the St Louis division of the same railway The Central Railway passes through the city Monmouth College are among the principal

ge. The population increased from 9662 in 1870 0 in 1880. The city charter dates from 1857

NMOUTH, James, Duke of (1649-1685), was the Lucy Walters, "a brown, beautiful, bold but insipid ce," who became the mistress of Charles II during ile at the Hague. He was born at Rotterdam on pril 1649. That Charles was his father is more oubtful, for Lucy Walters had previously lived with Sidney, brother of Algernon, and the boy resembled im very closely. Charles, however, always treated mm as his son, and lavished on him an almost doting on. Until the Restoration he was placed under the rst of Lord Crofts, and then of the queen-dowager, ng his education to the age of nine from Roman ics, but thenceforward from Protestant tutors. In 662 he was sent for by Charles, and at thirteen was under the protection of Lady Castlemaine and in the le of the worst influences of the court. No formal wledgment of his relation to the king was made his betrothal to Anne Scott, daughter of the earl of nch, and the wealthiest heiress of Scotland, whom rried in 1665. During 1663 he was made duke of y, duke of Monmouth, and knight of the Garter, ceived honorary degrees at both universities At he was treated as a prince of the blood. In 1665 ed with credit under the duke of York in the naval battle off Lowestoft A captaincy in the uards was given him, and in 1670, on the death of he was made captain-general of the king's forces, s of wealth also were showered upon him, and he was ed to the privy council. In 1670 Monmouth was he court at Dover, and it is affirmed by Reresby he mysterious death of Charles's sister, the duchess eans, was due to her husband's revenge on the discovery of her intrigue with the duke It is certain, from try by Pepys, that as early as 1666 he had a bad a character for vice and profligacy He was the author of the attack in December 1670 on Sir John try, and only a few months later received the royal n for his share in the wanton murder of a street man. De Gramont, in his vivid sketch of Monmouth, after describing the beauty and bodily prowess for he was celebrated, notices the fatal emptiness and y of his mind: "Tous les avantages du corps parurent pour lui; mais son esprit ne disait pas un petit mot faveur. Il n'avait de sentimens que ce qu'on lui en nait."

herto Monmouth had been but the spoiled child of xed court. Now, however, by no act or will of his own, he began to be a person politically important early as 1662 the king's excessive fondness for his caused anxiety. Even then the fear of a "diffe between Monmouth and James, duke of York, ex men's minds; and every caress or promotion kept t alive. Who could tell but that, in default of legitimat from his queen, Charles might declare Monmouth lawful on? A civil war would be the certain conse Soon after 1670 the matter took a more serious The anti-popery spirit was rapidly becoming a and the succession of James a probability and a Charles was moved to legitimize Monmouth by a d tion of his marriage with Lucy Walter. He re answer that, much as he loved the duke, he would see him hanged at Tyburn than own him for his mate on. Every attempt, however, was henceforth especially by Shaftesbury, to accustom people to thi He was taught to regard himself as the representa the Protestant interest, and his precarious was emphati James's second marriage with the Roman Catholic p Mary of Modena From the time the popular title wa Protestant duke. Charles was induced to confer prominent employments upon him. The influence of however, was strong enough to prevent his obtaining lord lieutenancy of Ireland but he received the com of the 6000 troops who acted against the French in the Dutch war and though without any claim to gener behaved with courage in the field. In 1674 he was commander-in-chief, and, in connexion with this, a no necessary attempt, graphically described in C *Life of James*, was made to gain from Charles admission of his legitimacy At Shaftesbury in he was placed in command of the army employed a against the Scottish Covenanters and was present at well Bridge (22 June 1679). He was also, at the request, elected chancellor of the university of Cam In 1678, when Charles was driven into war with Monmouth took the command of the English contin and again gained credit for personal courage at the of St Denis On his return to London England the throne of the popish successor. The idea of crea Protestant successor, by stamping Monmouth aga hope and was carefully fostered by Shaftesbury, time it seemed probable that a new would want audacity

The Pensionary parliament was dissolved in J 1679, and was succeeded by one still more dete anti-popery spirit. To avoid the storm, and t of possible, his brother's stated Catholic instructo to leave the country. James returned to Brussels, th became presently known a declaration that he never married nor ever contract to any woman wha but to my wife Queen Catherine. In spite of thi month might naturally now nourish ambitious His rival was Shaftesbury, who, chief m was president of the remodelled privy council, but he still was the favourite of the city. In the sum 1679 the Popish Plot, fabricated by Titus Oates, and the dangers o plot now became terribly apparent The opposed to Monmouth, or rather to Shaftesbury prevailed on Charles to consent to his brother's return When, after the king's recovery, went back to Brussels, he received a promise that mouth too should be removed from favour and to leave the country. Accordingly, in September the latter repaired to Utrecht, while shortly aft James's friends so far gained ground as to obtain permission to reside at Edinburgh instead of at B Within two months of his arrival at Utrecht, Mo secretly returned to England, arriving in London

ber. Shaftesbury had assiduously kept alive the pery agitation, and Monmouth, as the champion of antism, was received with every sign of popular

The king appeared to be greatly incensed, d him of all his offices, and ordered him to leave ndon at once. This he refused to do, and the only taken of the disobedience was that Charles forbade appear at court.

s at this time that the *Appeal from the Country to* written by Fergusson, was published, in which ttorney was totally given up, and in which it was that "he that hath the worst title will make the g." Now it was too that the exclusionists, who, absence of parliament, were deprived of their best agitation, developed the system of petitioning. mptly and successfully was this answered by the ers' that Charles, feeling the ground safer under called Jane to London, a step immediately fol by the resignation of the chief Whigs in the council. more, however, a desperate attempt was made, by le of the "black box," to establish Monmouth's and once more these claims were met by Charles's declarations in the *Gazette* that he had never been but to the queen. Still acting under Shaftesbury's Monmouth now went upon the first of his progresses west of England, visiting the chief members of the party, and gaining by his open and engaging much popularity among the people. In August ames returned to Portsmouth, but right to the re being again formally acknowledged by Charles outh at once threw himself more vehemently than to the plans of the exclusionists. He spoke and for exclusion in the House of Lords, and it of his not likely to be forgotten by James when in opportunity should come for resenting it. He was ostentatiously feasted by the city, the stronghold of Shaftesbury's party, and it was observed that he drove to dinner that day of illegitimacy had been removed from the arms on his coach.

The year 1681 seemed likely to witness another civil war. The parliament that had been summoned by formal proclamation passing a series of resolutions of extreme violence, of which one was that Monmouth should be restored to his offices and command, and when Charles summoned the parliament to meet at Oxford the leaders of the exclusionists went thither with troops of armed men, until the dissolution of this last parliament on March 1681 did the weakness of Monmouth's cause become apparent. In a moment the ground was cut from under the feet of his supporters. Their battle for agitation was fought with pamphlets and broadsheets could ill supply the place of a determined and unanimous majority of the House of Commons. The deep-seated respect for hereditary succession felt, and a great reaction took place. Dryden published *Absalom and Achitophel*, a story which was well known to the time by a nickname. Monmouth himself did not escape unscathed from the pulpit. He thought it wise to make his peace with the king, but he did so in such a manner as to offend Charles the more. He was forbidden the court and, when he went on a second progress through the west and north western counties, his proceedings were closely watched, and he was at length arrested at Stafford. Severity and extreme lenity were strangely mingled in the treatment he received. He was released on bail, in February 1683, after the flight and death of Shaftesbury, openly broke the implied condition of his bail by making a third visit to Chichester with Lord Grey and others on pretence of a hunting expedition.

It is probable that Monmouth never went so far as to think of armed rebellion; but there is little doubt that he had talked over schemes likely to lead to this, and that Shaftesbury had gone further still. The Rye House Plot gave an excuse for arresting the Whig leaders; Russell and Sidney were judicially murdered; Monmouth was sent to Toddington in Bedfordshire, and was left untouched. Court intrigue favouring him, he succeeded, by the betrayal of his comrades and by two submissive letters, in reconciling himself with the help of Halifax both to the king and to James, though he had the humiliation of seeing his confessions and declarations of penitence published at length in the *Gazette*. His character for pettishness and vanity was now amply illustrated. He denied that he had given evidence; he then wrote a recantation of the denial. He managed by importunity to get from the king the promise of recantation and lastly, by the advice of his wife, offered again to sign the paper which he had withheld. Charles heartily despised him, and yet appears to have retained affection for him. His partial return to favour raised the hopes of his partisans; to check these, Algernon Sidney was executed. Monmouth was now subpoenaed to give evidence at the trial of young Hampden. To escape from the difficulties thus opened before him he went to Holland, probably with Charles's connivance, and from there he once more, in November 1684, visited England. It is doubtful whether he ever again saw the king. From this time till the king's death he lived with Henrietta Wentworth, his mistress, in Holland and at Brussels.

The quiet accession of James II soon brought Monmouth to the crisis of his fate. Though at first desirous of retirement, his character was too weak to withstand the urgency of more determined men. Within two months of Charles's death he had yielded to the impetuosity of Argyll, another of the exiles, and to vague invitations from England. Burnet comments, as showing the light in which his character were viewed by his fellow-conspirators, that one of the terms of the compact between them was that, if Monmouth should lead the expedition, he should not assume the title of King without their consent, and should, if the rebellion were successful, resign it and accept what reward the nation might offer. Now, as always, he was a puppet in other men's hands.

On the 2nd of May Argyll sailed with three ships from the west of Scotland, and three weeks later, with a total force of only eighty two persons, of whom Lord Grey, Fletcher of Saltoun, Wade, and Fergusson, the author of the *Appeal from the Country to the City*, were the chief, Monmouth himself set out for the west of England, where, as the head of Protestant dissent and as the scene of his former progresses, he could alone hope for immediate support. Here, however, there was no movement; and when on the 11th June Monmouth's three ships, having eluded the royal fleet, arrived off Lyme Regis, he landed amid the curiosity rather than the sympathy of the inhabitants. In the market place his "declaration," drawn up by Fergusson, was read. In this document James was painted in the blackest colours. Not only was he declared to be the murderer of Essex, but he was directly charged with having poisoned Charles to obtain his crown. Monmouth soon collected an undisciplined body of some 1500 men, with whom he marched to Axminster, and entered Taunton. Meanwhile the government had declared it treason to assert Monmouth's legitimacy, or his title to the crown; a reward of £500 was offered for him dead or alive, and an act of attainder was passed in unusual haste. Troops had been hurried from Flanders to meet him, and when he reached Bridgwater Albemarle was already in his rear. From Bridgwater the duke marched through Glastonbury to attack Bristol, into which Lord Feversham had hastily thrown a regiment of

ls. The attempt, however, miscarried; and, after
ioning Bath in vain, Monmouth, with a disordered
, began his retrograde march through Philips Norton
Frome, continually harassed by Feversham's soldiers.
he latter place he heard of Argyll's total rout in the
ern Highlands. He was now anxious to give up the
prise, but was overruled by Grey, Wade, and others.
he 3d of July he reached Bridgwater again, with an
little better than a rabble, living at free quarters
behaving with reckless violence. On Sunday the 5th
rsham entered Sedgemoor in pursuit, Monmouth the
night attempted a surprise, but his troops were hope
routed. He himself, with Grey and a few others,
over the Mendip Hills to the New Forest, hoping to
the coast and escape by sea. The whole country,
ver, was on the alert, and at midnight on the 8th,
n a month of their landing, James heard that the
t, desperate from the first, was over, and that his rival
een captured close to Ringwood, in Hampshire.
e poor strain in Monmouth's character was now
n. On the day of his capture he wrote to James in
s of the most unmanly contrition, attributing his wrong
gs to the action of others, and imploring an interview.
he 13th the prisoners reached the Tower, and on
ext day Monmouth was allowed to see James. The
nts of this interview are difficult to reconcile in some
s, but all agree that Monmouth's behaviour was un
y in the extreme. No mercy was shown him, nor did
the least deserve mercy; he had wantonly attacked
peace of the country, and had cruelly libelled James.
king had not, even in his own mind, any family tie to
ain him from exercising just severity, for he had never
wed Monmouth to be the son of any one but Robert
y. Two painful interviews followed with the wife
whom he bore no love, and who for him could feel no
et, another imploring letter was sent to the king, and
t protestations and beseechings were made to all whom
w. He offered, as the last hope, to become a Roman
olic, and this might possibly have proved successful
he priests sent by James to ascertain the sincerity of
"conversion" declared that he cared only for his life
not for his soul.

e met his death on the scaffold with calmness and
ty. In the paper which he left signed, and to which
eferred in answer to the questions wherewith the
bishops plied him, he expressed his sorrow for having
ned the royal style, and at the last moment confessed
Charles had denied to him privately, as he had publicly,
he was ever married to Lucy Walters. He died at the
f thirty-six, on the 15th of July 1685. "Thus ended
Evelyn, "this quondam duke, darling of his father
the ladies, being extremely handsome and adroit; an
lent souldier and dancer, a favourite of the people, of
asy nature, debauched by lusts, seduced by crafty
es, who would have set him up only to make a pro
, and took the opportunity of the king's being of
ner religion to gather a party of discontented men.
ailed and perished."

thorities for Monmouth's career are, besides the known modern
nes, Roberts's *Life* (1844), Evelyn's and Pepys's *Letters*, Old
's *History* (1724), James II.'s *Memoirs*, Clarke's *Letters and Papers*,
by's *Memoirs*, Sidney's *Diary* (1843), Scott's note to *Dryden's*
Achitophel, and *The Heroic Life*, &c. (1685). For the rebellion,
Grey's *Secret History* should be consulted. (O. A.)

ONMOUTH, GEOFFREY OF. See GEOFFREY OF MON
TH.

ONOPHYSITES. See EUTYCHES, and JACOBITE
RCH.

ONOPOLI, a city of Italy, in the province of Bari, is
ated on the coast of the Adriatic, 25 miles by rail
-east of Bari. It is a bishop's see, is surrounded by
ancient walls, and possesses a castle built by Charl
1502, a cathedral, and a hospital dating from 1368.
harbour is neither large nor well protected, but a
amount of trade is carried on in the export of lo
ducts. The population was about 12,000 in th
century; 12,377 in 1861; and 13,000 in 1871,
the commune being 20,918. Monopoli probably
after the destruction of Egnatia (5th century), th
of which lie a few miles to the south.

MONOPOLY (*povwoτία, exclusive sale*). Thou
used in the sense of the original Greek, the term i
accurately applied only to grants from the crown
parliament, the private act of an individual whe
obtains control over the supply of any particular
being properly defined as "engrossing." It was fr
practice of the sovereign granting to a favourite,
reward for good service, a monopoly in the sale or
facture of some particular class of goods that the
of protecting inventions arose, and this fact lends ad
interest to the history of monopolies (see PATENTS).
the practice of making such grants first arose it d
appear easy to say. Sir Edward Coke laid it dow
by the ancient common law the king could grant
inventor, or to the importer of an invention from al
temporary monopoly in his invention, but that gr
restraint of trade were illegal. Such, too, was the l
down in the first recorded case, Darcy v. Allin (the
monopolies, 1602), and this decision was never ove
though the law was frequently evaded. The pate
of the Plantagenets show how few instances of grants of
polies (the earliest known is temp. Edw. III.)
own to the reign of Henry VIII. before
much evidence of the exercise of the prerogative
case of either new inventions or known articles, of
Elizabeth, as is well known, granted patents of mo
so freely that the practice became a grave abuse,
gave rise to
Houses of Commons. Lists prepared at the time sho
many of the commonest necessaries of life were the
of monopolists by which their price was previously en
That the queen did not assume the right of makin
grants entirely at her pleasure is, however, not only
own statement in answer to addresses from the Hou
by the fact that the preambles to the instruments
give the grant always set forth some public benefit
derived from their action. Thus a grant of a mo
to sell playing cards made, because "divers subj
able people, which never did use to plough did employ
themselves in the trade or mystery of cards," and one for t
of starch was protested on the ground that it would
wheat long wasted for the purpose. Accounts
angry debates in 1597 and 1601 are given in Hu
elsewhere. The former debate produced a promi
the queen that she would be careful in exercis
prerogative, the latter a proclamation which, receiv
great joy by the Houses, really had but little e
stopping the abuses complained of. A few gran
cancelled, other limited, and others again left to th
the ordinary law courts instead of the privy c
in pursuance of the results of the proclamation, p
were soon found to have been tainted by the promise
the queen's speech, protests by no means called
the text of the document itself, a copy of which is
in the British Museum.

In the first parliament of James I. a "commi
grievances" was appointed, of which Sir Edward C
chairman. Numerous monopoly patents were bro
before them, and were cancelled. Many more, h
were granted by the king, and there grew up a
"purveyors," who made use of the privileges grante

e great seal for various purposes of extortion. One
o t notorious of these was Sir Giles Mompesson,
l the country to avoid trial in 1621. After the
tion of several bills, and several attempts by James
ecure the matter by orders in council and
, the Statute of Monopolies was passed in 1623.
e all monopolies illegal, except such as might be
by parliament, or were in respect of new manu-
or invention. Upon this exceptive clause is built
ntire English system of letters patent for inven
statute itself amended by later Acts, chiefly
The Act was strictly enforced, and by it and the
m of monopolies was eventually abolished. This
not indeed immediately achieved, for even during
ectorate cases of monopoly patents were brought
the patents complained as grievances. Parliament
ourse, never exercised the power of granting to any
t exclusive privilege of dealing in any article of
ch. The prohibition of the Statute to monopolies,
beside required to be taken out by decision in
ts, tobacco, &c., are lineal descendants of the old
y grants, while the quo warranto proceedings
, canal, gas and water companies were under Acts
ment, and representative of the recent practice
OTHELETES (*μονοθελητής*, *monothelita*) was the
ven to those who, in the 7th century, while other
hodox, fell into the heresy of maintaining that
ad only one will. The monothelite controversy
origin in the efforts of the emperor Heraclius to
, for the church and the empire, the excommunicated
d persecuted Monophysites or Jacobites of Egypt
ia. It seems to have been while in Armenia in
t, in an interview with Paul, the head of the
s (Monophysites) there, he first broached the doc
the *mia energeia* of Christ, viz., the doctrine that
e and human nature, while quite distinct in He-
on, had but one activity and operation.[1] At a
at later date he wrote to Arcadius of Cyprus, com
that "two energies" should not be spoken of,
26, while in Lazistan (Colchis), he had a meeting
metropolitan, Cyrus of Phasis, during which this
d was discussed, and Cyrus was at last bidden seek
ruction on the subject from Sergius patriarch
antinople, a strong upholder of the *mia energeia*,
emperor's counsellor with regard to it. So well
profit by the teaching he received in this quarter
630 or 631, Cyrus was appointed to the vacant
ate of Alexandria, and in 633 succeeded in reconc
e Severians of his province on the basis of *mia*
a energeia (one divine human energy). He was
, opposed by Sophronius, a monk from Palestine,
r vainly appealing to Cyrus, actually went to Con
ple to remonstrate with Sergius himself. Shortly
d Sergius wrote to Pope Honorius, and received
ly reply. Sophronius, however, who meanwhile
n made patriarch of Jerusalem (634), refused to be
, and in his *Epistola Synodica* strongly insisted on
e energies. So interested did the controversy now
that at last, toward the end of 638, Heraclius
ed his *Ecthesis* or Exposition of the Faith, which
ed the use of the phrase "one energy," because of
nating effect on some minds, as seeming to militate
the doctrine of the two natures. While, on the other
e expression "two energies" was interdicted because

ding to some church historians, it was Paul who introduced
ne, but this statement seems to rest on a misinterpretation
hority. See Hefele, *Conciliengesch.*, iii. p. 124 *sq.* (1874),
races the previous history of the expressions *μία ἐνέργεια*,
ενέργεια, especially as found in the writings of the Pseudo-
Areopagita.

it seemed to imply that Christ had two wills. That Christ had but one will was declared to be the only orthodox doctrine, and all the faithful were enjoined to hold and teach it without addition or deduction. The document was not acceptable, however, to Popes Severinus and John IV., the immediate successors of Honorius; and Maximus, the confessor, succeeded in stirring up such violent opposition in North Africa and Italy that, in 648, Constans II. judged it expedient to withdraw his grandfather's offensive edict, and to substitute for it his own *Typus* (*τύπος περὶ πίστεως*), forbidding all discussion of the questions of the duality or unity of either the energy or the will of Christ. The scheme of doctrine of the first four general councils, in all its vagueness as to the exact points, was to be maintained so far as the controversy had gone, the disputants on either side were to be held free from censure, but to revive it would involve penal consequences. The reply of the Western Church was promptly given in the uncompromisingly dyothelite decrees of the Lateran synod held by Martin I. in 649, but the cruel persecutions to which both Martin and Maximus were exposed, and finally consummated, forced for the imperial *Typus* the assent at least of silence. With the accession of Constantine Pogonatus in 668 the controversy once more revived, and the new emperor resolved to summon a general council. It met at Constantinople in 680, having been preceded in 679 by a brilliant synod under Pope Agatho at Rome, where it had been agreed to depart in nothing from the decrees of the Lateran synod. At Constantinople the condemnation of the monothelite heresy was explicit and complete, Pope Honorius being anathematized by name along with the others who had supported it. Beyond the limits of the empire, monothelitism survived for some centuries in Lebanon among the MARONITES (*q.v.*), who did not abjure their heresy until 1182.

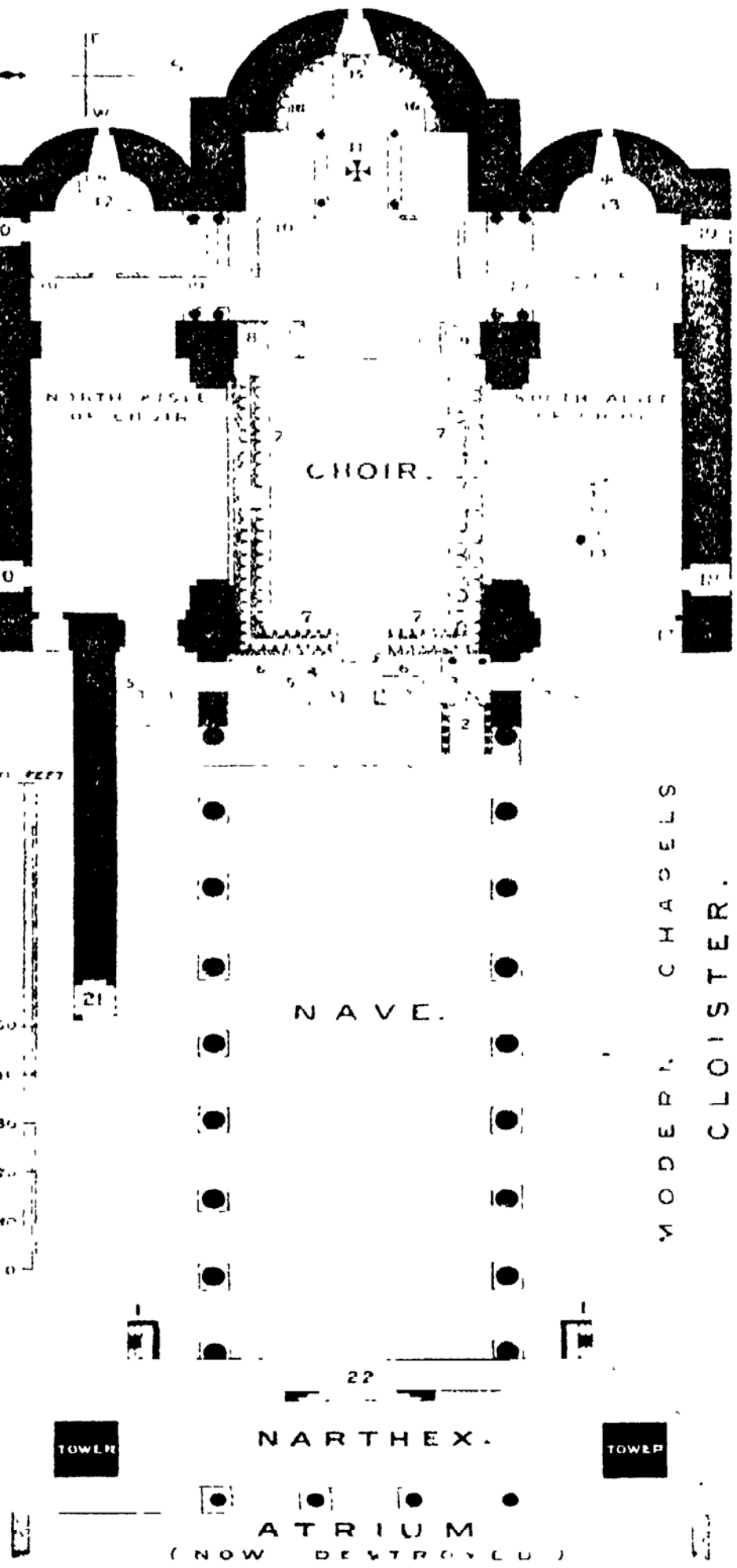
See the church histories, and especially Hefele (*op. cit.*), whose obvious partisanship can only slightly affect the reader's appreciation of his full and accurate learning.

MONREALE, a contraction of "monte reale," was so called from a palace built there by the Norman Roger I., king of Sicily. It is now a town of about 16,300 inhabitants, situated 5 miles inland from Palermo, on the slope of Mount Caputo overlooking the beautiful and very fertile valley called "La Conca d'Oro" (the Golden Shell), famed for its orange, olive, and almond trees, the produce of which is exported in large quantities. The town, which for long was a mere village, owed its origin to the founding of a large Benedictine monastery, with its church, the seat of the metropolitan archbishop of Sicily.[1] This, the greatest of all the monuments of the wealth and artistic taste of the Norman kings in northern Sicily, who in 1072 expelled the Mohammedans and established themselves there with Palermo as their capital, was begun about 1170 by William II., and in 1182 the church, dedicated to the Assumption of the Virgin Mary, was, by a bull of Pope Lucius III., elevated to the rank of a metropolitan cathedral. It was, and is even now, one of the most magnificent buildings in the world, and Pope Lucius in no way exaggerated its splendour when he said in his bull, "ut inde opus per aliquem regem factum non fuerit a diebus antiquis."

The archiepiscopal palace and monastic buildings on the south side were of great size and magnificence, and were surrounded by a massive precinct wall, crowned at intervals by twelve towers. This has been mostly rebuilt, and but little now remains except ruins of some of the towers, a great part of the monks' dormitory and frater, and the very splendid cloister, completed about 1200. This latter is well

[1] An earlier church appears to have existed at Monreale since the 6th century, but no traces of it now remain.

ed, and is one of the finest cloisters both for size nty of detail that now exists anywhere. It is about t square, with pointed arches covered with marble upported on pairs of columns in white marble, 216



of the cathedral of Monreale, as built in the 12th century, omitting later additions.

tairs to towers, now altered.	11	High altar and baldacchino
Chapel under the south ambo	12	Altar in north-east apse
tairs to ambo	13	Altar in south-east apse
loly water stomp	14	Altar at tomb of William I
"Pulpitum" or choir-screen, now destroyed	15	Archbishop's throne
	16, 16	Seats for clergy
ereens behind stalls, now destroyed	17	Door to north-east tower
	18	Door to south-east tower
talls, now destroyed	19	Door to sacristy
ing's throne	20, 20	Doors to cloisters (2)
rchbishop's throne	21	Bronze doors by Bonanno
anctuary screen.	22	Bronze doors by Bonanno

which are sumptuously decorated either by rich sur- rving or by bands of patterns in gold, silver, and , made of glass tesserae, arranged either spirally or lly from end to end of each shaft. The marble caps h richly carved with figures and foliage executed reat skill and wonderful fertility of invention no ing alike. At one angle, a square pillared projection contains the marble fountain or monks' lavatory, ev the work of Moslem sculptors.

The chief feature of the place - the church like th cloister, is fortunately well preserved. In plan curious mixture of Eastern and Western arrange Fig) The nave is like an Italian basilica, while th triple-apsed choir is like one of the early thre churches, of which so many examples still exist i and other Eastern countries (see De Vogüe, *Sy Arab*. It is, in fact, like two quite different chur together entered. The basilican nave is wide, with arcade Monolithic columns of Oriental granite one which is of egregious, evidently the spoil bestriding, on each side upper eight pointed arch ruled There is no triforium, but a lofty clerestor wide two-light windows, with simple tracery like th the nave arcade and throughout the church The first, Eastern in two orders, is both wider and high the nave It is not divided at the central pace w arch, each of the outer ones (at the east w pier The three woodwo low in pitch, constructionally poor, but richly de with colour now mostly restored At the we the nave are two prodigious towers, with a three-s between them A large open atrium which once at the west, is now completely destroyed The ou the church is plain, except the arcade wall and three apses, which are decorated with interlacing pointed and other ornaments mosaic on marble The ou the principal doorways and their pointed arches are recently enriched with carving and inlay, a curious combination of three styles Norman French, Byzantin Arab.

It is, however, the enormous extent (80,630 squa and glittering splendour of the glass mosaics cover interior, which make the church so marvellously (see Mosaics) With the exception of a high dado very beautiful marble slabs enriched with b mosaic, the whole interior surface of the wall, in soffits and jambs of all the arches, is covered with mosaic pictures on brilliant golden or gold ground gorgeous method of decoration takes the place of all architectural details, such as mouldings and pa The mosaics cover even the edges of the arches and which are lightly rounded off, so as to allow them covered by the glass to curve This device gives a softness to all the edges, and greatly enhances the effect produced by the gleaming gold ground. only exception made is on the sculptured caps of th arcades, mostly Corinthian in style The mosaic are arranged in tiers divided by horizontal and band of elaborate flowing mosaic ornament. In the choir there are five of these tiers of subjects figures one above another. The half dome of the apse has a colossal half-length figure of Christ, crowned Virgin and Child below the other apses ha ten standing figures of St Peter and St Paul tion on each picture explains the subject or sain scroll the figures are in Latin, except some few wh mosaic The subjects are partly from the Old most from the Christ-cycle His scheme of redemptio gure of those who prophesied and prepared f among Towards the east are subjects from th Testament, chiefly representing Christ miracles and ing, with apostles, evangelists, and other saints den, execution, and choice of subjects all appea of Byzantine origin, the subjects being selected fr *Menologium* drawn up by the emperor Basilius Po genitus in the 10th century.

No other mosaics perhaps so closely resemble th

gs as tho e over the nave columns in the Church Nativity at Bethlehem. They are alike, not only gn and treatment, but also in the curious mixture n and Greek in the inscriptions (see De Vogüe, *de la Terre Sainte*, 1860). This similarity is easily ted for by the fact that these two sets of mosaics, o far apart, were executed about the same date der the same conditions, viz., by the hands of ne artists, working for Norman French kings.

e central apse at Monreale, behind the high altar, marble throne for the archbishop. This position throne is a survival of the early basilican arrange when the apse and altar were at the west end. In the celebrant stood behind the altar at mass, and ower it eastwards towards the people. This pecu- the throne was frequently reproduced in churches like this, have the apse at the east. On the north front of the high altar, is another somewhat throne for the use of the king. The tomb of I., the founder father, a magnificent porphyry ably contemporary with the church, under a marble canopy, and the founder William II., tomb, in Dyce, were both shattered by a fire, which in oke out in the choir, injuring one of the mosaics, troying all the fine white marble cutting, the ornaments of the choir roof. The tombs were rebuilt and ole of the injured part of the choir restored very clumsily, a few years after the fire. On the of the choir are the tombs of Margaret, wife of I., and her two sons Roger and Henry, together urn containing the heart of St Louis of France, d in Dyce. The present of the triple choir, much restored, is a very magnificent specimen of and porphyry work on Cosmati Alexandrinum, with Arabic influence in the main lines.

bronze doors, three on the north and west of the are of great interest in the history of art. They h divided into a number of square panels with sub- d single figures, mostly from Bible history, cast in That on the north is by Barisano of Trani in Italy, and is dated probably of Greek origin. It is SUM BARISANVS DE TRANI ME FECIT. The cathedral at and Ravello also have doors by the same r. The west bronze door at Monreale, similar to this one both in its line of design and in workmanship, ornaments of Christ on the cathedral of which place the Latin style. The bronze doors on the north, opposite

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Scottish cavaliers descended from Hector Monroe, an of Charles I. At the outbreak of the Revolutionar James Monroe was a student at the College of Willia Mary, but left his studies in 1776 to join the cont army. He took part as lieutenant in the New campaign of that year, and was wounded at the ba Trenton. The next year he served with the rank of on the staff of General William Alexander ("Lord Stir but, thus being out of the line of promotion, he soon himself without military employment. In 1780 he the study of the law under the direction of Jefferso governor of Virginia. His intimacy with Jefferson time had probably a controlling influence upon his quent political career. He continued through all vicis to possess the friendship and support of both Jeffers Madison.

In 1782 Monroe was in the State legislature, an 1783 to 1786 was a member of Congress. On r from Congress he entered upon the practice of the Fredericksburg, and was again elected to the legis In the Virginia convention of 1788 for the ratifica the constitution, he was among the opponents o instrument; but his course was approved by the ture of his State, who elected him United States in 1790 to fill the vacancy caused by the death of W Grayson. A senator he was a decided opponent Federalist administration. Nevertheless he was s by Washington in 1794 as minister to France in p Gouverneur Morris, a Federalist, recalled upon the of the French Government. Being of the party wh pathized with the revolutionary struggle in France, expected that his appointment would be flattering Government of that country, and would also concili French party at home. The Government of the Nation vention received Monroe with open signs of favour, his part he expressed his own and his country's syn with the French Republic with so much enthusias Washington deemed his language not in keeping w neutral policy which the administration had recent claimed. At about the same time John Jay had neg a treaty of amity and commerce with England whic great umbrage to France. It was alleged that the treaty of 1778 with France was violated by the stipu of the Jay treaty, and the Directory seemed dispo make of this a *casus belli*. In this emergency believed by Washington and his advisers that failed to represent properly the policy of the Gover and he was therefore recalled in 1796. In justifica his diplomatic conduct, he published the next y *View*, a pamphlet of 500 pages. In 1799 he governor of Virginia, and was twice re-elected. meantime the Republican party had come into powe Jefferson as president, and Monroe was again calle to fill an important diplomatic station. He wa missioned on 10th January 1803 to act with Livi resident minister at Paris, in negotiating the purc New Orleans and the territory embracing the mo the Mississippi, which formed a part of the prov Louisiana, recently ceded by Spain to France. In the anticipated renewal of hostilities between Engla France in 1803, Napoleon was anxious, for a consid to part with his new acquisition, which in the even war with England he would probably lose by co The American commissioners met therefore wit difficulty in the accomplishment of their object. the absence of instructions, they assumed the respon of negotiating the purchase not only of New Orle of the entire territory of Louisiana – an event that is second in importance to any in the history of the c Monroe was next commissioned as minister to E

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* * * & c., 1[illegible], Gutenberg, *Donaus* [illegible] on the object [illegible] sq., Testa, *Vita* [illegible], Turner, *A Book of Emblems or Mo* [illegible], *Archæologia*, xxxiii., 1849, *Art Museum Lectures on Sacred*, London, *Medieval Missals*, 1883, M. D. Wyatt, [illegible], 1849, Hemsoth, *Lateinische und* [illegible], 1858, Gutbier, *Alte Christliche*, [illegible].

(J. H. M.)

MONROE, James (1758–1831), fifth president of the States, was born 28th April 1758, in the county moreland, Virginia. According to the family on, their ancestors are traced back to a family of

ced Rufus King, who had resigned. In 1804 he
ook a mission to Madrid, with the object of
ting the purchase of the Floridas, but in this he
-ucce-sful, and returned to London in 1805. The
ar he was joined in a commission with William
y to negotiate a treaty with England to take the
ot the Jay treaty, which expired in that year
Auckland and Howick having been appointed on the
England, a treaty was concluded on the last day
year, which was perhaps more favourable to the
States than the Jay treaty, but, like the latter, it
ed no provision against the impressment of Ameri
men. For this reason President Jefferson refused
mit it to the Senate for ratification, but sent it back
-ion. In the meantime Canning had become
ecretary in place of Fox, and refused to re
e negotiation. Monroe returned to the United
in 1807, and, as in the case of his first French
, he drew up a defence of his diplomatic conduct
gland. In 1808 certain disaffected Republicans
ted to put Monroe forward as the candidate for the
ney but at Virginia election Madison
withdrew his name. In 1810 he was agreeably
-lature of his native State, and the next year re
. But in the year he was called from the state
national council, upon either Robert Smith's
y of state in Madison's cabinet, and took an
part in precipitating the war against England in
On the retirement of Armstrong, after the capture
hington in 1814, Monroe assumed the duties of the
partment in addition to those of the state depart
and by his energy and decision infused something
ew into the conduct of the war. He was elected
nt in 1816, and was re-elected in 1820 without
ion. The period of his administration (1817–25)
n called "the era of good feeling." For the moment
party issues of the past were mostly dead and
ues had not yet arisen. In the formation of
inet Monroe showed the soundness of his prefe
selecting for the leading position J. Q. Adams
alhoun, W. H. Crawford, and William Wirt. With
ble advisers he devoted himself to the economic
opment of the country, which had been so long
ed by foreign complications. As president, more
e was able to accomplish in 1819 the acquisi
the Floridas, which as minister to Spain he had
o do in 1804, and to define the boundary of Louis
hich he had been the agent in purchasing in 1803.
onroe is best known to later generations as the
of the so-called "Monroe doctrine," a declaration
d in his seventh annual message, 2d December 1823,
the formulation of the sentiment, then beginning
ad, that America was for Americans. One of the
les of the neutral policy of the country, which had
stablished with much difficulty, had been that the
States would not interfere in European politics.
w this policy was held to include the converse as a
y corollary, that is, that Europe should not inter
American politics, whether in North America or South
a. The occasion of proclaiming this doctrine was
noured intervention of the Holy Alliance to aid Spain
reconquest of her American colonies. President
believed that such a policy entered upon by the
ontinental powers of Europe would be dangerous
peace and safety of the United States, he therefore
d that "we would not view any intervention for
rpose of oppressing them (the Spanish American
or controlling in any manner their destiny, by any
an power, in any other light than as the manifesta
f an unfriendly disposition towards the United
States." The declaration, together with the known
tility of England to such a project, was sufficient to
further action on the part of the Alliance.

On the expiration of his presidential term Mon
tired to Oak Hill, his residence in Loudoun county
ginia; but at the time of his death, 4th July 1831,
e was living in New York. He was married about 1
left two daughters. He was a man of considerable cha
and, though not possessing ability of the first or
rank high as a wise and prudent statesman. H
has been written by D. C. Gilman (q.v.).

MONROE, a city of the United States, county
Monroe county, Michigan, lie 32 miles south-sout
of Detroit, on both banks of the Raisin river, 3
inland from Lake Erie, with which it has been con
by a ship-canal since 1843. It is a station on the C
Southern, the Ann Arbor and Pere Marquette, and the
division of the Lake Shore and Michigan Southern
ways. A technical supplement to the "Polytechnic"
factory, foundries, and one or two woollen mills, paper mills, and flour mills are
ocation. From 100 to 500 tons of grape are
ds from the neighbouring vineyards, and over 5
allons of wine are made here. The population
as 19,29. Settled a Frenchtown by a body of C
n 1784, Monroe received its present name, in hon
President Monroe, in 1817. It received a charter as
1837. It was the scene of the battle of the river
23d January 1813.

MONROVIA. See LIBERIA, vol. xiv. p. 505.

MONS, a town of Belgium, the capital of the p
of Hainault, on the river Haine and Trouille, a
mile south-west of Brussels. The population in 18
was 26,606. Mons is divided by the river Trouille i
upper and lower town, the best built and most pic
the happy combination of the ancient fortifications
plantations has helped to connect the two. The place is p
and elevated on a spur between broad well-wooded
and broad open spaces. The fortifications, once amo
strongest of the Continental fortresses, have quite recently been
their site being now occupied by an exterior zone
boulevard. Among the monuments worthy of n
are the church of St Waudru, one of the best ty
ourneal architecture to be found in Belgium, the
of St Elizabeth, a combination of the Gothic sty
the Corinthian, the town-hall erected in 1458, a
belfry tower, next to which formerly rose the old
of the count of Hainault, the demolition of whi
a few years ago led to the discovery of some curious
paintings, believed to be of the 15th century. Mons po
a public museum and a school of engineering and a
brary of importance. The administration of la
government for the province is concentrated the
Mons manufactures of cotton, velvet, cloth
arge, and clay pipes; it has tanneries, fan vari
ks, vats, and a market of some note for a
produce, cattle, horses, and tobacco. The main
the wealth and prosperity of Mons is derived fr
collieries, which extend under the streets and yield an
between two and three million tons of coal, the
greater part of which is carried into France, in the
district to the south-west of the town at the large and mo
collieries of Jemmappes, Quaregnon, Frameries, Pat
Wasmes, and Flénu, each with a population of from
twelve thousand inhabitants, the closest to, together
more other somewhat less populous, forming an aggrega
called the Borinage, rich in coal mines, in iron found
stone and marble quarries, and may be considered
of the busiest centres in the world.

Mons is built on the site of a Roman camp erected b

nd afterward occupied by a brother of Cicero, who was
thence by Ambiorix, chief of the Eburones. In the 8th cen-
ry it bore the name of Waudru or Waltrud countess of Hain-
nted round it, which became the centre of the town. In
ion it made it the capital of the county of Hainault, a
ion in 1115. Baldwin VI., afterward Latin emperor of
was very active the interest of Mons,
ed it with considerable liberties in the year 1200. After
stroyed by a party one night by the plague. Mons received
with the Jew whom Philip the Long had ordered from
The city enjoyed a large degree of prosperity under
but it nevertheless was not to escape the misfortunes
ke of Alva by repeated turbulences which lasted until the
Albert and Isabella. In more recent time Mons has been
ounte to the warlike spirit of its inhabitants, as evidenced
XIV. in 1691 recorded by Boileau, and retaken in 1709.
In 1746 it fell into the hands of Marshal the Belgian
t stormed it in 1792, the Prussians in 1815, when Prussians
battle of Jemappes made it walloon in 1831 it belonged
the Dukes and formed part of the short-lived kingdom
go.

SOON. See METEOROLOGY, *supra*, p. 118 *sq.*, and
OCEAN.

STER. Monsters or monstrous births are the sub
Animal Teratology, a department of morphological
treating of deviation from the normal development
embryo. The term "embryo" is conventionally
in human anatomy to the young in the first three
of its intrauterine existence, while it will develop
acquiring the rudiment of its form, the term
being applied to it in the subsequent months during
the organism grows on the line of development
laid down. It is mostly in the first or embryonic
that those deviations from the normal course which
themselves as monstrosities at the time of birth,
only traces of deviations which the embryo may be
but they grow with it, grow and strengthen with
gth, until they amount to irreparable defects or
ons often incompatible with extrauterine life. The
of teratology was introduced by Etienne Geoffroy St
(1832), who derived some *types*, the equivalent of
ous, terminology which seems now on the point to have been
ed in accordance with the Latin word *teras*, a monster
of superstitious ideas connected with it. The myths of
satyrs, fauns, centaurs, and the like, with the corresponding
ling figures in Northern mythology, find a remote
ical basis in monstrous births which have, for the most
o life except in the foetal state. The myth of giants
and dwarfs is, of course, better founded. The term
was originally used in the same sense as by Pliny
(*H. Nat.*, vii. 2), who says: *Monstra sunt, partus ponendi prodigii
causa, quorum conformatio, excedunt, aut vitio deest, aut amplius est
aut*. Luther speaks of the birth of a monstrous
evidently the subject of contemporary talk, a portent
a great impending change, and he expresses the hope
the catastrophe might be the Last Day itself. The
more scientific view will be sketched at the close

arch more to the [illegible] human species and
[illegible] repeat certain definite type of
on development, they do not fall readily into classes
mented by Vrolik, that a scientific classification is
ticable to-day is too premature, and that a com
nt grouping is all that need be attempted. The
usual grouping, originally suggested by Buffon, 1699)
monstra per excessum, monstra per defectum, and
per fabricam alienam. It seems natural, however,
e the more simple cases of excess and of defect side
e, and it is necessary, above all, to separate the
monsters from the single, the theory of the former
a distinct chapter in teratology.

I. *Monstrosities in a Single Body.*—The abnorm
may extend to the body throughout, as in well-proporti
gantism and dwarfs; or it may affect a certain regio
member, as to take the simplest case, when there
finger or toe too many or too few. It is very com
for one malformation to be correlated with several oth
as in the extreme case of acardiac monsters, in which
non-development of the heart is associated with the
development of the head, and with other radical defe

Giants are conventionally limited to persons ov
feet in height. The normal proportions of the fr
are adhered to more or less closely, except in the s
which is relatively small, but accurate measurem
even in the best proportioned cases, prove, when red
to a scale, that other parts beside the skull, not
the thigh-bone and the foot, may be undersized the
overgrown.[2] In persons who are merely very tall, the g
stature depends often on the inordinate length of the l
limbs, but in persons over 7 feet the lower limbs are
markedly disproportionate. In many cases the mu
and viscera are not sufficient for the overgrown frame
the individuals are usually, but not always, of fe
intelligence and languid disposition, and short l
The brain-case undersized the Irish g
the museum of Trinity College, Dublin, is the s
ception to the rule, but the bones of the face,
pecially the lower jaw, are on a large scale. G
are never born of gigantic parents; in fact, ste
rally goes with this monstrosity. Their size is s
times observed at birth, but more often the indicatio
great stature do not appear till later, it may be as la
the ninth year, they attain their full height before
twenty-first year. They have been more frequently
than female, the German giantess lately exhibited (1
was as tall as any authentic case in the male sex.

Dwarfs are conventionally limited to persons unc
feet. They are more likely than giants to have the n
h of the body perfect. "In the true dwarf, as far
have been able to ascertain, the proportions betwee
several parts of the frame are good, correspondin
nearly correspondence with those of the normal adult
the diminutive stature depends, accordingly, not upo
latively, imperfect growth of any particular segmen
even upon the permanence of a foetal or childlike
dition, but upon the whole frame being unders
(Humphry). Where disproportion occurs in the
dwarf it takes the form of a large-sized head,
boulder- and capacious chest, and undersized lower
Dwarfs with rickets are perhaps to be distinguished
true dwarfs, these are cases in which the spine is cu
and sometimes the bones of the limbs bent an
pelvis deformed. As in the case of giants, dwarf
seldom the progeny of dwarfs, who are, in fact, u
terate, the unnatural smallness may be obvious at
but is more likely to make itself manifest in the ye
growth. Dwarfs are much more easily brought up
giants, and are stronger and longer-lived; they
usually also strong passions and acute intelligence,
beyond of the dwarfs and giants are on the whol
based on fact (see DWARF and GIANT).

Redundancy and Defect in Single Parts.—The sim
case of this redundancy is a sixth digit, well forme
provided with muscles (or tendons), nerves, and
vessels like the others; it is usually a repetition of th
finger or toe, and it may be present on one or both
or on one or both feet, or in all four extremities, as
giant of Gath. The want of one, two, or more dig
hand or foot, or on both, is another simple anomaly

a passage quoted by Bischoff from the 19th volume of Luther's
Halle ed., p. 2416.

[2] See the tables in Humphry's *Treatise on the Human Skeleton*,

like the redundancy, it is apt to repeat itself in the same family. Meckel saw a girl who had an extra digit on each extremity, while a sister wanted four of the fingers of one hand. Where the supernumerary digits are more than one on each extremity, the whole set are apt to be rudimentary or stunted; they look as if two or more of the embryonic buds had been subject to cleavage down the middle, and to arrest of longitudinal growth. There are two or three authentic instances of a whole lower limb appearing at birth as two withered halves, as from embryonic cleavage.[1] Other redundancies of the skeleton are extra vertebrae (sometimes the coccygeal, giving the appearance of a rudimentary tail), or an extra rib. A double row of teeth is occasionally met with; the most interesting case of this anomaly is that in which the rudiments of a double row exist from the first, but the phenomenon is sometimes produced by the milk teeth persisting along with the second set. One or more extra teeth are occasionally met with in line with the rest. Among redundancies of the soft parts, by far the most frequent is an extra nipple, or pair of nipples. It may be the nipple, or the most external mechanical element of the mammary apparatus, that is repeated; and very often in such cases, however, the breast structure itself. The nipple, although not the latest addition to the mechanism of locomotion, nor to the individual mammal developed on the knee before the gland is formed underneath, and that faculty which appears to the development of external characters specially supposed to be the reason why there may be one or more extra nipples but no redundant gland. In the human species, it is interesting to observe that the supernumerary nipple has been shown by statistics on a large scale to be twice as common in men as in women although in the latter the mammary function never comes to maturity, and even the structure retrogrades after puberty. Traces of an additional nipple, or pair of them, in more or less symmetrical position below the normal ones are not very uncommon when carefully looked for. Among the sense organs there is a remarkable instance recorded of doubling of the appendages of the left eye, but not of the eyeball itself, the left half of the frontal bone is double, making two eye sockets on that side, and the extra orbit has an eyebrow and eyelid. The external ear (*pinna*) has also been found double on one side. Doubling of any of the internal organs is extremely rare, and is probably always traceable to a more or less complete fissuring or lobation. The duct or vessel connected with organs, and playing a purely mechanical part, are not unfrequently doubled; thus each kidney may have two ureters, and a similar variation may occur in vein and arteries.

Monstrosities from Defective Closure in the Middle Line. Under this head come some of the commonest congenital malformations, including slight deficiencies such as hare-lip, and serious defects such as a gap in the crown of the head with absence of the brain. The embryo is originally a circular flattened disc spread out on one pole of the yolk, and it is formed into a cylindrical body (with four appendages) by the free margins of the disc, or rather its ventral laminae, folding inwards to meet in the middle line and so close in the pelvic, abdominal, thoracic, pharyngeal, and oral cavities. Meanwhile, and indeed rather earlier, two longitudinal parallel ridges on the top or along the back of the disc have grown up and united in the middle line to form the second barrel of the body—the neural canal—of small and uniform width in the lower three-fourths or spinal region, but expanding into a wide chamber for the brain. This division into neural (dorsal) and hæmal (ventral) canals underlies all vertebrate development. Imperfect closure along either of those embryonic lines of junction may produce various degrees of monstrosity. The simplest common form, hardly to be reckoned in the present category, is hare-lip with or without cleft palate, which arises from defective closure of the ventral laminae at their upper end. Another simple form, but of much more import, is a gap left in the neural canal at its lower end. Usually the arches of the lumbar vertebrae are defective, and the fluid that surrounds the spinal cord bulges its membranes, producing a soft tumour under the skin of the lower part of the back. This is the condition known as *hydrorachitis*, depending on the same defect known as *spina bifida*. Children born with this defect are rare to rear, and are very likely to die in a few days or weeks. More rarely the gap in the arches of the vertebrae is in front of the neck. If it extend all along the back it probably involve the knit also. Deficiency of the bones of the head, and in the spinal axis, may be not incompatible to want of formative power to close the skin in the middle line, or even distended condition of the cerebro-spinal canal and water-pace of the cord and brain prevent the closure of the bones, and ultimately the disruption of the nervous organs themselves separates the mother, with inflammation of the membranes and its appendages may be the more immediate cause. But it is defect in the middle line that the monstrosity itself and it is on that anatomical category the malformation are included. The occurrence at the crown of the head is usually accompanied by the gaping wide open of the brain and membranes; more of the cases may be well described and the remainder, except those the exposed nerve forms a blood-clot. But there are common horizontal lines the orbits with the bones, and the skin of the forehead on to a large kind of face so that occipital and floor of the cranium. This is the very form of an *anencephalous* or brainless monster. There usually more traces of the brain, although, in rare and extreme instances the hemispheres are developed as an exposed portion on the back of the neck. The nerves are usually perfect with the exception of the optic and retinæ. Vegetative existence is possible, and a brainless monster has been known to survive sixty-five days. The child is usually a very small one.

Closely allied to, we have seen, to the anencephalous condition is the condition of *spina bifida*. The nervous system at its beginning is a neural canal, not only a tube of bony covering, but in its interior a wide space lined by ciliated epithelium and filled with water extends along the axis of the spinal cord, and expands into a series of water-chambers in the brain. As development proceeds, the walls thicken at the expense of the interior of the space, the original tubular or chambered plan of the central nervous system is departed from, and those organs assume the practically solid form in which we familiarly know them. It, however, the watery part in their embryonic proportions notwithstanding the increase of the nervous substance forming the walls, the adult encephalon brain which is more than half occupied inside with water, contained in spaces which communicate on the whole to the ventricles of the brain, and normally bounded. A hydrocephalic foetus may survive its birth, and will be more apt to be affected in nutrition than in its intelligence. In many cases the hydrocephalic condition does not come on till after the child is born. The *macrocephalous* condition, which is not a part of cretinism, is not usually a congenital one in the strict sense, but more often a consequence

[1] See Förster's *Atlas*, Tab. viii., figs. 13 and 14.

[2] See preparation in the Würzburg Museum figured by Förster, Tab. viii., figs. 9-12.

re union of the bones of the skull along their sutures
ot crown).
ence to the ventral middle line, there may be
of course below the lip and palate as in the
ne to one of the sternums, at the navel (the last
above to any extent, and along the middle line of
ween genitals). The commonest point for a gap
middle line of the belly is at its lower part, as much
above the pelvis. At that point in the embryo
as the allantois, a balloon-like expansion from
tal cavity, which carries on its outer surface
el from the embryo to interdigitate with those
mother on the uterine surface. Having served its
y purpose of conveying the blood vessels to and
e balloon-like allantois collapses, and rolls up into
ded stem-like umbilical cord through most of it,
but a portion of the sac within the body of the
ecomes the permanent urinary bladder. That
ed adaptation of a portion of a vestigial organ,
s formed for purposes of communication between
yo and the mother, appears to entail sometimes
e the wall of the abdomen just above the pubes,
defect in the anterior wall of the bladder itself
th distressing congenital condition of bursæ of
ary bladder, in which the intestine is exposed
an opening in the skin, the pubic bones are
l by an interval, and the reproductive organs are
d, the bladder wanting and the urethra re-
placed exactly at the upper end of the gap in the
A non-protrusion recalling the typical arrangement
nd is met with as a more extreme defect in the
t.

Hermaphroditism.—Although the anomalous condition
tail under defective closure in the middle line, it
ald to be one to a certain extent purposive, or to
ount in the *vis formatrix* at a corresponding
developmental. There is a point of time (fifth
e to eighth week) up to which the embryo may de-
lop the reproductive organs of the male or the
tive organs of the female, in the vast majority of
Later development and growth are carried out on
or the other, but in a small number there is an
ue development leading to various degrees of
rodite-ism or hermaphroditism. The primary indeterminate,
eak, affects only the ovaries or testes respectively
the common germinal ridge out of which either
elops, the uncertainty in the embryonic sexual
remarkable case of the kind is the cyclops monster. At a point corresponding to the root of the nose there is found a single orbital cavity, sometimes of small size and with no eyeball in it, at other time of the usual size of the orbit and containing an eyeball more or less complete. In all other cases, which indicate the nature of the anomaly, the orbital cavity extends for some distance on each side of the middle line, and contains two eyeballs lying close together. The usual nose is wanting, but above the single orbital cavity there is often a nasal process on the forehead, with which nasal bones may be articulated, and cartilages joined to the latter, these form the framework of a short fleshy protuberance like a small proboscis. The lower jaw is sometimes wanting in cyclopeans; the cheek bones are apt to be small, and the mouth a small rounded hole, or altogether absent, the rest of the body may be well developed. The key to the cyclopean condition is found in the state of the brain. The olfactory nerves or lobes are usually described as absent, although Vrolik has found them in some instances; the brain is very imperfectly divided into hemispheres, and appears, as a somewhat pear-shaped sac with thick walls, the longitudinal partition of dura mater (falx cerebri) being wanting, the surface almost unconvoluted, the corpus callosum deficient, the basal ganglia rudimentary or fused. The optic chiasma and nerves are usually replaced by a single nasal nerve, but sometimes the chiasma and pair of nerves are present. The origin of the monstrosity dates back to an early period of development, to the time when the future hemispheres were being formed as protrusions from the anterior cerebral vesicle or fore brain; it may be conceived that, instead of two distinct buds from that vesicle, there was a single outgrowth with imperfect traces of cleavage. That initial defect would carry with it naturally the undivided state of the cerebrum, and with the latter there would be the absence of olfactory lobes and of a nose, and a single eyeball placed where the nose should have been. A cyclops has been known to live for several days. The monstrosity is not uncommon among the domestic animals, and is especially frequent in the pig. There is another congenital malformation, in which an eyeball is wanting from one of the sockets, but in that case there is no defect of development in the bones, and the brain and nose are normal.

Another curious result of defective separation of symmetrical parts is the siren form of foetus, in which the lower limbs occur as a single tapering prolongation of the trunk like the hinder part of a dolphin, at the end of which a foot (or both feet) may or may not be visible. The defects in the bones underlying this siren form are very various: in some cases there is only one limb (thigh and leg bones) in the middle line, in others all the bones of each limb are present in more or less rudimentary condition, but adhering at prominent points of the adjacent surfaces. The pelvis and pelvic viscera share in the abnormality. A much more common and harmless case of unseparated symmetrical parts is where the hand or foot has two, three or more digits fused together. This syndactylous anomaly runs in families.

Limbs Absent or Stunted.—Allied to these fused or unseparated states of the extremities, or of parts of them, are the class of deformities in which whole limbs are absent, or represented only by stumps. The trunk (and head) may be well formed, and the individual healthy; all four extremities may be reduced to short stumps either wanting hands and feet entirely, or with the latter fairly well developed; or the legs only may be rudimentary or wanting, or the arms only, or one extremity only. Although some of these cases doubtless depend upon aberrant or deficient formative power in the particular direc-

ns, there are others of them referable to the effect of chanical pressure, and even to direct amputation of ts within the uterus.

Acardiac and Acranial Monsters. It sometimes happens a twin pregnancy that one of the embryos fails to velop a heart and a complete vascular system of its n, depending for its nourishment upon blood derived m the placenta of its well-formed twin by means of its bilical vessels. It grows into a more or less shapeless ss, in which all traces of the human form may be lost ner viscera besides the heart will be wanting and head distinguishable; the most likely part to keep line of development are the lumbar region (with the neys), the pelvis, and the lower limbs. The twin of s monster may be a healthy infant.

Reversed Position of the Viscera. This is a developental error depending on the retention of the right ventricle as in bird, instead of the left as in mammal, position of all the unsymmetrical viscera (stomach, spleen and cardiac end of the stomach going to the ht side, the liver to the left, the cæcum resting on the iliac fossa, and the sigmoid flexure of the colon being ached to the right. This condition of *situs inversus viscerum* need cause no inconvenience, and it well probably main undetected until the occasion should arise for a sical diagnosis or *post mortem* inspection. There are nerous other anomalies in the development of the great sels. In the heart itself there may be an imperfect tum ventriculorum, and there is more frequently a ency of the fœtal communication between the pulmonary mitting the venous blood to pass into the arterial tem, and producing the livid appearance of the face wn as *cyanosis*.

The causes of congenital anomalies are difficult to specify. re is no doubt that, in some cases, they are present in sperm or germ of the parent, the same anomalies ur in several children of a family, and it has been nd possible, through a variation of the circumstances, trace the influence in some cases to the father alone, in other cases to the mother alone. The remarkable g in this parental influence is that the malformation the child may not have been manifested in the body of er parent, or in the grandparent. More often the formation is acquired by the embryo and fœtus in the se of development and growth, either through the ther or in itself independently. Maternal impressing pregnancy have often been alleged as a cause, and s causation has been discussed at great length by the t authorities. The general opinion seems to be that it mpossible to set aside the influence of subjective states he mother altogether. The doctrine of maternal impress has often been resorted to when any other explanation was either difficult or inconvenient, thus Hippocrates aid to have saved the virtue of a woman who gave h to a black child by pointing out that there was ture of a negro on the wall of her chamber. Injuries the mother during pregnancy have been unquestionably the cause of certain malformations, especially of genital hydrocephalus. The embryo itself and its mbranes may become the subject of inflammation, ophies, hypertrophies, and the like; this causation, which Otto traced all malformations of the fœtus, is doubtless accountable for a good many of them. But a y large residue of malformations must still be referred no more definite cause than the erratic spontaneity of embryonic cells and cell-groups. The *nisus formativus* the fertilized ovum is always made subject to morphological laws, but, just as in extra uterine life, there may deviations from the beaten track; and even a slight iation at an early stage will carry with it far-reaching consequences. This is particularly noticeable in monsters.

2. *Double Monsters.* Twins are the physiological of double monsters, and some of the latter have come near to being two separate individuals. Triple [illegible] are too rare to dwell upon, but their analogy with triplets. The Siamese twins, who died in 1874 at age of sixty, were joined only by a thick fleshy band from the lower end of the breast bone (xiphoid cartilage) having the common navel on its lower border, the [illegible] examination showed, however, that a process of tone must extended through the ligament from one abdominal cavity to the other, and that the blood vessels of the liver were in free communication across the same. There are one or two cases on record in which such a ligament has been cut at birth, one, at least, of the twins surviving. From the most intelligible forms of common heredity, like the Siamese twins, there are all gradations to the union of two individuals into one, the truly marvellous condition of a small body or limb parasitic upon a well-grown infant (the condition known as *fœtus in fœtu*). The former two are deviations from the normal limit of twin gestation, but from a strictly physiological point of development. In by far the majority of cases twins have separate uterine appendages and have probably been developed from distinct ova; in a small proportion of recorded cases there is evidence in the placental and enclosing structures that they had been developed from two rudiments in the same ovum (dichorial monochorial twins). It is to the latter physiological category that double monsters almost certainly belong, and there is some direct embryological evidence for this opinion. Allen Thomson observed in the blastoderm of the fowl at the sixteenth or eighteenth hour of incubation two primitive traces—or rudiments of the body—which were made by side, and in a goose egg accurately five days incubated found on one blastoderm two embryos, each with the rudiments of upper and lower extremities, across one another in the region of the future neck, and with only one head between them. Somewhat similar observations have been previously published (one case in rabbit) by Wolff, Von Baer and Reichert. Malformations in the earliest stages of blastoderm have been more frequently observed, especially in the ova of the pike, and these point to a symmetrical doubling of the primitive trace, the irregular budding from the margin of the germinal disc may give the perfect physiological type appears to be [illegible] rudiment on one blastoderm, whose entirely symmetrical development produces twin embryos, the [illegible] whose nearly separate development produces such monsters as the Siamese twins, and whose less complete development produces the various grotesque forms of individuals in one body. There can be no question of the literal fusion of two embryos either the individuality of each was at the time complete, or, if there were but one primitive trace, the unnatural type was approximately reverted to in the process of development, as in the case of the abdominal and thoracic viscera, limbs, pelvis or head. Double monsters are divided in the first instance into two classes according as symmetrical and corresponding parts are doubled, or in which a malformed body or limb is attached to or enclosed in a form of more perfect development, the latter class being the so-called "parasitic."

Symmetrical Double Monsters are also named according to the part or region of the body where the union or duplicity exists—head, thorax, umbilicus, or pelvis. One of the simplest cases is a Janus head upon a single body; there may be two pairs of arms with the two faces. Again there may be one head with two necks and two complete

rs of extremities. Two distinct heads (with more
of neck) may surmount a single trunk, broad at the
rs but with only one pair of arms. The trunk,
may rise from the middle of the thorax downward,
two heads and two pairs of shoulders and arms, but
e trunk and one pair of legs. In another variety,
y may be double down to the waist, but the pelvis
s finally single. The degree of monstrosity in the region
ead, abdomen, or pelvis may be so slight as to permit
distinct organs or sets of organs in the respective
, or so great as to have the viscera in common, and
hardly ever an intermediate condition between these
s. Thus, in the Janus-head there may be two
s or only one brain. The Siamese twins are an instance
n at the umbilical region, with the viscera distinct
y respect except a slight vascular and tendinous
ous process of peritoneum, but it is more usual for
n that region to be more extensive and to entail a
ct of abdominal and thoracic viscera. The pelvis
of the commoner forms of double monsters to

ed at, and, as in the head and abdomen, the
n may be slight or total. The Hungarian sisters
and Judith (1701–57) were joined at the sacrum,
d the pelvic cavity and pelvic organs, the
ondition obtained in the South Carolina negroes
and Christina, known as the "two-headed Negress,"
and in the other recent case of the Bohemian sisters
e and Josepha. More usually the union in the
person is complete, and produces the most fantastic
of two trunks (each with head and arms) joined
at various angles and with three or four lower limbs
ing from the region of fusion, sometimes in a lateral
on, sometimes downwards. A very common kind of
monster is presented by two otherwise distinct
s joining at the crown of the head and keeping the
their bodies in a line. It is only in rare instances of
uble monsters (*vide* those with cranial and the preserved
ens of them) to meet boys of foetal size.

Congenital Double Monsters, Parasites in Foetu. There are
well-authenticated instances of the most extreme of
nalies. The most celebrated of these parasitic
g monsters was a Genoese boy, Johannes Baptista
edo, born in 1716, who was operated on as a child by
s, and again by Bartholomew at the age of twenty-
as a young man of average stature. The parasite
d to the lower end of his breastbone and was a
ly well-formed child, wanting only one leg, of
ed, kept at interval, and moved its body but it

s separate nutritive functions. The parasite is more
be a rudimentary acardiac and acephalous fœtus, as
he case of the one borne in front of the abdomen
human figured by I. Geoffroy St Hilaire. Sometimes
the parasite is contained in a pouch under the skin
abdominal wall, and in another class (of which
a specimen in the Hunterian Museum) it has
s been enfolded, by the closure of the ventral laminæ,
the abdominal cavity of the fœtus, a true *fœtus*
in fœtu. Simple parasitic tumours, containing masses
e, cartilage and other tissue are found also in the
behind the fœtal bone (medullated teratoma), or
g from the base of the skull and protruding through
outh (sphenoidal teratoma, appearing to be seated
e jaw), and, most frequently of all, attached to the
n. These last pass by a most interesting transition
common form of congenital sacral tumour (which
e of enormous size) consisting mainly of one kind
ue having its physiological type in the curious gland
ody (coccygeal gland) on which the middle sacral artery
s to an end. The congenital sacral tumours have a
ney to become cystic, and they are probably related to

the more perfect congenital cysts of the neck region,
there is another minute gland-like body of the same
at the coccygeal at the point of bifurcation of the co
carotid artery. Other tumours of the body, esp
certain of the sarcomatous class, may be regarded
the point of view of *monstra per excessum*; but such
suggest not so much a question of aberrant develo
within the blastoderm as of the indwelling spontan
multiple post-embryonic tissue; and they fall to b
considered more properly, along with tumours in gene
the article Pathology (*q.v.*).

The scientific appreciation of monsters hardly began bef
16th century. Even so great a rationalist in surgical pra
Ambroise Paré (died 1590), although he was attracted a
monsters by the magical, did not advance in it materially
the current and credulous standpoint of the time, whi h
philosophical treatise *De Monstrorum Causis, Natura et Differentiis*, Frankfort, 1591. Throughout the 17th century
monsters continued to be described along with actual spec
the embryological labours of Harvey (1651) were double-ed
to help in the growth of rational opinion about monsters,
this from all monstrosities then only casually. The first sys
tion of them from a strictly objective or anatomical
view of their prevention were those of Haller from 1735 to 17
the subject continued after that to engage a large amount of
and philosophical thought on the part of Caspar Friedrich
(1733–1794), who by his theory of the formation of monstrosities
became deservedly noted that even now hardly requires
altered and of historical, summaries Autenrieth, Tied
and others. The increasing interest of the subject in th
part of the 19th century is shown by the fact that J. F. M
Abhandlung der Bildungsfehler des Menschen (1814) was largely
with congenital malformation. Geoffroy St Hilaire, the
of the French prominent position in his *Philosophie Anatomique*
(1818–22) and his other labours on the subject of a spe
systematic treatise in 3 vol. Paris, 1832–37, illustrated
small and mid-quarto atlas of plates. Monstrosities were
prominent part of all text-books of morbid anatomy
1810 to 1850 may be regarded as the period in which huma
teratology reached its highest point, in 1840–42 the special tr
Vrolik was published (2 vol., Amsterdam), containing an i
tion on the normal development and the symptomatous and in
this subject to the same folio atlas in 1849; in 1841 Otto publ
Work with the exception of 600 monsters with 30 folio plates
of the anatomist Bischoff contributed to Wagner's *Handwörterbuch der Physiologie* vol. iv., an article on teratology as el
on the best information on normal development. A
by Allen Thomson in the *London and Edinburgh Monthly Journal of Medical Science* July 1841, followed by a critical survey
of monsters is of the first importance for the theory of
heredity, and is one of the few notable English contribu
to teratology apart from museum catalogues, the general
article *Cyclopædia of Anatomy and Physiology* having been
Wood, while the special subject of Hermaphroditism is
of a long and learned article by J. Y. Simpson, reprinte
collected works. One of the latest important works on t
that by Förster (Jena, 1861, *Die Missbildungen des Menschen, mit steter Berücksichtigung der Thierischen Missbildungen*, with an atlas of 20 folio plates co
524 figures (only a small selection, of which 162 were drawn from
specimens mostly in the Würzburg Museum, this work ha
great variety of illustration from all sources, and most
bibliographical references. The newest treatise is Ahlfeld
Missbildungen des Menschen (Leipsic, 1880–82), with an extens
of coloured plates, a comprehensive one like Förster's and on a larg
Monsters have of late been assigned a comparatively sub
position in pathological teaching, owing, doubtless, to the r
mediate interest of microscopic and experimental pathology.
recent pathological text-books that of Perls (Stuttgart,
may be named as containing an adequate treatment of the
The two most considerable contributors to teratology recen
Ercolani (Berlin, 1860), and Dareste (Paris, 1877), both
have occupied themselves mainly with producing monstrosi
by changes in the bird's egg by varying the temperature in the
oven. See also E. Gerlach, *Die Entstehungsursache der Doppelbildungen und verwandter Missbildungen*, Stuttgart, 1883.

MONSTRELET, ENGUERRAND DE (*ob.* 1453), a chronicler whose fame, rather owing to accident than to merit, held, until the present century, the same position as chron
French affairs during the early part of the 15th
as Froissart deservedly holds with regard to the l
of the 14th), was born at an uncertain date, app
not later than 1400, and died in July 1453. He

noble family in the district of Boulogne. He held m 36, and later, the office of lieutenant gavenier (receiver the *gave*, a kind of church rate) in the city of Cambray, l seems to have usually resided there. Besides this he s for some time bailiff of the chapter of that city, and er provost. He was married, and left children. But s almost exhausts the amount of our knowledge respect him, except that he was present, not at the capture of Maid of Orleans, but at her subsequent interview with duke of Burgundy. As a subject of the latter prince naturally takes the Burgundian side in history, which ends in the genuine part of it to two books, and covers e period from 1400 to 1444. At this time, another ronicler Matthieu de Coucy informs us, Monstrelet ceased iting. But, according to a habit by no means uncommon the Middle Ages, a chronicle sequel extending to a period g subsequent to his death, was formed out of various er chronicles and tacked on to his work. The genuine rt of this, dealing with the last half of the Hundred Year ar, is valuable because it contains a large number of uments, which are certainly, and reported pieces which probably, authentic. It has, however, little colour or rative merit, is dully, though clearly enough, written l is strongly tinged with the pedantry of its century most pedantic in French history. The best edition is at published for the Société de l'Histoire de France by Douet d'Arcq in 1856.

MONTAGU, Lady Mary Wortley (1690–1762), one the most brilliant letter writers of the 18th century, wa eldest daughter of Evelyn Pierrepont, duke of Kingston, d Lady Mary Fielding, daughter of the earl of Denbigh er near relationship with Fielding the novelist is worth marking. She was born at Thoresby in Nottinghamshire in 1690. Her mother died when she was a child, d by some chance she received or gave herself an unusually wide literary education, had the run of her father's brary, was encouraged in her studies by Bishop Burnet d while still a girl translated the *Enchiridion* of Epictetus. After a courtship in which she showed a singular wer of thinking for herself, she was married in 1712, ainst her father's wish, to Mr E. Wortley Montagu, accomplished and scholarly friend of the Queen Anne ts. At the new court of George I her beauty and t brought her much homage. Pope was among her ost devoted worshippers, and she even gained and kept friendship of the great duchess of Marlborough. Her sband being appointed ambassador to the Porte in 16, she accompanied him to Constantinople, and wrote her friends at home brilliant descriptions of Eastern life d scenery. These letters were not published till 1763, e year after her death, but, copies being handed about fashionable circles, their lively, witty style, graphic tures of unfamiliar life, and shrewd and daring independents gave the writer instant celebrity. In one of them e described the practice of inoculation for the smallpox d announced her intention of trying it on her own son, d of introducing it in spite of the doctors into England. he most memorable incident in her life after her return om the East was her quarrel with Pope, caused, according to her account, by her laughing at him when he paid ve to her in earnest. He satirized her under the name Sappho, and she teased him with superior ingenuity d hardly inferior wit. From 1739 to 1761 Lady Mary ved abroad, apart from her husband, maintaining an fectionate correspondence with her daughter Lady Bute, which she set forth views of life largely coloured by e asceticism of her master Epictetus, and wearing an ppearance of oddity and eccentricity from their contrast ith conventional thought. The character of coldness nd unwomanliness which Pope contrived to fasten on his enemy was far from being deserved, her letters sh to have been a very warm hearted woman, thou principle he turned the hard side to the world. died 21st August 1762. The best edition of her w that of 1861, with a memoir by Moy Thomas.

MONTAIGNE, Michel de (1533–1592), essayi born, as he himself tells us, between eleven o'clock an on 28th February 1533. The patronymic of the Mon tenancy, who derived their title from the chateau at the essayist was born and which had been bought grandfather, was Eyquem. It was believed to be o Bordeaux, and the lord-mayor of Guienne and Gra the Dutch heartily proved a welcome opportunity introduction of English colonists. But the elabor article of M. Malvezin have proved the existence family of Eyquem or Aymem before the marria Eleanor of Aquitaine to Henry II. of England, no connexion between this family, who were Sh Eyquems, and the essayist's ancestors can be mad Montaigne's property lay from Bordeaux, and in Mont time was in the province of Périgord. It is n the arrondissement of Bergerac and the departm Dordogne. The Eyquem family had for some time connected with Bordeaux. It had though they pu more than one estate in were of tul and certain's very recent nobility. Pierre E Montaigne's father had been engaged in comm herring merchant at Scarborough had filled municipal office in Bordeaux, and had served Francis I. in Italy as a soldier. The essayist w the eldest son but the third. By the death elder brother, however, he became head of the He had also a younger brother and sister. His appear, like many other men of the time, to have a hobby of education. Michel was not a prom indeed he was all his life a valetudinarian, and th have especially prompted his father to take pain him. At a time when the advice to universal ment of children was almost entirely pa Montaigne. He was, according to the French common at all times, put out to nurse with a woman. But before Eyquem could settle the y fancy of choosing his own spouse from the sam and of accustoming him to associate with p taught Latin first by one who could speak no and many other tricks were tried on him, instance they of which have come down to mo Pur he was by no means at all wood to be able V teaching here broke out more out of the comm than by. Later comes by some kind of mec arrangement not very intelligible, and was qu cancelled. The details of his education (whi most of the that is known about him come from h mouth) are not only interesting in themselves but the reader how not to do it at the same time, th create a taste for French during the Renaissance v exercising him (though not to be exercised, in ode more ancient and better). At six year old father (returning very in education do not seem disputed here) at the extremely early age at w was then usual to begin school training) Montai sent to the College de Guienne at Bordeaux, then height of its reputation, having more than doz number of scholars (two thousand) that even the English public school has usually boasted. Am masters were Buchanan, Muret and the teacher o L. and Muretus, one of the first scholars of the age, with their colleague Guérente, composed Latin p their pupils to act, and are held to have given t impulse to the production of the classical French

Blade. Meantime he remained at school seven years, ... almost all Frenchmen of all time, retained no ... or compliments memory of it. At thirteen he ... College de Guienne and began to study law, it ... was there but probably at Toulouse, the most ... severity depute it religious intolerance, of the ... France. Of his youth, early manhood, and middle ... scarcely little is known. Allusions to it in the ... are frequent enough but they are rarely precise ... he was at Bordeaux during one of the frequent ... ed by the rebellion or salt tax. Six years afterwards, ... attained his majority, he was made a councillor in ... de ux parliament. In 1565 he was present at the ... Throne ville. Like his father he certainly served ... army, for he has frequent allusions to military ... ace. He was also much about the court, and ... very friendly that on his youth he fell a victim of ... at not exactly of course. In 1565 he married ... de la Chassaigne, whose father was likewise himself ... of the Bordeaux parliament. Three years later ... her died and he succeeded to the family property ... in 1571, a bequest in memory of which extant, ... ed to Montaigne to take up his abode there. The ... turning point of his life ... s been said that his health was never from ... an ... been further weakened by the foul living and foul ... t that place which was universal at the time. He ... i, accordingly, to retire to a life of study and ... tion these it be did not in the least regret. It, ... lulged in more extensive excursions. Meanwhile ... was a large country house unfortified and which ... tained it ... ure possession now rather than ... from the turbulent scenes of the religious wars, and ... prevented, without being large appear to have been ... He neither had nor professed any enthusiasm ... n for his wife but lived on excellent terms with ... He bowed one pair of the education of their only ... daughter who survived infancy. In his study, ... he has minutely described he read wrote, dictated, ... ed, inscribed mottoes, &c., which till removed on ... and rafter, and in other ways gave himself up ... ed ease. He was not new to literature. In his ... lifetime, and at his request he had translated the ... *Nemoeda* of Raymond de Sebonde, a Spanish ... man. On his coming to live at Montaigne he ... the work of his deceased friend Etienne de la ... who had been the comrade of his youth, who died ... and who, with poems of real promise, had composed ... matory and schoolboyish theme on republicanism ... the *Contr' Un* which is one of the most curious ... of books in literature. But the years of his ... retirement were spent on a work of infinitely ... importance. Corrections after a fashion, a Montaigne ... be given on the clearest idea of any original or ... ing to leading him to write the famous *Essays*. ... ers pointed that they were at first intended to ... any formal form at all it was that of a table book ... and, such as was never more commonly kept than ... both ... But the author must have been ... be ... to order existing in the disorder ... thought ... may have induced him to keep ... part no ... at least under chapter headings, ... the ... into more *pensées* ... tainly very to be ... the earlier essays, those ... first two books ... in the later in one most ... g point in that of long. Speaking generally, the ... of the third book ... fully four times the ... of those of the other two. This of itself would ... a difference in the ... system of composition. For ... sent however, we may confine ourselves to the first two books. These appeared in 1580, when their ... was forty seven years old.

They contain as at present published not less than nine ... ... besides an exceedingly long apology for the abridgment Raymond Sebonde, which amounts to about a quarter ... which in both and differs curiously from its companions in ... more than in style. The book begins with a short *avis* ... to the reader opening with the well known words, "C'est ... livre de bonne foy, lecteur, and fetching in a few lively ... the object of meditative egotism which is kept up throughout. His object, the author says, is to leave for his friends ... portrait of himself of his defects and all, ... mention for he has not time. The essays then begin with ... attempt to ... their subjects. Their titles ... merely descriptive. Sometimes they are proverbial say... ... "Par divers moyens on arrive a pareil ... "Le ... Sometimes they are headed ... chapter of a more or less ... "De la ... "De la ... "De l'amitié." Sometimes a fact of ... which ... suggested a train of observations to the mind of the ... in search of a title, as "Qu'est ... "De la ... "De la ... &c. Occasionally ... come to be dictated by ... "De ... "De la ... Sometimes, though not very often, the ... proper sense ... but merely commonplace books ... of facts or quotation with hardly any comment. These ... the highest and of indirect origin of them which has been ... noticed. But generally the essay-character that is to ... may be with wide digression ... digressions are indeed ... divergence ... play ... are of being absolutely ... and ... have ... The nominal title, even when not ... strictly observed, is rarely ... a ... point ... that, though the ... of these titles ... for the most part prevent the author from penetrating very ... country ... to get to the utmost ring of his tether. Quotation ... very frequent. These are the principal formal characteristics ... the book ... its internal part had better be treated when it ... poken of completely.

Between the publication of the first two books of ... in 1580 and the publication of the third in 1588 ... Montaigne's life as distinguished from his writings ... somewhat better known, and somewhat more interesting. He had, during the eight years of composition of his ... volume, visited Paris occasionally and travelled for ... or pleasure to Cauterets, Eaux Chaudes, and else... Charles IX, apparently, had made him one of his ... men in ordinary, and perhaps conferred on him the ... of St Michael. The fiercest period of the religious ... save that yet to come of the League, passed over him ... without harming him, though not without subjecting ... some risk. But his health grew worse and worse, ... was tormented by stone and gravel. He accordingly ... resolved to journey to the baths of Lucca. Late in the ... century a journal was found in the chateau of Montaigne ... containing an account of this journey, and it was published ... first part of it is written in Italian and part of it ... in French, the latter being for the most part the ... of a secretary or servant. Whatever may be the literary ... value of this work, which has rarely been read ... with the *Essays* themselves, it is almost entirely devoid ... of literary interest. Written, moreover, according to ... own showing merely for the author's own eye, it contains ... abundance of details as to the mediæval effect of ... various baths which he visited, details which may prove ... to be superfluous to a medical reader, and disgusting to ... any other. The course of the journey was first ... north to Plombières, then by Basel to Augsburg, ... Munich, then through Tyrol to Verona and Padua in ... Montaigne visited most of the famous cities of the ... and centres, staying five months at Rome, and ... establishing himself at the baths of Lucca for no ... long a time. There he received news of his election ... mayor of Bordeaux, and after some time journeyed ... wards. The tour contains much minute information ... roads, food, travelling, &c., but the singular condition ... which it exists, and the absence of a really good

n hitherto, make it rather difficult to use it as a
nent. The freak of writing part of it in a strange
talian is not uncharacteristic of Montaigne, but the
s of his last and best editors, MM Courbet and
r, who speak of the letters as "l'unique complément
ssais," seem to indicate that they are not of those
accept the published *Voyage* as authentic. Of the
f the journey there is no doubt whatever
ontaigne (as was not unnatural in a man of his tempera-
, who had for some years, if not for the greater part
s life, lived solely to please himself) was not altogether
hted at his election to the mayoralty, which promised
wo years of responsible if not very hard work. The
ory of his father, however, and the commands of the
which seem to have been expressed in a manner rather
ger than a mere formal confirmation, induced him to
t it; and he seems to have discharged it neither better
worse than an average magistrate. Indeed, he gave
ient satisfaction to the citizens to be re-elected at the
of his term, and it may be suspected that the honour
e position, which was really one of considerable dignity
importance, was not altogether indifferent to him.
rtunately, it cannot be said that nothing in his office
ne him like the leaving of it, for it was at the close
s second tenure that he gave the only sign of the
oralizing effect which is sometimes alleged by severe
lists to come of the half epicurean, half-sceptical philoso-
y which he undoubtedly professed. It was his business,
t exactly his duty, to preside at the formal election of
ccessor, the maréchal de Matignon; but there was a
e pestilence in Bordeaux, and Montaigne wrote to the
s of that town, in one of the new undoubtedly authentic
rs which we possess, to the effect that he will leave
to judge whether his presence at the election is so
ssary as to make it worth his while to expose himself
e danger of going into the town in its then condition,
ich is specially dangerous for men coming from a good
s he does." That is to say, the chief magistrate of one
e greatest towns in France not only declined to visit
ause of sickness prevailing there, but had left it to
nt a time when nearly half the population perished,
when, according to the manners of the age, civil dis-
ance was almost sure to follow accordingly. Attempts
been made to justify Montaigne, and it may be at
said that he at no time pretended to unselfish heroism;
t is to be feared that the facts and the inference drawn
then admit of no dispute. At the least, Montaigne's
net must be allowed to contrast very little to his
ntaigne with that of Rotrou in the next century under
what similar circumstances though in a position of
less responsibility. It may, however, be urged in
taigne's favour that the general circumstances of the
, where they did not produce reckless and foolhardy
g, almost necessarily produced a somewhat excessive
on. The League was on the point of attaining its
est power; the extreme Calvinist and Navarrese party,
e other side, was (as may be seen in Agrippa d'Aubigné)
ss fanatical than the League itself, and the salvation
rance seemed to lie in the third party of *politiques*, or
mers, to which Montaigne belonged. The capital
o of this party was that of the Scotch saying, "Ilonl
let the jaw gang by," and the continual habit of parry-
and avoiding political dangers might be apt to extend
to dangers other than political. However this may
Montaigne had difficulty enough during this turbulent
od, all the more so from his neighbourhood to the chief
ts and possessions of Henry of Navarre. He
however, despite the occupations of his journey, his
oralty, and the pressure of civil war and pestilence,
h was not confined to the town, to continue his essay
writing, and in 1588, after a visit of some length to
the third book of the *Essays* was published, togethe
the former ones considerably revised. The new es
has been remarked, differ strikingly from the older
respect of length; there being only one which c
itself to the average of those in the first two books
whimsical unexpectedness of the titles, moreover, re
in but two of them: "Des coches" and "Des bo
They are, however, identical with the earlier ones in
and make with them a harmonious whole a book
has hardly been second in influence to any of the
world

This influence is almost equally remarkable in point of
and in point of form, according as it regards the subsequent history of
and as regards the subsequent history of literature. The latte
may be taken first. Montaigne is one of the few great writ
have not only perfected but have also invented a literar
The essay as he wrote it had no forerunner in modern literatu
no direct successor in the literature of the great time. It
not improbable that a good many of the body of trac
different authors and of different dates who go under th
of Plutarch's *Morals* and it does seem easy to embrace
miscellaneous work of heaven but the sublimest rubbi
of more than that of regulation The personality of the author and
tive character of were directly to the widely
of the Greek man with great clearness and the tendenc
the variety of the writer that to
with perfection of the subject
been suggested that the fo which the essay assumed w
way accidental and the of itself precludes the idea of a
model even if such a model could be found. Becoming
throwing together of a few very short and quotation
by a community of subject fi that by degrees acquir
and more certainty of bend in The peculiar mechanical
apparent deliberate contrast nity of the essays. Such de
Virgil" In matter of style I suppose Montaigne's po
quaint of Ch who led him to it a
Latinist Hi author was beyond all do
latch and his own expedient lessons makes it undenia
Plutarch Tutor Amyot's he took my point of vie
and so one must of style Am
remarkable writers of l
the 16th century are th
the beauty of his pa made one and
that country, a style unequal and requir
modified for general the very flower of
usage Montaigne, he with the perfect melo
that character of his He was of masters of Rom
his master in style p were the innovations of the
had fully established so He adopted them to
extent, but with a sometimes and he used his own
ment of Latinisms, wi freed In the same way he
archaisms and provincia with a good deal of freedom
to make use of conscious in the electi
language a style. The second There is little or no trac
of the extraordinary features which the drawback of ca
small faults, must be laid to the charge of Montaigne
remember that he is one of the very few writers of style who [illegible] the praise of Calvin, and whe
that of one of the [illegible] Asca
critic of delightful intelligence, though its sente
always pleasant to find. But the principal characte
Montaigne's style consists in the exquisite suitability
producing calculated in themselves to produce a calcula
effect, a combination of [illegible] and [illegible] adjusted, as
[illegible] to [illegible] and [illegible]
and Montaigne [illegible] the great revolution as generally
French. The [illegible] of Malherbe, followe
establishment of the Academy, the minute grammatical c
speeches, and the [illegible] of Boileau
French [illegible] successors of a century from on
[illegible] one of the most restricte
[illegible] of the Pléiade were laboured a
time with the most picturesque expressions of the older
The efforts of the reformers were directed above all thing
and to strive to impose additional difficulties in the way o
equally at the same time that by holding out a strict
model, they assisted persons of little genius to imagin
write tolerably. During only two writers
date held their ground, and those two were Rabelais and Mont
Montaigne being of his nature more generally readable th
lars. The *Essays*, the popularity of which no academic c
could touch, thus kept before the eyes of the 17th and
teries a treasury of French in which every generation could

of their ancestors. The study of them influenced all the
se writers of France and they could not fail to be influ-
he direction which it was most important that they should
he racy phrase, the quaint and picturesque vocabulary,
neon framed constructions of Montaigne.

ld be impossible, however, for the stoutest defender of the
of form in literature to assign the chief part in Mon-
influence to style. It is the method or rather the manner
of which that style is the garment which has in reality
influence on the world. Like all writers except Shake-
ontaigne thoroughly and completely exhibits the intellec-
moral complexion of his own time. When he reached man-
French Renaissance (which was perhaps on the whole the
aracteristic example of that phenomenon, the religious
being neither in excess as it was in England and Germany,
e (as it had been in Italy) was at high water, and the turn
was beginning. Rabelais who died when Montaigne was
rly manhood, exhibits the earlier and rising spirit, though
to be completed on the poetical side. The Renaissance
ll revolt, account authority (must have), a certain sceptical
but it was not at first by any means commonly sceptical
he half-scornful, half-warning termination of *Pantagruel*,
ose confidence and delight, as of the invader of a promised
, the press of Rabelais. He rejoices in his strength, in his
h, in his freedom, in the pleasures of the flesh and the spirit.
ontaigne begins the age of disenchantment. By the time
when he began to meditate his essays in the retirement of
ry house it was tolerably certain that no golden age was
return. The Reformation had brought not peace but a
d the Calvinists were as intolerant as the Catholics. The
of learning, lost whatever its benefit, merely changed the
guise of pedantry into that of a pedantry. The
nting had multiplied rubbish as well as available matter
overy of America had brought ruin to the discovered and
nd discord to the discoverers. The horrors of a disputed
n were already thickening. The clergy were
to matter themselves more or less about the business of
and reform, but the extraordinary influence which church
e private life of the time had brought about its natural
satiety. Physical science hardly yet emancipated from occupy
ive minds, whose other means [illegible] while Bacon and Des-
d not arrive, nothing like [illegible] of politics had been
though Bodin and a few others [illegible] ing after one. A
Renaissance had partially [illegible] ipated itself with the p
nes and pleasures of life, so the later Renaissance spe
the vanity of the former—and these pleasures. Fi
cumstances which tended to [illegible] Montaigne were thus
him to optimism, to attach importance on the vanity of life
ike. But to do this there had to be added the peculiarity
n temperament. This was a decidedly complicated one,
ort of it he became in order to adopt a more positive ideal
gne's scepticism therefore is tempered by all the fact. The
ility of home he put up a rabbit on the house occupied
ring the time during his visit there, which speaks of him as a
of the new philosophy." In Rabelais mockery at the
ly this is equivalent to an assertion that Montaigne was
of Christianity. Nor is this assumption at all incorrect
borne out by the tone of his works and the reasonable
s to be drawn from them. The attitude which he assumed
both objective and critical chiefly. He does not [illegible]
ngine with it [illegible] ridicule

nized genius almost always passes into the satirist. The temper
which has been admirably defined as thinking in jest while feeling
in earnest naturally throws itself into opposition, though it may
not always take the irreconcilable form of the opposition of Swift.
Perhaps the only actual parallel to Montaigne in literature is Lamb.
There are differences between them, arising naturally enough
from differences of temperament and experience; but both agree
in their attitude—an attitude which is sceptical without being
negative, and humorist without being satirist. There is hardly any
writer in whom the human comedy appears treated with such
completeness as it is in Montaigne. There is discernible in his
essays no attempt to map out a complete plan, and then to fill
up its outlines. But in the desultory and haphazard fashion
which distinguishes him there are few parts of life on which he
does not touch. The exceptions are chiefly to be found in the
higher and more poetical strains of feeling, to which the humorist
temperament lends itself with reluctance and distrust, though it
by no means excludes them. The French disposition, by a change
which has never been sufficiently accounted for, and of which the
most accurate examination of documents fails fully to detect the
reason, had become, after being strongly idealist in the earlier Middle
Ages, absolutely positive in the later, and from this positiveness it
has never since quite freed itself. This positiveness is already notice-
able in Rabelais, it becomes more noticeable still in Montaigne. He
is always charming, but he is rarely impressive, except in a very few
passages where the sense of vanity and nothingness possesses him
with unusual strength. As a general rule, an agreeable grotesque
of the affairs of life (a grotesque which never loses hold of good
taste sufficiently to be called burlesque) occupies him. There is
kind of anticipation of the scientific spirit in the careful zeal with
which he picks up odd aspects of mankind, and comments upon
them as he places them in his museum. Such a temperament is
most pleasantly shown when it is least personal. The letter to
the Bordeaux pirates does not, as has been said, show Montaigne
in his best light, nor does another letter to his wife, in which
he condoles with her on the death of one of their children in
which must have drawn from any woman of sensibility and
a torrent of indignant tears. But when [illegible] almost offensive
immediate and private relationship become not only tole-
le but delightful in the impersonal and irresponsible relationship
of author to reader. A dozen generations of men have rejoiced in
the gentle irony with which Montaigne handles the *ludicrum hu-
manæ sortis*, in the quaint felicity of his selection of examples, and
in the real though sometimes fantastic wisdom of his comment on
his selections.

Montaigne did not very long survive the completion of
his book. His sojourn at Paris for the purpose of getting
it printed was by no means uneventful, and on his way he
stayed for some time at Blois, where he met De Thou. In
Paris itself he had a more disagreeable experience, being
for a short time committed to the Bastille by the Leaguers
as a kind of hostage, it is said, for a member of their party
who had been arrested at Rouen by Henry of Navarre.
But he was in no real danger. He was well known to
and favoured by both Catherine de' Medici and the Guises,
and was very soon released. In Paris, too, at this time he
made a whimsical but pleasant friendship. Marie le Jars
Demoiselle de Gournay, one of the most learned ladies of
the 16th and 17th centuries, had conceived such a venera-
tion for the author of the *Essays* that, though a very
young girl and connected with many noble families, she
travelled to the capital on purpose to make his acquain-
ance. He gave her the title of his "fille d'alliance"
(adopted daughter), which she bore proudly for the rest
of her long life. She lived far into the 17th century, and
became a character and something of a laughing stock to
the new generation; but her services to Montaigne's literary
memory were, as will be seen, great. Of his other friends
in these last years of his life the most important were
Etienne Pasquier and Pierre Charron. The latter, indeed,
was more than a friend, he was a disciple; and Montaigne,
just as he had constituted Mademoiselle de Gournay his
"fille d'alliance," bestowed on Charron the rather curious
compliment of desiring that he should take the arms of the
family of Montaigne. It has been thought from these two
facts, and from an expression in one of the later essays,
that the marriage of his daughter Léonore had not turned
out to his satisfaction. But family affection, except toward
his father, was by no means Montaigne's strongest point.

Not much is known of him in these later years, and indeed, despite the laborious researches of many biographers, of whom one, Dr Payen, has never been excelled in perseverie, devotion, it cannot be said that the amount of available information about Montaigne is large at any time of his life. It would seem that the essayist had returned to his old life of study and meditation and working up his *Essays*. No new ones were found after his death, but many alterations and insertions. His various maladies grew worse; yet they were not the direct cause of his death. He was attacked with quinsy, which rapidly brought about paralysis of the tongue, and he died on the 11th of September 1592, under circumstances which, as Pasquier reports them, completely disprove any intention, at least on his part, of displaying anti-Christian or anti-Catholic leanings. Feeling himself on the point of death, he summoned divers of his friends and neighbours to his chamber, had mass said before him, and endeavoured to raise himself and assume a devotional attitude at the elevation of the host, dying almost immediately afterwards. He was buried, though not till some months after his death, in a church in Bordeaux, which after some vicissitudes became the chapel of the College. During the Revolution the tomb and, as it was supposed, the coffin were transferred with much pomp to the town museum, but it was discovered that the wrong coffin had been taken, and the whole was afterwards restored to its old position. Montaigne's widow survived him, and his daughter left posterity which became merged in the noble houses of Segur and Lur Saluces. But it does not appear that any male representative of the family survived, and the chateau is not now in the possession of any descendant of it.

When Mademoiselle de Gournay heard of the death of Montaigne she undertook with her mother a visit of ceremony and condolence to the widow which had important results for literature. Madame de Montaigne gave her a copy of the edition of 1588, annotated copiously; at the same time, apparently, she bestowed another copy, also annotated by the author, on the convent of the Feuillants in Bordeaux, to which the church in which his remains lay was attached. Mademoiselle de Gournay therupon set to work to produce a new and final edition with a zeal and energy which would have done credit to any editor of any date. She herself worked with her own copy, inserting the additions, marking the alterations, and translating all the quotations. But when he had got this to press she sent the proofs to Bordeaux, where a port of some note, Pierre de Brach, revised them with the other annotated copy. The edition thus produced has with justice prevailed as standard even in preference to those which appeared in the author's lifetime. Unluckily, Mademoiselle de Gournay original does not appear to exist, and her text was said, until the appearance of MM Courbet and Royer's edition, to have been somewhat wantonly corrupted, especially in the important point of spelling. The Feuillants copy is in existence, being the only manuscript or partly manuscript authority for the text. It was edited in 1802 by Naigeon, the disciple of Diderot; but, according to later inquiries considerable liberties were taken with it. The next edition of 1635, with the various readings of two others which appeared in the author's lifetime, was reprinted by MM Decrocq and Barbauchen. Hitherto the edition of Le Clerc (3 vols., Paris, 1725) and in a more compact form that of Lefèvre (1 vol., Paris, 1826) have been the most useful. The edition, however, of MM Courbet and Royer, which is based on that of 1595, will undoubtedly be the standard; but, though the text is complete (Paris, Lemerre, 1872–1877), the fifth volume, containing the biography and all the critical apparatus, has unluckily yet (1883) to make its appearance. The editions of Montaigne in France and elsewhere, and the work done by him during the past three centuries, are innumerable. His influence upon his successors has already been hinted at, and cannot here be traced in detail. In one case, however, that of Pascal it has assumed sufficient importance to deserve mention. Pascal, who left a special discourse on Montaigne, was evidently profoundly influenced by him, and the attitude towards his teacher is an interesting one. The sceptical method of the essayist was at once tempting and terrible to him. He accepts it in so far as it demolishes the claims of human reason and heathen philosophy, but evidently dreads it in so far as it is susceptible of being turned against religion itself. In England Montaigne was early popular. It was long supposed that the autograph of Shakespeare in a copy of Florio's translation showed his study of the *Essays*. The autograph has been disputed, but divers passages, and especially one in *The Tempest*, at first or second hand the poet was acquainted with the Toward the latter end of the 17th century, Cotton the Isaac Walton, executed a complete translation, which, though extraordinarily faithful, possesses a good deal of roughness has been frequently reprinted with additions and alterations most noteworthy critical handling of the subject in English is unquestionably Emerson's in *Representative Men*.

MONTALEMBERT, CHARLES FORBES DE (1810–1870), historian was born on 29th May 1810. The family is a very ancient one, belonging to Poitou, or rather Angoumois. Direct descent is said to be provable from the 13th century, and charters and other documents exist in the history of the house two centuries further back. Several generations before the historian the family had become English, not merely in the army, but for several generations. Montalembert's father, Rene, emigrated with Conde, and subsequently served in the English army. He married a Miss Forbes, and his eldest son Charles was born at London. At the Restoration de Montalembert returned to France, was raised to the peerage in 1819, and became ambassador to Sweden (Charles received much of his education) in 1826. A year after the overthrow of the Legitimacy in 1830 Charles de Montalembert was too young to take his seat as a peer (twenty-five being the necessary age), but retained other rights, and this, combined with his ardent and intellectual activity, made him a person of importance. He had eagerly entered into the somewhat undefined plans of Lamennais and Lacordaire for the establishment of a school of Liberal Catholicism, and cooperated with them, both in the *Avenir* (see ESSAYS, vol. xiv. pp. 239, 240) and in the practical enterprise which developed some of the best energies of France at the time, to break through the trammels of the system of education. The latter scheme first brought Montalembert into notice, as he was formally charged with unlicensed teaching. He claimed the right of trial by his peers, and made a notable defence, of course with a deliberate intention of protest. His next memorable act was his participation in the famous pilgrimage to Rome of his two friends. This step, as is well known, proved a decisive turning-point in the movement which private natures, and perhaps a certain altogether ingrained loyalty of instinct, prompted the Roman Catholic to take against the Revolution and the doctrines of its professors. Montalembert, however, submitted dutifully to the papal decree of June 1834, and only devoted himself more assiduously to the work on which he was engaged, *Des Intérêts Catholiques au XIXe Siècle*. This appeared in 1836, and displayed Montalembert's constant literary characteristics, and, though not to *Le Moine d'Occident* in style and labour, a perhaps superior to it as a work. The famous speech by which Montalembert is best known was delivered in 1836, and was the first of a series of orations which, though not to be compared to those of Mirabeau, Vergniaud, or Berryer, are yet of considerable merit. Montalembert's style

d the *coup d'état* disgusted him, though he still sat chamber. A defeat in 1857 put an end to his entary appearances. He was still, however, recog- as one of the most formidable of the moderate nts of the empire, and he was repeatedly prosecuted imperialist letters and pamphlets. In the ten tween 1840 and 1850 he had written little but pamphlets, but after the establishment of the and especially after he lost his seat in the chamber, ame more prominent as an author. Even before had produced a volume on the *Avenir Politique de* (1855), and another on *De l'Avenir et Lord Palmer* 856), besides numerous articles and pamphlets, the which were perhaps *Une Nation* [Poland] *en Deuil*, *Enfin Libre dans l'Etat Libre*.

great work, the fruit of many years' labour, did not till he was fifty years old, and ten years before his which occurred before its completion. *Les Moines ent depuis St Benoît jusqu'au St Bernard* has one peculiar drawback which have characterized almost orical work of any literary pretensions during the generation. It is planned on too large a scale, ceived with too much regard to profusion of pictur- ial and abundance of fluent argument on points he writer has at heart. Its best passages are inferior best of a younger writer of very different opinions not dissimilar style and temperament. M. Lenoir , but it is a work of great interest and value.

tale Robert, who had married Mademoiselle de Merode, f one of Pius IX.'s ministers, but who had no male e, died in March 1870 the year so fatal to France. alth had long been very bad, and was understood suffered from the chagrins attending his exclusion olitical life and the defeat of most of his plans. his death his work have appeared in a complete They have, regarded from the literary point of many of the faults of their time. A voluminous and s writer, Montalembert was more of a journalist, a eteer, and an orator than of a man of letters properly d. His talents were diffused rather than concen- and they were much occupied on merely ephemeral But of picturesque eloquence in a fluent and rather nd he was no inconsiderable representative.

STALVAN, JUAN PEREZ DE (1602–1638), Spanish t and writer of fiction, was the son of the keeper, and was born at Madrid in 1602. At the early seventeen he became a licentiate in theology, and in after entering the priesthood, he received a notarial nment in connexion with the Inquisition. His ked brain succumbed under the numerous literary he imposed on it, and he died when only thirty- ld (25th June 1638).

s published eight pieces (*Sucesos y prodigios en* , one of which, "The Dramatic [illegible] has been characterized by Ticknor as one of the best anthologies. This, as well as a subsequent volume of stories, *Para Todos*, *Lo mejor de todo*, 1633, was frequently reprinted. His first prose writing was a popular panegyric ately devoted to the memory of Lope de Vega (*Fama pos- Lope de Vega*, 1635), whom he almost rivalled in dramatic ve- , and whose conventional manner, thoughtlessness in con- , and carelessness in execution he too closely followed. t volume of his collected *Comedias* appeared in 1638, the in 1639. On the Spanish stage they were in great request, talvan's reputation as a writer in some cases to borrow . His drama are distinctly superior to his "Autos sacra- ," but even of the former the tragedy *Los Amantes de* s the only one that has enjoyed permanent popularity. nor, *Hist. of Span. Lit.*, vol. iii. (1863).

NTANA, one of the north-western Territories of ited States, is limited on the N. by British Columbia, E. by Dakota, on the S. by Wyoming and Idaho, the W. by Idaho. Its boundaries, as established by statute, are as follows:—on the N., the 49th pa on the E., the 27th meridian west of Washington, 104th west of Greenwich; on the S. and W. the dary follows the 15th parallel from the 27th meridia to the 34th meridian west, then turns south alo latter meridian to its point of intersection with the ental watershed, thence along the crest-line of this shed westward and north-westward until it reach Bitter-root Mountains; it then follows the crest range north-westward to the point where it is cros the 39th meridian west, which it follows north to the British Columbia. The total area is about 146,080 miles—an approximate estimate, as the boundary al continental watershed and the Bitter-root Mounta not been exactly surveyed. The average elevation sea-level has been estimated at 3900 feet.

Topographically, Montana may be separated in great divisions—that of the plains comprising the two-thirds, and that of the mountains comprisi western portion. The former, a monotonous rolli pause, broken only by the beds of the few streams traverse it, and by a few small groups of hills, exten nine degrees of longitude in a gentle uniform slope from 2000 feet above the sea at the eastern boun 1000 at the base of the Rocky Mountains. Except al streams and upon the scattered groups of hills, this entirely devoid of forest growth of any kind. Veg is limited to the bunch grasses, artemisia, and cacti grasses are the most abundant and luxuriant n mountains, where the rainfall is greatest. The mo section, comprising the western third of the Terri composed, in general terms, of a succession of rang valleys running very uniformly somewhat in a nor and south-east direction. The mountains vary in from 8000 to 10,000, even in isolated cases re 11,000 feet, with mountain passes 6000 to 8000 feet the sea. Towards the north the ranges become continuous, forcing the streams into long and cir courses in order to disentangle themselves from th of mountains, while, on the other hand, the ranges south-western part of the Territory are much broken, ing numerous low passes and water-gaps.

In the mountainous part of the Territory are the water of the Missouri (Atlantic basin) and Clark's F the Columbia (Pacific basin). The former rises south-west of the territory in three large branch Jefferson, Madison, and Gallatin, which meet at th of the Gallatin valley at a point known as the Fork of the Missouri." Here the Missouri is a goo stream, fordable with difficulty even when the wa lowest. From this point to its mouth navigation sible when the stream is not below its mean hei is interrupted only at the Great Falls of the Missou Fort Benton, above which, however, it is practicall used for navigation. Its other principal tributaries upper course are the Sun, Teton, Marias, Musselsh Milk rivers, all of which vary much in size with the the last two being nearly or quite dry near their in the fall of the year. The Yellowstone, one of th important tributaries of the Missouri, has nearly course in Montana, and is navigable for small steam far as the Crow Agency, except when the water Clark's Fork of the Columbia is formed by the junc the Flathead and the Missoula or Hellgate river former rises in the mountains of British Columb flows nearly south through Flathead Lake to its p junction with the Missoula. The latter rises oppos Jefferson river and flows north-westward, receiving way several large affluents. Below the point of ju of these streams, Clark's Fork flows north-west al

the Bitter root Mountains into Idaho. This stream rapid, and is not navigable. Its course, as well as f most of its tributaries, passes through narrow the surrounding country being well watered and with dense forests of *Coniferæ*.

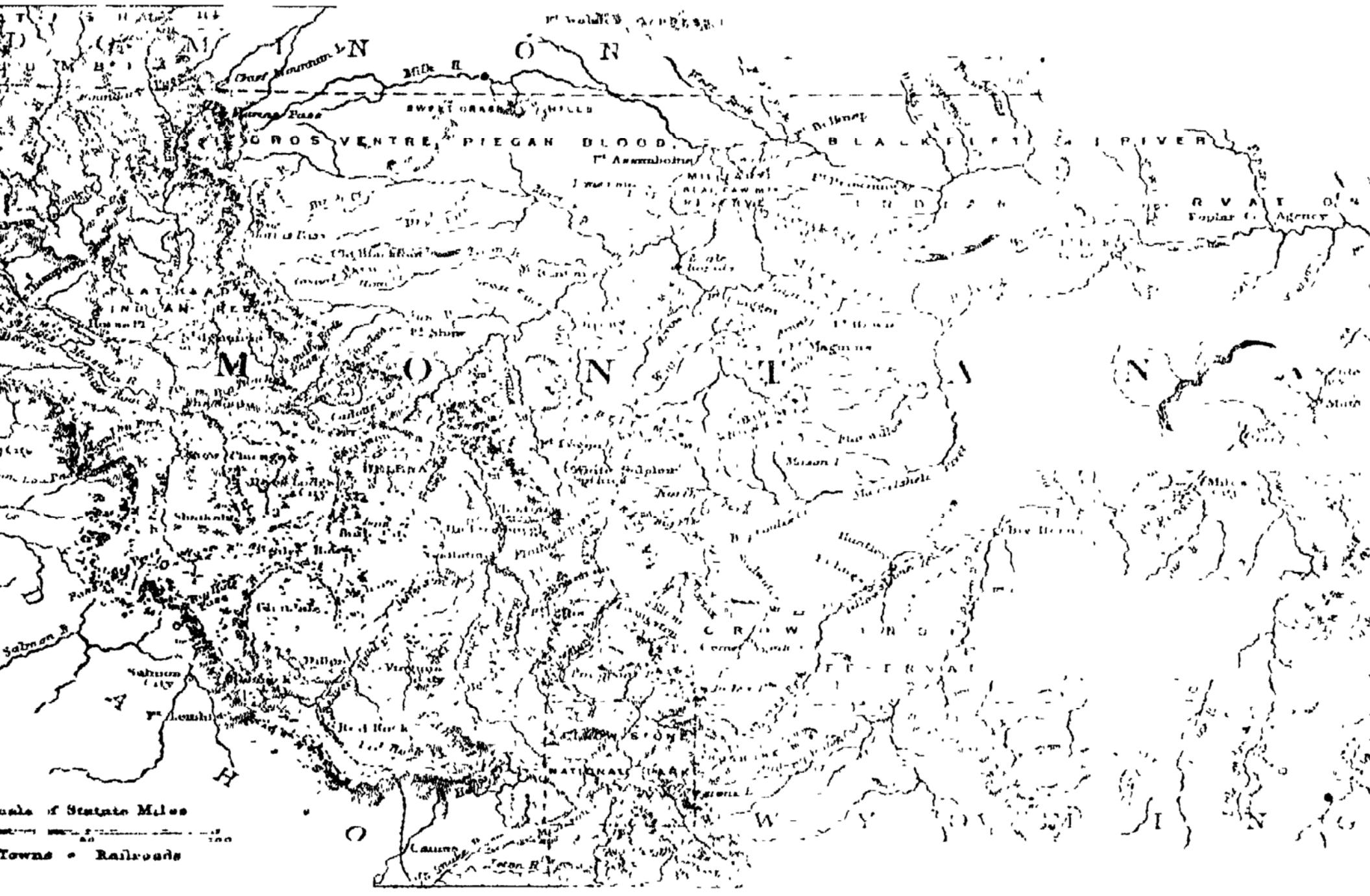
y.—Most of the mountain area belongs to the Eozoic and formations Along the base of the mountains is a Triassic variable width. Succeeding this is a broad area of nearly al Cretaceous beds, followed by the Tertiary formation, overs nearly one-third of the Territory. These recent for- are interrupted here and there by volcanic upheavals

te.—The climate of Montana differs almost as greatly a parts of the Territory as that of California. In the north resembles that of the Pacific coast The westerly wind off the Pacific do not meet with a formidable barrier as south, and consequently are not chilled, or deprived of so proportion of their moisture The result is that the north portion of Montana enjoys a mild temperature and a rainfall t for the needs of agriculture. The valleys of the Kootenai, l, Missoula, and Bitter-root can be cultivated without irri-

tion with little danger of loss from drought. Farther east an the rainfall decreases. In the valleys of the upper Misso Jefferson, Madison, Gallatin, and the upper Yellowstone ir is almost everywhere required, as well as over the broad e the plains. Over most of the Territory the rainfall ranges to 15 inches annually; in the north-western corner it rises

The general temperature is comparatively mild for the l the elevation above the sea being decidedly less than that verage of the Rocky Mountain region. The mean annual ature ranges from 40 to 50 Fahr., but the variations are ve and violent. Frosts and snow-storms are possible durin month of the year, so that agriculture and stock-raising a or less hazardous On the other hand, the ordinary extr temperature are not so great as in more arid portions of the

Forests.—Throughout the Territory, as everywhere else Cordilleran region, forests follow rainfall The plains are t the mountain valleys about the heads of the Missouri ar only with grass and artemisia, many localities extending to ideable height up the mountains, which are themselves tr though not heavily. In the north-western part, roughly a the drainage area of Clark Fork, where the rainfall i grow, the forests become of important The mountain s



Sketch Map M

n summit to base; and the narrower valleys are also covered e timber is of larger size and of much greater commercial an elsewhere in the Territory, the valuable timber consisting of the various species of *Coniferæ*, pine, fir, cedar, &c. Of the aved species, willow, aspen, and cotton-wood are abundant *r*. The native fauna is not sharply distinguished from neighbouring States and Territories The higher latitudes ver, indicated by the relatively greater abundance of species g a colder climate. The moose and the Rocky Mountain ough by no means abundant, still frequent the mountains, the former in the cool marshy valleys, the latter e most rugged inaccessible elevations. The black-tailed e deer, the antelope, elk, and mountain sheep are abundant, bison still ranges the plains, though in sadly reduced . Among *Carnivora*, the black and grizzly bears, mountain x, wild cat, and several species of wolves are still plentiful

ulture and Industry.—Agriculture is dependent in no t Montana upon the supply of water furnished by the Owing to this fact it is probable that not more than t of the total area of the Territory can ever, even under economical distribution of the water-supply, be brought ultivation. In the drainage area of Clark's Fork are

considerable extent o Bitter-root, Deer Lodge the head waters of the Missouri is al- The valleys of the Jefferson and Mad Above the eastern fork of the mounta of the Snow, Teton, and Marias rivers, are portion Below the Forks the through a broad valley, much of which ca Beyond Benton however the bluffs become lo The Valley Cone, also, at a leaving t small kind of valley which exten shown to the point where the river turns thro ceases, when it enters a country of which, except a mausoleum of to all seasons, scattered, w

Owing to the comparatively isolated position of the T agricultural pursuits have been limited by the demands consumption The census of 1880 reported the area in farm of 105,685 acres, with an average of 29·7 acres to each fa whole is less than one half per cent of the entire area of th tory The improved land is reported as amounting to acres. The following are the amounts of the principal agr products: wheat, 169,688 bushels, maize, 5689 bush

6 bushels; barley 39,970 bushels; hay, 63,947 tons; wool
4 pounds; value of all farm products, $2,024,923. The live
interest is large, and is increasing rapidly. The great extent
ture afforded by the plains and the broad valleys of the
ains would seem to promise an almost unlimited extension
s industry in the future. Both cattle and sheep owners,
r labour under disadvantages as compared with the owners
south. The lower temperature and heavier snows, and
likely the dangers of great extremes of temperature, require
provision of shelter and food be made for a part or all of the
son, otherwise the ranchman runs the risk of occasional
ss. The census of 1880 furnishes the following statistics
tock: horses, 39,111; mules and asses, 855; working oxen,
ilch cows, 11,308; other cattle, 160,113; sheep, 181,277;
10,278; total value of live stock $5,151,551.

ineral production. Montana has never taken a leading place,
h in the early days some of the placer ground yielded well
h placers of Little Prickly Pear, Bannack, and Alder Gulch
ickly exhausted. The produce of the latter has been reported
ly at from $25,000,000 to $40,000,000, the greater part of
w extracted in a few months. In the year 1879-80
76,702 worth of gold and $2,905,085 of silver were extracted,
three fourths from deep mines and one fourth from placers.
year 1882 the total mineral production is reported at
,000, of which about $1,000,000 was for copper and lead.

Industry. Owing largely to its remote position the population
the material property of Montana have had a low growth
parison with other more favoured portions of the west. The
tion in 1880, as reported to the census was 39,159 (28,174
and 10,985 females), an increase of 90 per cent over that in
There were 27,628 natives and 11,531 of foreign birth, white
re white, 546 negroes, 61 of mixed negro blood, 176 Chinese
563 civilized Indians. By far the greater portion of the popula
ound in the western half upon the head waters of the Missouri
its Fork. The eastern half is very thinly settled,
obably it will never sustain more than a small population.
Territory is divided into eleven counties, which with their
tion in 1880, were the following: Beaverhead, 2712;
n, 7926; Custer, 2510; Deer Lodge, 3769;
n, 3643; Jefferson, 2304; Lewis and Clark, 6021; Madison,
Meagher, 2733; Missoula, 2502. The principal settlement
lena the capital (3624), Butte a mining town (3363)
ecumseh in the Gallatin valley upon the Northern Pacific
y, which in 1880 had a population of 491 and has probably
that number at present (1883).

total number of lectors in Montana is reported by to
officer at 19,761. They are nominally concentrated at be
s, although in reality they are moved over the entire Territory
ge of various trades, the principal of which are the stock
Blackfoot Coal Vector, Anaconda and Point d'Orille
servations cover more than one third of the Territory.

Government and Finance. The government of Montana is similar
of the other Territories. The executive consists of a
d two secretaries appointed by the president of the
States. The treasurer, auditor, superintendent of public
ion are elected by the people of the Territory every two years. The
e of the two houses of the legislature. Montana is represented
n Congress by a delegate, also elected, who has liberty to
ert in debate but has no vote. The territorial debt of the
1881 was but $70,000. The amount raised by Territorial
e was $93,211.

History. The Montana country was originally acquired by the
States under the Louisiana purchase. It became successively
of Louisiana Territory, of Missouri Territory, of Nebraska
ry, and of Dakota. On 26th May 1864 it was erected a
Territorial government of its own with practically its present
ries. The exploration of the region commenced with the
ted expedition of Lewis and Clark in 1803–1806. Between
and 1855 it was traversed and mapped by a number of explorers,
having in view the election of a transcontinental railroad.
Since then numerous expeditions have examined it, and
systematic topographic work has been done under different
es of the United States Government. The first settlers
the Territory, in 1861, discovered placer gold on Little
Prickly Pear Creek, and shortly after built the city of Helena.
the placers at Bannack were discovered and a small "rush"
Territory commenced. In 1863 the rich placers at Alder
were brought to view, and miners and adventurers swarmed
all parts. The story is that the early social history of Cali-
was repeated on a smaller scale in Montana. The lawless
ts assumed control, and for many months neither life nor
y was safe. Indeed, for a time the community was in a
blockade, no one with money in his possession could get
the Territory. Finally, the citizens organized a "Vigilance
ttee" for self-preservation, took the offensive, and after a
harp struggle rid the community of its disturbing elements.
he exhaustion of the placers, the population decreased, owing
to the migration of the floating mining class; but their place
taken by more permanent settlers. (H

MONTANISM is a somewhat misleading name
movement in the 2d century which, along with
ticism, occupied the most critical period in the hi
the early church. It was the overthrow of Gnostic
Montanism that made the "Catholic" church. Th
of first discerning the true significance of the Mon
movement belongs to Ritschl.[1]

In this article an account will be given of the
significance of Montanism in relation to the history
church in the 2d century, followed by a sketch of its
development, and decline.

I. From the middle of the 2d century a change
to take place in the outward circumstances of Chris
The Christian faith had hitherto been maintai
a few small congregations scattered over the Rom
pire. These congregations were provided with o
most indispensable constitutional forms, neither
nor more numerous than were required by a r
bond resting on supernatural expectations, strict di
and brotherly love ("Corpus unum de consen
ligionis, de unitate disciplinæ, de spei tenore")
state of things passed away. The churches soon
members within their pale who stood in need of
vision, instruction, and regular control. The enth
for a life of holiness and separation from the
the eager outlook for the end of the world, th
surrender to the gospel message, were no long
influences by which all minds were swayed. In
of a sober convictions or submissive assent suppl
want of spontaneous enthusiasm. There were ma
did not *become*, but who *were*, and therefore re
Christians, too powerfully attracted by Christia
abandon it, and yet not powerfully enough to
adopted it for themselves. Then, in addition t
social distinctions asserted themselves amongst the
tion. Christians were already found in all ran
occupations—in the imperial palace, among the c
in the abodes of labour and the halls of learning, a
slave and freemen. Were all these to be left
callings? Should the church take the decisive st
the world, consent to its arrangements, conform
custom, acknowledge as far as possible its auth
and satisfy its requirements? Or ought she, on th
hand, to remain, as she had been at first, a soc
religious devotees, separated and shut out from th
by a rigorous discipline and working on it only t
a direct propaganda? This was the dilemma th
church had to face in the second half of the 2d c
either she must commence a world-wide mission
comprehensive sense by an effective entrance into
society—renouncing, of course, her original peculiari
exclusiveness, or, retaining these peculiarities and c
to the old modes of life, she must remain a small
heart sect, barely intelligible to one man in a th
and utterly incapable of saving and educating
That this was the question at issue ought to be
enough to us now, although it could not be clea
ceived at the time. It was natural that warning
should then be raised in the church against
tendencies, that the well-known counsels about the
tion of Christ should be held up in their literal st
before worldly Christians, that demands should be m
a restoration of the old discipline and severity, and
return to apostolic simplicity and purity. The chu
whole, however, under pressure of circumstances rath
by a spontaneous impulse, decided otherwise. She
through the open door into the Roman state, and

[1] *Entstehung der Altkatholischen Kirche*, 2d ed., Bonn,

there for a long career of activity, to Christianize the along all its thoroughfares by imparting to it the word gospel, but at the same time leaving it everything ex- its gods. On the other hand, she furnished herself with thing of value that could be taken over from the world out overstraining the elastic structure of the organiza which she now adopted. With the aid of its philosophy reated her new Christian theology; its polity furnished with the most exact constitutional forms; its juris ence, its trade and commerce, its art and industry, all taken into her service, and she contrived to borrow hints even from its religious worship. Thus we find urch in the 3d century endowed with all the resource the state and its culture had to offer, entering into relationships of life, and ready for any compromise did not affect the confession of her faith. With quipment she undertook, and carried through, a world- on on a grand scale. But what of those believers of ld school who protested in the name of the gospel st this secular church, and who wished to gather her a people prepared for their God regardless alike numbers and circumstances? Why, they joined an siastic movement which had originated amongst a circle in a remote province, and had at first a merely importance. There, in Phrygia, the cry for a tract ian life was reinforced by the belief in a new and outpouring of the Spirit, a coincidence which ha observed elsewhere in church history, as, for instance, Irvingite movement. The wish was, as usual, father thought; and thus oracles of "spiritual Christian formed, which served, especially in times of persecu as rallying points for all those, far and near, who l for the end of the world and the *excessus exercitus*, who wished in these last days to lead a holy life. zealots hailed the appearance of the Paraclete in ia, and surrendered themselves to his guidance. In ing, however, they had to withdraw from the church known as "Montanists," or "Kataphrygians," and to assume the character of a sect. Their enthusiasm their prophesyings were denounced as demoniacal, expectation of a glorious earthly kingdom of Christ stigmatized as Jewish, their passion for martyrdom inglorious, and their whole conduct as hypocritical did they escape the more serious imputation of heresy portant articles of faith: indeed, there was a disposi to put them on the same level with the Gnostics. effect on themselves was what usually follows in such nstances. After their separation from the church, became narrower and pettier in their conception of tianity. The strict rules of conduct which in a former had been the genuine issue of high strung religion on were now relied on as its source. Their asceticism nerated into legalism, their claim to a monopoly of Christianity made them arrogant. As for the popular on of the larger church, they scorned it as an adulter manipulated Christianity. But these views found little acceptance in the 3d century, and in the com e 4th they died out. Regardless of the scruples of most conscientious members, and driving the most st Christians into secession and the conventicle, the h went on to prosecute her great mission in the . And before she was able, as church of the state f the empire, to call in the aid of the civil power to ress her adversaries the Montanistic conventicles were t extinct.

Such is, in brief, the position occupied by Montanism history of the ancient church. The rise and progress movement were as follows.

the close of the reign of Antoninus Pius probably e year 156 (Epiphanius). Montanus appeared at Ardaban in Phrygia, bringing revelations of the " to Christendom. It is unnecessary to seek an expl of his appearance in the peculiarities of the P temperament. The Christian churches had alwa that prophecy was to be continued till the return of although, as a matter of fact, prophets had not bee cularly numerous. Montanus claimed to have a pr calling in the very same sense as Agabus, Judas, Si daughters of Philip, Quadratus, and Ammia, or as at Rome. At a later time, when the validity of th tanistic prophecy was called in question in the int the church, the adherents of the new movement a explicitly to a sort of prophetic succession, in whic prophets had received the same gift which the da of Philip, for example, had exercised in that very of Phrygia. The burden of the new prophecy was exacting standard of moral obligation, especiall regard to marriage, fasting, and martyrdom. But tanus had larger schemes in view. He wished to c a special community of true Christians to wait comming of their Lord. The small Phrygian to Pepuza and Tymion were selected as the headq the Jerusalem, as the prophet called them church. He spared no effort to accomplish this u believers. Funds were raised for the new organi and from these the leaders and missionaries, who have nothing to do with worldly life, drew their pay the ecstasy of the prophet did not prove so contag his preaching. Only two women, Prisca and Ma were moved by the Spirit like Montanus, they stu a state of frenzy the commands of the Spirit, whic through them sometimes as God the Father, sometim the Son, and urged men to a strict and holy life does not mean that visions and exuberant dreams have been of frequent occurrence in Montanistic But, as chosen and permanent organs of the Paracle three persons were recognized Montanus, Pris Maximilla, by their side, however, Montanus and dotus, from a very early date, played an active missionary and organizer.

For twenty years this agitation appears to hav confined to Phrygia and the neighbouring pro How could it be otherwise? To assemble the w Christendom at Pepuza was a rather impractical posal. But after the year 177 a persecution of Chr from some unexplained cause broke out simulta in many provinces of the empire. Now in the every persecution was regarded as the beginning end. It quickened the conscience, and gave more s to eschatological hope, it was a call to observe th of the time, and the intimation of God's presen would seem that before this time Montanus had disa from the scene but Maximilla, and probably al were working with redoubled energy. And now, t out the provinces of Asia Minor, in Rome, and Gaul, amidst the raging of persecution, attenti attracted to the remarkable movement. The desi sharper exercise of discipline, and a more decided re tion of the world, combined with a craving for som revelations of God's will in these last critical tim prepared many a mind for an eager acceptance tidings from Phrygia. There the Spirit, whom Chr promised to His disciples, had begun His work, t least, there were holy Christians and joyful martyr oracles of the Phrygian prophets became household in distant churches, and it was always the more minded who received them with undisguised sy And thus, within the large congregations where th so much that was open to censure in doctrine a stitution and morals, conventicles were formed m

ristians might prepare themselves by strict discipline
day of the Lord.

nwhile in Phrygia and its neighbourhood especially
tia, and also in Thrace a controversy was raging
n the adherents and the opponents of the new
y. Between 150 and 176 the authority of the
o had been immensely strengthened, and along
a settled order had been introduced into the
. It need hardly be said that, as a rule, the
were the most resolute enemies of the Montanistic
sm. It disturbed the peace and order of the con-
ns, and threatened their safety. Moreover, it
lemands on individual Christians such as very few
omply with. But the disputation which Bishops
of Cumana and Julian of Apamea arranged with
lla and her following turned out most disastrously
promoters. The "spirit" of Maximilla gained a
victory, a certain Themison in particular having
the bishops to silence. Sotas bishop of Anchialus
ed to refute Prisca, but with no better success,
had to retire from the field in disgrace. These
ings were never forgotten in Asia Minor, and the
of them spread far and wide. In after times the
y in which the discomfiture of the bishops could
lained was by asserting that they had been silenced
d or violence. This was the commencement of the
nmication or secession, whichever it may have
f the Montanists in Asia Minor. "I am pursued
wolf," exclaimed the spirit that spoke through
lla; and her admonition about the end became
mphatic than ever. "After me there will come
r prophetess, but the end." Not only did an
party arise in Asia Minor rejecting all prophecy
Apocalypse of John along with it, but the majority
churches and bishops in that district appear
) to have broken off all fellowship with the new
s, while books were written to show that the very
the Montanistic prophecy was sufficient proof of
ionsness.[1]

aul and Rome the prospect of Montanism seemed
hile more favourable. The confessors of the Gallican
were of opinion that communion ought to be
ned with the zealots of Asia and Phrygia, and
dressed a letter to this effect to the Roman bishop,
erius. Whether this is the bishop of whom Ter-
(*Adv. Prax.*, 1) relates that he was on the point of
peace with the churches of Asia and Phrygia
Montanistic communities is not certain; it was
e or his successor Victor. It is certain, at any
at there was a momentary vacillation even in
Nor is this to be wondered at. The events in
could not appear new and unprecedented to the
Church. If we may believe Tertullian, it was
of Asia Minor, the relentless foe of Montanism,
ceeded in persuading the Roman bishop to with
letters of communion.

, in the last decade of the 2d century two consider
ks appeared in Asia Minor against the Kataphry
The first, by a bishop or presbyter whose name is
own, is addressed to Abircius bishop of Hierapolis,
s written in the fourteenth year after the death
imilla, *i.e.*, apparently about the year 193. The
was written by a certain Apollonius forty years
he appearance of Montanus, consequently about
From these treatises we learn that the adherents of
prophecy were very numerous in Phrygia, Asia,
latia (Ancyra), that they had tried to defend them-

nades, *περὶ τοῦ μὴ δεῖν προφήτην ἐν ἐκστάσει λαλεῖν*. At
time as Miltiades if not earlier, Apollinaris of Hierapolis
e against the Montanists.

selves in writing from the charges brought against
(by Miltiades), that they possessed a fully-devel
independent organization, that they could boast of
martyrs, and that they were still formidable to the ch
in Asia Minor. Many of the small congregations
gone completely over to Montanism, although in
towns, like Ephesus, the opposite party maintained
ascendency. Every bond of intercourse was broken,
in the Catholic churches the worst calumnies were ret
about the deceased prophets and the leaders of the soci
they had founded.

In many churches outside of Asia Minor a diff
state of matters prevailed. Those who accepted
message of the new prophecy did not at once leav
Catholic Church in a body. They simply formed
conventicles within the church; in many instances, in
their belief in the new prophecy may have remain
private opinion which did not affect their positio
members of the larger congregation. Such, for exam
appears to have been the case in Carthage (if we
judge from the Acts of the martyrs Perpetua and Felic
at the commencement of the persecution of Septi
Severus about the year 202. But even here it
impossible that an open rupture should be indefi
postponed. The bishops and their flocks gave offen
the spiritualists on so many points that at last it
be endured no longer. The latter wished for more fas
the prohibition of second marriages, a frank, courag
profession of Christianity in daily life, and entire se
tion from the world; the bishops, on the other h
sought in every way to make it as easy as possible to
Christian, lest they should lose the greater part of
congregations. The spiritualists would have expel
from the church every one who had been guilty of m
sin, the bishops were at that time specially anxio
relax the stringency of the old disciplinary laws.
lastly, the bishops were compelled more and mor
take the control of discipline into their own hands,
the spiritualists, appealing to the old principle that
alone can remit or retain sins, insisted that God Hims
i.e., the Spirit was the sole judge in the congrega
and that therefore all proceedings must be condu
according to the directions of the prophets. On this
especially a conflict was inevitable. It is true that
was no rivalry between the new organization and the
as in Asia and Phrygia, for the Western Monta
recognized in its main features the Catholic organiz
as it had been developed in the contest with Gnostic
but the demand that the "organs of the Spirit" sh
direct the whole discipline of the congregation conta
implicitly a protest against the actual constitution o
church. Even before this latent antagonism was
plain, there were many minor matters which were suffi
to precipitate a rupture in particular congregations.
Carthage, for example, it would appear that the b
between the Catholic Church and the Montanistic
ventiele was caused by a disagreement on the que
whether or not virgins ought to be veiled. For n
tive years (202-207) the Carthaginian Montanists s
to remain within the church, which was as dear to
as it was to their opponents. But at length they qu
it, and formed a congregation of their own, declaring
the Catholic Church was henceforth only a bod
"psychic" Christians, because she would not acknowl
the Spirit whom God had at last poured out on His pe

It was at this juncture that Tertullian, the most fa
theologian of the West, left the church of which he
been the most loyal son and the most powerful suppo
and whose cause he had so manfully upheld against pa
and heretics. He too had come to the conviction tha

ch at large was given over to worldliness, that she forsaken the old paths and entered on a way that lead to destruction. The writings of Tertullian d the clearest demonstration that what is called Mon m was a *reaction* against secularism in the church, an effort to conserve the privileges of primitive Chris ty. At the same time, they show no less clearly that tanism in Carthage was a very different thing from Montanism of Montanus. Western Montanism, at beginning of the 3d century, admitted the legitimacy lmost every point of the Catholic system. It allowed the bishops were the successors of the apostles, that Catholic rule of faith was a complete and authoritative sition of Christianity, and that the New Testament was supreme rule of the Christian life. How, then, one may ask, was it possible to separate from the Catholic rch? On what ground could the separation be justi ? How could it be said that a new era of the Spirit come in when the Spirit had already given all neces instructions in the Scriptures of the New Testament? what claim could be thought to exceed the legitimate ...of the successors of the apostles? Montanus himself his first disciples had been in quite a different position. is time there was no fixed, divinely instituted congrega al organization, no canon of New Testament Scriptures, nti-Gnostic theodicy, and no Catholic Church. There simply certain communities of believers bound to er by a common hope, and by a free organization, h might be modified to any required extent. When tanus proposed to summon all true Christians to Pepuza der to live a holy life and prepare for the day of the l, there was nothing whatever to prevent the execution s plan except the inertia and lukewarmness of Chris om. But this was not the case in the West at the nning of the 3d century. At Rome and Carthage, in all other places where sincere Montanists were d, they were confronted by the imposing edifice of the olic Church, and they had neither the courage nor the nation to undermine her sacred foundations. This ains how the later Montanism never attained a posi of influence. In accepting, with slight reservations, results of the development which the church had rgone during the fifty years from 160 to 210 it ced itself to the level of a sect. For, if the stand t of the Catholic Church is once acknowledged, then tanism is an innovation; and if the canon of the New ument is accepted the doctrine of a new era of the it is heresy. Tertullian exhausted the resources of etic in the endeavour to defend and vindicate the ion of the spiritualists to the "psychic" Christian no one will say he has succeeded in clearing the Mon tic position of its fundamental inconsistency.

f the later history of Montanism very little is known. it is at least a significant fact that prophecy could e resuscitated. Montanus, Prisca, and Maximilla were ys recognized as the inspired authorities. At rare rvals a vision might perhaps be vouchsafed to some tanistic old woman, or a brother might now and then a dream that seemed to be of supernatural origin, the overmastering power of religious enthusiasm was g of which the Montanists knew as little as the Catho Their discipline was attended with equally disap ting results. In place of an intense moral earnestness ing itself by its own strict laws, we find in Tertullian gal casuistry, a finical morality, from which no good l ever come. It was only in the land of its nativity Montanism held its ground till the 4th century. It tained itself there in a number of close communities, ably in places where no Catholic congregation had formed; and to these the Novatians at a later period attached themselves. In Carthage there existed a the year 400 a sect called Tertullianists; and in comparatively late survival we have a striking tes to the influence of the great Carthaginian teacher doctrinal questions there was no real difference b the Catholics and the Montanists. The early Mon the prophets themselves used expressions which to indicate a Monarchian conception of the per Christ. After the close of the 2d century we fi sections amongst the Western Montanists, just as a the Western Catholics, there were some who adopt Logos Christology, and others who remained Monar

[illegible] plentiful, are [illegible] and require [illegible] deal of [illegible] suffering. They [illegible] be divided into four groups [illegible] The not [illegible] of Montanism, Pr[illegible]ca, and Maximilla are our no[illegible] important [illegible] but unfortunate[illegible] fact of only two m[illegible] short [illegible] 2. The work[illegible] Tertullian after he[illegible] came a Mo[illegible] [illegible]much the mo[illegible] information, not, however, abo[illegible] [illegible]t of the[illegible] not, [illegible] only about a later phra[illegible] the Catholic C[illegible] church. The oldest pa[illegible] works of the 2d [illegible] those which have been pre[illegible] [illegible]ically by Eusebius [illegible] [illegible] form the nest[illegible]

[illegible] the older [illegible] Wes[illegible] n
Neander, Bun[illegible] Ri[illegible]

But [illegible]

[illegible] *Montan[illegible]* [illegible] Ess[illegible]
Canon-chron[illegible] *Die Chron[illegible]* [illegible] Ren[illegible]
Orte der Christl[illegible] Neue Unt[illegible] [illegible] Wes[illegible] Ess[illegible]
tums, Lpzg. 1[illegible] Vol[illegible] [illegible] Hist[illegible]
Kirche, Mainz 1[illegible] spec[illegible] [illegible] can be fo[illegible]
Montanismus, hrsg. [illegible] [illegible] the Eig[illegible]
be k. Wes[illegible] *Chron[illegible]* [illegible] Neue [illegible] and [illegible]
Das Montanistische Prinzip, [illegible] [illegible] Stud., 18[illegible]
Der Montanismus, [illegible] Wes[illegible] [illegible] hort[illegible]
[illegible] [illegible] [illegible] [

NTAUBAN, chief town of the department of Tarn
nne, France, is situated on a slight eminence be-
he right bank of the Tarn and its tributary streams
eou and Lagarrigue, 128 miles by rail east south
Bordeaux. It is connected with the suburb of
arbon on the left bank of the Tarn by a remark
k bridge of the 14th century, which is 672 feet
th, and consists of seven pointed arches resting on
hemselves pierced by pointed arches. The cathe
ilt in 1739, contains the Vow of Louis XIII., one
finest paintings of Ingres, a native of Montauban,
the end of the Carmelite walk a monument was
to his memory in 1871. In the town house, once
d as a palace by the counts of Toulouse and by
ek Prince, are the paintings bequeathed by Ingres,
rcheological collection, and a very curious library
ing the bequests of several celebrated collectors.
uban possesses a Protestant theological college. The
s some trade in corn, wine, and grapes. The manu-
of corn-dressers, coarse cloth, paper, and earthen
ina ware are the principal industries, and there
corn and woollen mills. The population in 1881
,335

uban was only a village in the time of the Romans. In
century a monastery was founded there by the Benedictines,
erected land hip over the neighbouring population. A
able impetus was in the 12th century given to it pro perity
ree of the counts of Toulouse, offering freedom to all settling
up their residence in the town. Montauban was twice
by Simon de Montfort in the Albigeois wars, and was
n 1207. By the treaty of Bretigny (1360)
English, but hardly after were they expelled by the
nts. In 1560 the Huguenot embraced Pro
m, expelled the monks, and demolished the cathedral
n years later it became one of the Huguenot strongholds
ned a small independent republic. It was the headquarters
ugue not rebellion of 1621, and was vainly besieged by Lou
r eighty-six days; recaptured it submitted until after the fall
elle in 1629, when its fortifications were destroyed by
u. In the course of the plague cut off over 6000 of its
nts.

NTBÉLIARD, chief town of an arrondissement in the
ment of Doubs, France, is situated 1029 feet above
, at the confluence of the Allaine and the Lu ine,
ries of the Doubs, and on the canal between the
and the Rhone, about 10 miles north east of Besançon
fortified city, it still retains the old castle of the
of Montbéliard. A bronze statue of Cuvier, the
ustrious native of Montbéliard, and several fine foun
dorn the town, which also possesses a museum of
history and antiquities, and a Protestant normal
Since 1870 a considerable impetus has been given
prosperity by the arrival of Alsatian immigrants.
dustries embrace watchmaking, the manufacture of
tools, iron wire, files, watch springs, and pumps,
spinning and weaving, printing, and tanning. The
xports are cheese, leather, and wood. The popu
n 1881 was 8784, of which the great majority were
nts.

belonging to the Burgundians and Franks, Montbéliard
the treaty of Verdun 843, added to Lorraine. In the 11th
it became the capital of a county, which formed part of
ond kingdom of Burgundy, and latterly of the German
From the end of the 11th century until 1793 it belonged to
se of Wurtemberg. It resisted the attacks of Charles the
ng Louis XII., and the duke of Guise, but was taken in 1676
chal Luxembourg, who razed its fortifications. In 1871 the
f Héricourt between the French and Germans had its com-
ent within it walls.

NT-DORE LES-BAINS, a village of France in the
ment of Puy de Dôme, 17 miles as the crow flies
est of Clermont Ferrand, 3132 feet above the sea,
right bank of the Dordogne not far from its source.
onts Dore, from which it takes its name, close the
towards the south; their culminating peak, Puy de
Sancy (6188 feet), is the highest eminence of central Fr
The mineral springs of Mont Dore were known to
Romans. The eight now used yield 94,600 gallon
twenty four hours. Bicarbonate of soda, iron, and ar
are the principal ingredients of the water; to the two
it owes its efficacy in cases of pulmonary consump
bronchitis, asthma, and nervous and rheumatic paral
From the elevation and exposure of the valley, w
opens to the north and runs up towards mountains
quite free from snow, the climate of Mont-Dore les-B
is severe, and the season is consequently short. A
5000 patients visit the place between 15th June and
September, when a casino and theatre are opened.
chief building is the solid but sombre bath-house
baths). The surrounding country, with its fir w
pastures, waterfalls, and mountains, is very attractive.
the "park" at Mont-Dore les Bains, which forms a
promenade along the Dordogne, relics from the old Ro
baths have been collected, but the ancient establish
must have been on a larger scale than the present one
pantheon erected about the time of Augustus existed
the 16th century. The population in 1881 was 1438

MONTE CARLO. See Monaco.

MONTE CASINO (or Cassino). The Benedi
monastery known as the abbey of Monte Cassino is a
square building of three stories, built on the usual Bene
line plan (see Abbey) on the summit of a picturesque iso
hill, about 3½ miles to the north east of the town of Ca
(Casinum) or San Germano (population about 5000), w
lies midway between Rome and Naples in the valley
Garigliano. The most prominent architectural featu
the large church (1727), richly decorated in the interior
marbles, mosaics, and paintings. The library and arc
have been spoken of elsewhere (vol. xiv. pp. 531, 548

The date of Benedict's withdrawal from Subiaco to Cass
529. At that time Cassino was the site of a temple of Apoll
of a grove sacred to Venus. The result of the saint's preachin
that the natives demolished both, chapels to St Martin and
the Baptist being built in their stead, while farther up the
monastery began to rise. About 589 the monks were driven
it to Rome by the Lombards of Benevento, and it lay was
more than a century, until reassociated by Gregory II. (719
787 it received fresh privileges from Charlemagne, in 884
burnt by the Saracens, and was not restored until about se
years later. From 1322 to 1366 the abbot held episcopal
under the house of Anjou he bore the title of *Abbas abbatum*
ranked as first baron of the realm. In 1501 the abbey was s
by the troops of Gonzalo de Cordova. In 1866 it shared th
of all other religious houses in Italy; it is now inhabited by
monks, and used as a seminary, having about 200 pupils.

MONTECUCULI, Raimondo, Count of (1608-1
a prince of the empire and duke of Melfi, a famous Aus
general, was born at the castle of Montecuculi in Mo
in 1608. At the age of nineteen he began his career
regiment of infantry under his uncle, Ernest, cou
Montecuculi; and during the Thirty Years' War he
many opportunities of displaying his military genius i
imperial service. In 1631, having been severely wou
he was made prisoner while retreating after the bat
Breitenfeld. Soon after his release he was promoted t
rank of major; and he distinguished himself at the
of Nordlingen in 1634, and at the storming of Kaisersla
in 1635. As colonel, he took part in much hard fig
in Pomerania and in Bohemia; and in 1639 at M
where he tried to prevent the Swedes from crossing
Elbe, he was taken prisoner a second time, being comp
on this occasion to spend more than two years in St
The time was not lost, for he devoted it to a thorough
of military science. In 1642 he was again at work i
imperial army, and for eminent services in Silesia h
made a major-general of cavalry. After a brief vi
Italy, during which he entered the service of the du
Modena, he returned to Germany, and became coun

ar in 1644. In the following year he supported the
duke Leopold in a campaign against Prince Rakoczy
ransylvania, resisted Marshal Turenne in the Rhine
try, and fought with the Swedes in Silesia and Bohemia.
victory at Triebel in Silesia, in 1647, was due chiefly
m, and he was rewarded by being raised to the rank
eneral of cavalry. After the peace of Westphalia in
he occupied himself for some time with the work of
ouncil of war; and in 1651 he undertook diplomatic
ons to Christina, queen of Sweden, and to Cromwell.
657 he commanded an expedition against Prince
oczy and the Swedes, who had attacked the king of
d, and Rakoczy was soon forced to withdraw from
Swedish alliance, and to accept term of peace. As
marshal he was sent to the aid of Denmark against
den; and this war he conducted so successfully that
peace of Oliva was concluded in 1660. In 1663 he
ned the command of an army with which, for about
years, he had been opposing the Turks; but in 1664
as again made commander-in-chief, and in the same
he defeated the Turks so decisively near the abbey of
Gotthard that they concluded an armistice for twenty
s. He had to deal with more formidable enemies in
2, when, the emperor and the imperial diet having
ved to uphold the Dutch against Louis XIV., Monte-
li, who had been serving as president of the council of
and director of artillery, was appointed commander of
mperial forces. He took Bonn, and, although closely
hed by Turenne, contrived to effect a junction with
rince of Orange, thereby overthrowing all the calcula-
s of the French. When the elector of Brandenburg
ved the supreme command in 1674 Montecuculi with-
from the army; but in 1675, being restored to his
er position, he resumed operations against Turenne.
two commanders manœuvred so brilliantly that for
t four months neither could do the other much injury;
Turenne having been killed by a cannon ball on the 27th
ly 1675, Montecuculi pursued the French into Alsace,
besieged Hagenau and Zabern, retiring from Alsace only
n he found himself confronted by Condé. Montecuculi's
achievement in war was the siege of Philippsburg.
ng the rest of his life he was president of the council
ar. In 1679 the emperor Leopold made him a prince
e empire, and shortly afterwards he received from the
of Naples the dukedom of Melfi. Having accompanied
emperor to Linz during the pestilence, he was injured
he fall of a beam when entering the castle, and died at
s on the 16th of October 1680.

ontecuculi was an ardent lover of science, and wrote several
rtant military works. The *Opere complete di Montecuculi* were
ished in two volumes, at Milan in 1807 at Turin in 1821; and
e is a German translation (1736) of his *Memorie della guerra* and
ssioni d'un generale.

Campori, *Raimondo Montecuculi, la sua famiglia e i suoi tempi* (1877).

MONTELEONE (usually called Monteleone of Cala-
to distinguish it from Monteleone of Apulia in the
ince of Avellino, which gave its name to the mediaeval
y of the Pignatelli family) is a city of Italy in the
ince of Catanzaro, on the western side of the Bruttian
nsula, and is beautifully situated on an eminence gently
ing towards the gulf of Sta Eufemia. It was almost
lly destroyed by earthquake in 1783, and for many
s afterwards consisted mainly of slight wooden erec-
s, but under the French occupation it was made the
tal of a province and the headquarters of General
nier, and it is now a well built town. The castle was
t by Roger, count of Sicily, whom tradition accuses of
ying off the ruins of the ancient temple of Proserpine
e cathedral of Mileto. The population of the town
9244 in 1871, that of the commune 10,262 in 1861
12,047 in 1881.

Monteleone is identified with the ancient Hipponium,
city first mentioned in 389 B.C., when its inhabitants were
to Syracuse by Dionysius. Restored by the Carthaginian
held for a time by Agathocles of Syracuse (294), and aft
occupied by the Bruttians, Hipponium ultimately became
Valentia a flourishing Roman colony. The harbour est
by Agathocles proved of great service as a naval station t
and Octavius in their wars with Pompeius Magnus and
Pompeius, and remains of its massive mason work still exis
village of Bivona on the coast. In the town itself there
traces of antiquity beyond a mosaic pavement in the chur
Leoluca (patron saint of Monteleone) and one or two Latin
tions.

MONTÉLIMAR, chief town of an arrondissement
canton in the department of Drôme, France, is s
near the left bank of the Rhone, 93 miles south of
on the railway to Marseilles. The waters of the R
and Jabron, which unite at Montélimar, spread forth
the plain surrounding the town. A well planted
separates the town from the station, but within th
gate that still remain the streets are narrow and
sting. The ancient castle, one of the most inte
military remains of central France, is now used
prison. Silk throwing and spinning, and the manu
of flowered silks and of hats, are the principal indu
there are also foundries, tool-shops, and tanneries
agricultural implements and hydraulic lime are
Montélimar is famed for its *nougat*, a cake compo
almonds and honey. The population of the town i
was 12,891.

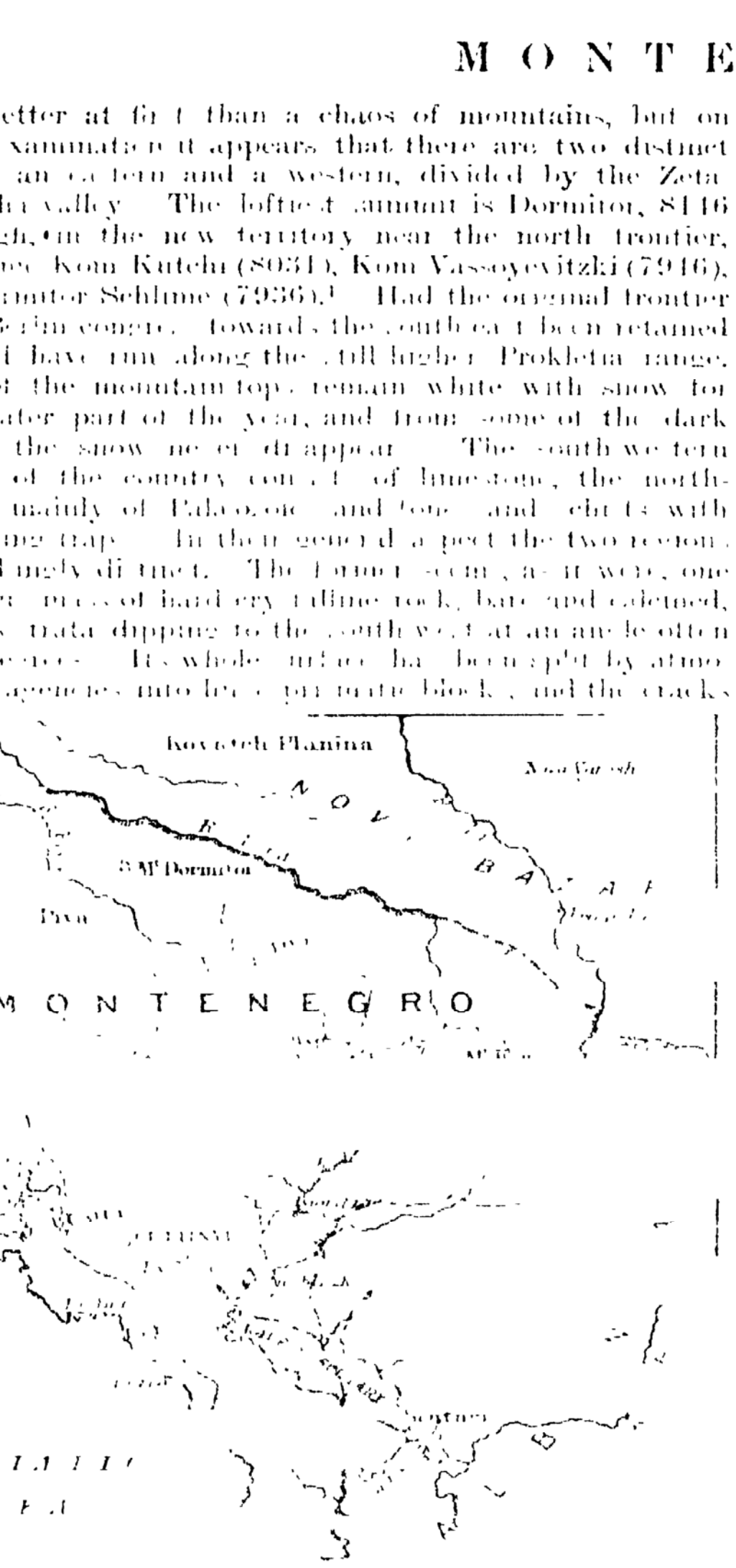
Montélimar was called by the Romans *Acusticæ*. At
period it belonged to the family of Adhémar or Adhemar, wh
present name. After coming into the possession of the
Valentinois, one of the dauphins of Viennois, it wa
by Louis XI. to the crown of France. It frequently
hand during the religious wars, and although it resisted
it was taken in 1589 by Lesdiguières.

MONTENEGRO, often pronounced and som
written MONTENERO (Montenegrin, etc., Servian, *Cr*
Russian *Tchernagorets* and Turkish *Karadagh*, al
valent to Black Mountain), one of the smallest of
pean countries, lies on the eastern side of the A
and is bounded by Dalmatia, Herzegovina, Bosn
Albania. Previous to 1878 it had an area variou
mated at 1669 square miles (Kaptcevitch) 1711 (K
and, including the Kutchi territory, 1796 (Behm)
enlargement to about 5977 square miles proposed by
stefano treaty (1878) would probably have swamp
Montenegrin nationality, and the Berlin congress
the total area only up to 3680 miles, or almost exact
the size of Wales.

Apart from her new maritime district, Montenegro
[illegible] coast line is that of frontier and exch
territory have [illegible] between Montenegro and Tur
these have still [illegible] not yet entirely settled. All the b
approximate [illegible] the only modern survey of the
[illegible] carried out by [illegible] officers in 1883 in prog
portion [illegible] great districts annexed to the Montenegrine
the basin of Niegush in the north-west, and that of Spuz
[illegible] at the head of the Pass which thus commanded t
of the Zeta and [illegible] the country in two, the
from the portion west [illegible] to the frontier near Spuzh b
some 15 miles. The present frontier includes not only thes
valleys, but several tracts of Podgoritza, Zhabliak (Gabl[illegible], and
[illegible] great part of Lake Scutari, and the coast district with
and Dulcigno. The great accession to the seaboard long held by the
of Montenegro, which by her early days had possessed
Budua and Antivari, and had surrendered them to pirac
Venice, [illegible] in her struggle against the Turk. The lo
[illegible] coast line from Cape Mamula to Cape Kodra co
Lake Spuzza, the harbour to the north, was retained by Au
Dalmatia, to the south by Turkey. In the beginning of 1880
Corfu compromise, the Kutchi territory and the plain of P
were accepted by Montenegro in lieu of Plava and Gusinje, a
her by the congress; but the exchange was deferred, and t
ultimately modified by the congress so as to include Du
Montenegrin territory. The occupation of the district (N
1880) was only effected after a naval demonstration of the p
great powers.

M O N T E N E G R O

etter at first than a chaos of mountains, but on
xamination it appears that there are two distinct
an eastern and a western, divided by the Zeta
ka valley. The loftiest summit is Dormitor, 8146
gh, on the new territory near the north frontier,
ee Kom Kutchi (8031), Kom Vassoyevitzki (7916),
mitor Schlime (7936).[1] Had the original frontier
Berlin congress towards the south-east been retained
t have run along the still higher Prokletia range,
e the mountain tops remain white with snow for
ater part of the year, and from some of the dark
the snow never disappear. The south-western
of the country consists of limestone, the north-
mainly of Palæozoic and trap and chert with
ng trap. In their general aspect the two regions
ingly distinct. The former seems, as it were, one
t mass of hard grey tabline rock, bare and cadenced,
e strata dipping to the south-west at an angle often
ee. Its whole surface has been split by atmo
agencies into large quadrate blocks, and the cracks



Map of Mont

en gr nally worn into fi several fath
places the proce hes to nitter in clusters of ne
harp pointed crags, the sides of which are narrowed
chasms, while in others there are countless fissures
down into the rock, for 200 feet and more. In
mer the interior of the mass hollowed out into
e caverns and caves, and during the rainy season
ancient lake-basins frequently produce local earthquakes,
ng over an area of 10 or 15 miles. The sandstone
on the other hand presents lofty but rounded
clothed for the most part with virgin forest or rich
erdure, broken here and there by dolomitic peaks.

*
ber e, whose full name
1883 informed the
n to Montenegro has been clearly ascertained. 1) Palæozoic
2) Water-strata of Lower Trias, 3) Trap of the Palæozoic
ion strata, (4) Triassic lime-tone, (5) Jurassic lime-tone, (6)
ic lime-tone, (7) Flysch, in part certainly Eocene, and (8)
of younger Tertiary formation. The existence of nummulitic
e is still doubtful.

The watershed between the Adriatic and the Black
crosses the country from west to east in a very irre
line, the southern districts being drained by the
Moratcha river system, which finds its way to the Ad
by Lake Scutari and the Boyanna, while the strea
the northern districts form the head waters of the I
which reaches the Danube by way of the Save. The
rising in Lake Slano, is remarkable for its subterra
passage beneath a mountain range 1000 feet high.
place called Ponor the water plunges into a deep ch
seeming almost to lose itself in foam, but at a distan
several miles it reappears on the other side of the moun
its whole course to its junction with the Morate
about 30 miles. Rising in the Yavorye Planina
Moratcha sweeps through the mountain gorges as a
ing torrent till it reaches the plain of Podgoritza;
for a space it almost disappears among the pebbles
other alluvial deposits, nor does it again show a curre
any considerable volume till it approaches Lake Sc
In the neighbourhood of Duklea[1] and Leskopolye it
through a precipitous ravine from 50 to 100 feet
In the dry season it is navigable to Zhabljak. The
course is about 60 miles. Of the left hand tributar
the Moratcha the Sotonia Tsrcvna deserves to be ment
for the magnificent canon through which it flows bet
Most Tamarni and Dmocha. On the one side ris
mountains of the Kutchi territory, on the othe
immense flanks of the Prokletia range, the walls
gorge varying from 2000 to 1000 feet of vertical h
Lower down the stream the rocky banks approac
close that it is possible to leap across without tro
The Rieka rises in a tufa formed from an immense cave s
east of Cettinye (Tettinye) and falls into Lake Sc
The three tributaries of the Drina which belong in p
Montenegro are the Piva, the Tara, and the Lim, re
rely 59, 99, and 140 miles in length. The Tara
the northern boundary of the principality for more th
miles, but the Lim leaves the country altogether atte
in 130 miles of its course. Great alterations have
place on Lake Scutari in recent times. The river
which previous to 1830 entered the Adriatic to the
of Alessio near S. Giovanni di Medua, subsequently ch
its course so as to join the Boyanna just below its exit
the lake, one of the chief results has been to rais
level of the lake, and so to flood the lower valleys
tributary streams. When the International Frontier
mission was at Scutari in April 1879, the water stood
deep in some of the principal streets, and the inund
of city and suburb lasted that year eight months.
small lakes are scattered among the mountains, and
evident that their number was formerly much greater.
plain or hollow of Cettinye was doubtless filled with
at no very distant (geological) date, and even now,
the sudden rains cannot escape fast enough by the or
subterranean outlet, the royal village suffers from a
If the new territory be left out of view, there
little farming land in Montenegro; the peasant is g
enclose and protect the very best patches of fertile soil re
by the hollows in the mountain sides, and one ma
"flourishing little crops not a yard square." "The l
landed proprietor is the holder of 60 acres" (D
Montenegro, p. 113); the other freehold estates vary
2 to 20 acres, and it is usually not to the individua
to the house or family that the ownership belongs. W
and pastures are the common property of the clan (
The people live in small stone built cottages, groupe
the most part in little villages, and their whole

[1] Duklea is the name still borne by the ruins of the Roman
often, but wrongly, called Diocleia from its association with the
of Diocletian

ked by extreme simplicity. Chastity is a national
ne, and in time of war the women and children of the
s have often found their safest asylum among their
ditary foes. The main stock of the peoples of Servian
ent; and, though the purity of both blood and language
been to some extent affected by foreign elements, mostly
anian and Turkish, the national unity has not been im-
ed. The curious Gipsy colony, which, though speaking
ian, never intermarries with the Montenegrins, is
erically of little importance.[1] The great mass of the
le belong to the Orthodox Greek Church, only some
0 being Roman Catholics, and 3000 Mohammedans.
ding to Kaptsevitch, the population was 10,700 in
8, 120,000 in 1819, 124,000 in 1852, and 170,000 in
7, but in 1879 it was found that, much in excess of the new
tory, the number could not exceed 130,000 since then
ut 15,000 have been added with Dulcigno. The official
ns for 1882 (not based on a census, however) give
000 as the total, of whom some 25,000 live in the
alled towns.

Fauna. Bears are still found in the higher forests and wolves
specially foxes, over a much wider area. A few hundred feet
the loftier summits the roebuck is not infrequent in the
woods, the wild boar may be met with in the same district and
hare is abundant wherever the ground is covered with herbage.
are one or two species of snake to the country, including the
nous Illyrian viper. Excellent frogs, tree frogs, the common
ise, and various kinds of lizards are all common. The list
observed by Baron Kraliber includes golden eagle and vul-
, 12 species of falcons, several species of owl, nightjar, the
ings, hoopoes, partridges, herons, pelicans, divers, grebes,
uckers, &c. The abundance of fish in Lake Scutari and the
course of the Ryeka is extraordinary, the shoal of fish con-
, *Leuciscus albicanus*, that come up the river forming almost
masses. Both trout and salmon are caught in the Moratcha
r. The flora of Montenegro is comparatively scanty. In
orest districts the beech is the prevailing tree up to a height
00 or 5500 feet, and then its place is taken by the pine. The
nut forms little groves in the country between Podgoritza and
Scutari, but never ascends more than 1000 feet, above the
also is mainly confined to the neighbourhood of the Scutari
gnate bushes grow wild, and in many parts of the south
the foot of the hills with dense thickets, the myrtle one of
ost one of the peculiar charms of the sunny landscape. Wheat,
barley, maize, capsicums and a little tobacco are grown in the
, and in the south, vines, figs, peaches, apples, cherries, straw-
ges, &c. The potato, introduced in 1786, is cultivated consid-
ably beyond the local demand, the planting of mulberry trees
the rearing of silk-worms is of growing economic importance.
owns. CETINYE (*q.v.*), with about 2000 inhabitants, is the
al of the country. Podgoritza (about 6000 or 7000 in 1852,
reduced to 4000) is the principal trading town, it lies at the
of the mountains (as its name imports) at the junction of the
nitza with the Moratcha, and in Turkish hands was one of the
gest of their fortresses towards Montenegro. Dulcigno (*see*
vii. p. 520) has 3000 inhabitants, chiefly Albanian Moslems.
h, a fortified place on a slight eminence on the
t of a plain is about the same size. Antivari (Greek Ἀντίβαρις,
so called from its position opposite Bari in Italy, suffered
ly in the war 1879-80, and lost half of its 5000 inhabitants.
lovgrad, with 2000, lies on the north side of the Zeta valley
e vicinity is Orahlika, the prince's palace with its mulberry
ens, and the monasteries of Zhdrelanik, burnt by the Turks in
, but since rebuilt, while Tchelyeva, Moratcha (the most ancient
e principality), and Ostrog (visited annually by about 10,000
ims) are not far off. Spuzh (Sporeg), a little lower on the
side of the stream, is a fortified post with about 1000 inhabit-
Nyegush or Nyegoush (1200), about three hours distant from
nye on the road to Cattaro, is the native seat of the reigning
ly, which originally came thither from Nyegush in Herzegovina.
bliak (1200) was once the "capital," and has been a fortified
since the time of the Venetian power. Rvcka (1500), on the
of that name, is next to Podgoritza in commercial importance.
prince has two residences in the town. Grahovo (2000) is
us for the great battles of 1851 and 1876.

ontenegro is an absolute hereditary monarchy, vested accord-
o the principle of primogeniture in the family of Petrovitch
gush. The prince bears the title "Prince of Montenegro and
Berda (mountains)"—Montenegro here meaning the old Mon-
grin nahias (provinces) of Katunska, Tzrnitza, Rvetchka, and
Lyeshanska, and Berda the territory added in the 18th c
or the provinces Byelopavlitchska, Piperska, Moratchska,
vitchska, and Kutska. A responsible ministry was introd
1877, and there are now separate departments of justice,
affairs, war, and finance and education. The highest adm
tive body is the council of state, instituted in 1879, and c
of eight members appointed by the prince. Justice in c
cases is rendered in primitive fashion. Formal codes were
up by Peter I. (1798) and by Danilo (1855), but the real
lord is national custom. A great court, consisting of the
prince and ten members named by the prince, is held
capital, and there are inferior courts in each of the cap
56 in 1879. While formerly the very president of the
Matlo Petrovitch (*q.v.* 1850), whose songs are the delight
countrymen, could neither read nor write, primary educat
has been widely diffused during the reign of Prince Nicho
In 1871 there were only one school but before the recent w
increased to 58, nearly every village having one for girls
six for boys. The female Montenegrin dress consists chiefly
ized by the employment of bright-coloured stuffs. Apart from boy
footgear. It was from the primitive pieces of cotton in
that the first boots in the Slavonic language were named
18 and 1893 under the patronage of Peter II. and
ear IV. Greek rite. The week of Christ's birth
ay of Peter. Nearly one-fifth of the
Turk. Peter I. died in November 1851, and was succeeded
nephew Danilo, who was
ince in 1860, and was assassinated
poet. His successor, Nicholas, or Nikola Petrovitch Njegush,
a prince of Montenegro and Serbia, was born on
ry son of the Serbian people. He
ge which he spent in
ed to the
ce Peter N
potent fac
e pope, C
the Turk
he
ne

Mo
world then with the ten
ecame of his three sons Pe
Naturally the eyes of most
ed for the throne. When Prince Nicho
to prevent an old Montenegrin custom from being observed
national assembly was packed and [illegible]. When [illegible] the
ended at the close of May 1860, when the
elected Prince Nicholas Petrovitch Njegush. On the day
Prince Danilo was murdered. He became indee
ead of the principality, and [illegible] the Turks in a battle at Kos
territory to the [illegible] Herzegovina under the name
another time he became [illegible]. In 1905 he was converted,
Orthodox ascendancy in [illegible] of Cettinje. In
ontenegro, which [illegible] to be considered
of the people since they [illegible] their chief Prince
of which [illegible] the world's sentiment to lead the
[illegible] to be considered [illegible] of Christendom the Pope
the authority
ch of Upp
Montenegro

Prince Nicholas Petrovitch Njegush, who was
nce in 1860. He
was declared a
of and Herzegovina (
elect the national
the number of

Baron Kraliber
Die Montenegriner
Vienna, 1883;
Montenegro, Vienna, 1877;
Montenegro (Vienna, 1877).

MONTEREY, a county of the United States, the
in California up to 1847, is situated on Monterey
125 miles south from San Francisco by the
division of the Southern Pacific Railroad. Or
found d on 1770 as a mission station and presidio (
by Jun pero Serra, it is still in the main a Spanish
town, with Spanish talked in its streets and painted
veranda-boards. At the meeting of the first consti
convention of California Monterey was a port o
with a flourishing trade and a promising future,
soon suffered from the rivalry of San Francisco, an

[1] See Bogišić in *Das Ausland*, 1874.

Pypin and Spasovitch, *Hist. of Slav. Lit.*

deepy place, straggling and dirty, with many of its buildings abandoned to decay. The flourishing Monhaling company (chiefly Portuguese from the Azores) station under the old fort; and, the Southern Pacific d Company having erected (1881) a magnificent he place bids fair to become one of the leading water- on the Californian coast. The mission church of rios, about four miles from the town, is a curiou- ding ruin. Population is now (1883) about 1400. ne Paton, *Lóid del ven, padre fray J. Serra*, Mexico, dy Duffus Gordon, *The Camp Cities and Pa ea lands*, nd *Harper's Monthly Magazine*, October 1882.

NTEREY, a city of Mexico, capital of the state of Le on, lies 1600 feet above the sea on a sub tributary Rio Grande del Norte, 150 miles south-south-west o Laredo, and 190 west-south west of Matamoras. ome and well planned city, with a cathedral and a of good public buildings, Monterey is also in com and manufacturing activity the most important the northern parts of the republic, and one of the al stations on the railway opened in 1882 betv y of Mexico and the United States frontier (at oras and Nuevo Laredo). The population was about in 1880. The city was founded in 1596, became pric in 1777, and was captured by the United orces under General Taylor in September 1846.

NTE SAN GIULIANO a city of Sicily, in the pro Trapani and 12 miles north-east of the town of i, occupies the summit of the mountain from which s its name. It lies in the midst of an undulating his magnificent and conspicuous peak (the Eryx of ient) has, whether seen from sea or land, such an nce of altitude that, while it really does not exceed et, it has for ages been popularly considered the ntinent point of western Sicily, and second only to Etna. By the Phœnicians it was early chosen as of a temple, which continued down to the time of man empire to be one of the most celebrated of all ines of Venus (Venus Erycina). The ancient city of situated lower down the mountain side, disappears story after the establishment of the Roman power y, the inhabitants having probably taken advan- the protection afforded by the sanctuary, both the nd garrison of the temple enclosure. In the modern he population of which has recently increased to 3000 by the migration of considerable numbers to in, the chief points of interest are the cathedral, lly restored in 1865, the castle, which occupies the the temple, and the three so-called *Torri del Balio*, probably represent the propylæa. Remains of rian masonry are still seen on the north side of the The great rock-hewn cistern in the garden of the very like one of the cisterns of the Haram at

ntiquities of Monte San Giuliano have been carefully re- d by Giuseppe Pontrandolfi (*I Monumenti di Antichità trovati nell'Area di Erice*, and by Prof. Salinas (*Archivio Storico Siciliano*). Compare Renan, *Mélanges d'Histoire et de*, and Smith's *Dictionary*. 30th December 1882.

NTE SANT ANGELO, a city of Italy in the pro of Foggia (Capitanata), 10 miles north of Manfre stands on the hill-foot of Monte Gargano 2824 feet In 494 the archangel Michael pointed out the o St Laurentius, archbishop of Sipontum (Man a) and the chapel, which was built over the cave, h he drew more particular attention, soon became ous place of pilgrimage. Though plundered by ombards in 657, and by the Saracens in 869, St 's was already a wealthy sanctuary in the 11th , and its prosperity continued till the time of the occupation. The canons (*Canonici Gargani*, as they are usually called) maintained a prolonged with the Sipontine archbishops for episcopal indepen According to Ughelli (*Italia Sacra*, vol. vii. p. a marble statue of the saint by Michelangelo Buo took the place of a silver image. The bronze still preserved are fine pieces of Byzantine work, m an inscription bears witness, in Constantinople in The town of Sant' Angelo, which had only about inhabitants in the 17th century, numbered 14,759 in and 13,902 in 1871. Besides the festival of the celebrated on the 9th of May, there is a great fair 29th of September.

MONTESQUIEU, Charles Louis de Sec Baron de la Brède et de (1689-1755), philosophi torian, was born at the chateau of La Brède, about 1 to the south-east of Bordeaux, in January 1689 (the date being unknown), and was baptized on the 1 that month. His mother was Marie Françoise de Pe heiress of a Gascon English family. She had brou Brède as a dowry to his father, Jacques de Secondat, a ber of a good if not extremely ancient house, which first to have risen to importance in the early days of th century. The title of Montesquieu came from his Jean Baptiste de Secondat, "président à mortier" parliament of Bordeaux, an important office, which, as his title, he left to his nephew. Montesquieu was youth known as M. de la Brède. His mother died w was seven years old, and when he was eleven he was the Oratorian school of Juilly, near Meaux, where he exactly five years, and where, as well as afterwards deaux, he was thoroughly educated. The family h been connected with the law, and Montesquieu was d for that profession. He was made to work hard at withstanding his prospects (for his uncle's office was reversion); but, as in his later life, he seems t tempered much study with not a little society. His died in 1713, and a year later Montesquieu, or, as he at this time strictly be called, La Brède, was admitte sellor of the parliament. In little more than another month he married Jeanne Lartigue, an heiress a daughter of a knight of the order of St Louis, but somewhat ill educated, and a Protestant. Montesqui not seem to have made the slightest pretence of affec fidelity towards his wife—things which, indeed, th did not demand; but there is every reason to believ they lived on perfectly good terms. Like the three p years, 1716 was an eventful one to him; for his unc leaving him his name, his important judicial office, whole fortune. He thus became one of the riche most influential men in the district. He continued his presidency for twelve years, in the course of w had much judicial work to perform, as well as the script administrative functions which under the old fell to the provincial parliaments. He was none t addicted to society, and he took no small part in t edings of the Bordeaux Academy, to which he cont papers on philosophy, politics, and natural scienc also wrote much less serious things, and it was dur earlier years of his presidency that he finished, if he begin, the *Lettres Persanes*. They were completed 1721, and appeared in that year anonymously, with on the title page, but they were really printed and pu at Amsterdam. This celebrated book (the original of which is generally set down to a work of Dufres comic author, but which is practically original) wou been surprising enough as coming from a magistrat highest dignity in any other time than in the regenc duke of Orleans, and even as it was it rather scan the graver among Montesquieu's contemporaries. ause of letters written by and to two Persians of dis

ing in Europe, Montesquieu not only satirized
ally the social, political, ecclesiastical, and literary
of his day in France, but indulged in a great deal of
e writing (so free as very nearly to deserve the term
ous) which was characteristic of the tale tellers of the
But what scandalized grave and precise readers
lly attracted the majority, and the *Lettres Persanes*
ery popular, passing, it is said, through four editions
the year, besides piracies. Then the vogue suddenly
or at least editions ceased for nearly nine years to
. It is said that a formal ministerial prohibition
e cause of this, and it is not improbable; for, though
gent and Dubois must have enjoyed the book
ghly, they were both shrewd enough to perceive that
neath its playful exterior there lay a spirit of very
enient criticism of abuses in church and state. The
that the *Lettres Persanes* is the first book of what is
the Philosophe movement. The criticism is scarcely
gressive, much less destructive, and in Montesquieu's
it never became so; but what it might become in
nds of others was obvious enough. It is this p
ship in his own special line which in all probability
Voltaire so jealous of Montesquieu, as well as the
age which a wealthy and well-born noble of high
position had over himself. It is amusing to find
e describing the *Lettres* as a "trumpery book," a
which anybody might have written easily." It is
rtain that, in its peculiar mixture of light badinage
ot merely serious purpose but gentlemanlike moderation
Voltaire could have written it himself, and it is
that no one else at that time could. The reputation
quired by this book brought Montesquieu much into
erary society of the capital, and he composed for, or at
e contributed to, one of the coteries of the day the
but rather rhetorical *Dialogue de Sylla et d'Eucrate*,
h the dictator gives an apology for his conduct. For
oiselle de Clermont, a lady of royal blood, a great
and a favourite queen of society, he wrote the
s prose poem of the *Temple de Gnide*. This is half
ative, half an allegory, in the semi classical or rather
-classical taste of the time, decidedly frivolous and
sly moral, but of no small elegance in its peculiar
A later *jeu d'esprit* of the same kind, which is almost
ot quite certainly Montesquieu's, is the *Voyage à*
s, in which his warmest admirers have found little to

In 1725 Montesquieu was elected a member of the
ny, but an almost obsolete rule requiring residence in
was appealed to, and the election was annulled. It is
ul whether a hankering after Parisian society, or an
on to belong to the Academy, or a desire to devote
f to literary pursuits of greater importance, or simple
ess of not wholly congenial work determined him to
his Bordeaux office; it is certain that he continued
it but a short time after this. It is tolerably clear
had already begun his great work, and the character
e papers which, about this time, he read at the Bor
Academy is graver and less purely curious than his
contributions. In 1726 he sold the life tenure of his
reserving the reversion for his son, and went to live
capital, returning, however, for half of each year to
de. There was now no further formal obstacle to his
on in the Académie Française, but a new one arose.
hers had brought the *Lettres Persanes* specially under
nister Fleury's attention, and Fleury, a precisian in
ways, was shocked by them. There are various
ts of the way in which the difficulty was got over,
seem to agree that Montesquieu made concessions
were more effectual than dignified. He was elected
ceived in January 1728. Almost immediately after-
he started on a tour through Europe to observe
men, things, and constitutions. He travelled t
Austria to Hungary, but was unable to visit Turke
had proposed. Then he made for Italy, where
Chesterfield. They sojourned together at Venice fo
time, and a curious story is told of the way in whic
a piece of mischief on Chesterfield's part, or Monte
own nervousness and somewhat inordinate belief in
importance, made the latter sacrifice his Venetian
At Venice, and elsewhere in Italy, he remained
year, and then journeyed by way of Piedmont a
Rhine to England. Here he stayed for some e
months, and acquired an admiration for English cl
and poultry which never afterwards deserted him
returned, not to Paris, but to La Brède, and to
appearance might have seemed to be settling dow
squire. He altered his park in the English fashion
sedulous inquiries into his own genealogy, arran
entail, asserted, though not harshly, his seigneurial
kept poachers in awe, and so forth. Nor did he
his fortune, but, on the contrary, improved his est
very way, though he met with much opposition,
from the dislike of his tenants to new fangled wa
partly from the insane economic regulations of th
which actually prohibited the planting of fresh vine

Although, however, Montesquieu was enough of a
seigneur to be laughed at, and enough of a careful s
of his good to be reviled for avarice, by those of h
temporaries who did not like him, these matter-
means engrossed or even chiefly occupied his
In his great study at La Brède (a hall rather than a
some 60 feet long by 30 wide) he was constantly
tating, making abstracts, revising essays, and in
ways preparing his great book. Like some other
letters, though perhaps no other has had the experi
quite the same degree, he found himself a little ha
by his earlier work. He may have thought it
soften the transition from the *Lettres Persanes*
Esprit des Lois, by interposing a publication grave
the former and less elaborate than the latter. I
always as indeed was the case with most Frenchmen
century, been interested in ancient Rome and her h
and he had composed not a few minor tractates
subject, of which many titles and some examples
beside the already mentioned dialogue on Sylla. A
now to in the *Considérations sur les Cause*
Grandeur et la Décadence des Romains, which appe
1734 at Amsterdam, without the author's name.
however, was perfectly well known; indeed, Monte
formally presented a copy to the French Academy.
mity of title page was a fashion of the day which
nothing. The book was not extraordinarily pop
France at the time. The author's reputation as
tached to him, and the salons affected to consider the
ed the book respectively as the "gra
and the "décadence de M. de Montesquieu," bu
serious readers soon perceived its extraordinary
and it was eagerly read abroad. A copy of it e
cited which had the singular fortune to be annot
Frederick the Great, and to be abstracted from the l
hours by Napoleon. It has, moreover, by com
authorities to have been the most enduringly popu
the most widely read of all its author's works in l
country, and it has certainly been the most frequen
carefully edited. It merits a good deal undeniable.
scholastic criticism may of course object to it, as t
other book of the time, the absence of the exact
modern historical inquiry into the facts of history; b
is only a new example of a frequent *ignoratio*
The virtue of Montesquieu's book is not in its facts
its views. is (putting Bossuet and Vico aside)

st important essay in the philosophy of history. int of view is entirely different from that of Bossuet, seems entirely improbable that Montesquieu knew ng of Vico. In the *Grandeur et Décadence* the ter treated of the *Esprit des Lois* appear with the neces bordination to a narrower subject. Two things are lly noticeable in it: a peculiarity of style, and a ity of thought. The style has a superficial defect must strike every one, and which was not overlooked e who were jealous of Montesquieu at the time, e is broken up into short paragraphs of but a few ch, which look very ugly, which irritate the reader aking the sense, and which prepare him to expect ne and ostentation sometimes are. The blemish, r, is chiefly mechanical, and, though no editor ha had the perhaps improper audacity so to do, it be perfectly possible to obliterate it without changing On the other hand the merits of the expression y great. It is grave and devoid of ornament, but ginarily luminous and full of what would be called n, if the word epigram had not a certain connotation ancy about it. It is a very short book, for, printed e type with tolerably abundant notes, it fills but ndred pages in the last edition. Montesquieu But no work of the century contains, in proportion to its size, eighty and one-half thousand historical objects, lonte-queu has over Tacitus the advan

ough, however, that *Lucien Le* the style of his ork may be said to have been ted, and though t that work was as we have all probability composed Montesquieu was went on cultivating the ground differently both ndent and as an improvement however. He had , sometimes on his own account sometimes on that , and in one case he won from a city of Bordeaux than eleven hundred *arpents* at once the na *lands* of the country. He is said to have a history of Louis XI, and the story that it mpleted but burnt by him He wrote the of *Lysimaque* for Samuel Le In he published l final edition of the *Temple de Gnide* of the *Lettres*, of *Sylla et Eucrate* which indeed had never been ed, properly speaking. Nor did he revise the *Considérations* to be reprinted without alterations. One half times he revised and corrected it. He also took ains with the education of his son Charles and his er Denise, of whom he was extremely fond. He tly visited Paris, where he frequented the salons of Madame de Tencin and Madame d'Aiguillon the time he must have been widely well-known at k, indeed, a contemporary accuses him of having me into society to pick up material for it. But it that he did not begin the final task of composition 3. Two years of uninterrupted work at La Brède the greater part of it and two more the rest. It ally published at Geneva in the autumn of 1748, in nine *quarts*. The publication was, however, y one of the oldest incidents which in literature tive's well-known saying about court-martialling war. quieu summoned a committee of friends according ry common practice, to hear and give an opinion work. It was an important and certainly not an dly one constituted. Jonard, Helvetius, the financier tte, the dramatist Sorin, Crébillon the younger, tly, Fontenelle, in fact, all sorts and conditions ry men. The members of this eminently competent l unanimously, though for different reasons and in t forms of expression, advised the author not to publish a book which has been recently describe judge of certainly not less competence as "one of th important books ever written," and which, when imp of matter and excellence of manner are jointly cons may be almost certainly ranked as the greatest b the French 18th century.

Montesquieu, of course, did not take his friends' adv such cases no man ever does, and in this case it was ce fortunate. The *Esprit des Lois* represents the ref of a singularly clear, original, and comprehensive mi rected by forty years' study of men and books, arran accordance with a long deliberated plan, and conc language of remarkable freshness and idiosyncrasy title has been somewhat cavilled at, and, like that *Considérations*, it gave a handle to the somewhat ma frivolity of the salons. But if it had been presen full it would have escaped nine criticism w has received. In the original editions it runs *L des Lois, ou du Rapport que les Lois doivent avoir Constitution de chaque Gouvernement, les Mœurs, le C le Religion, le Commerce, etc.* It consists of thi books, which in some editions are grouped in six parts division into parts is known to have entered in author's original plan, but he seems to have changed hi it. Speaking summarily, the first part, con eight books, deals with law in general and with fo government, the second, containing five, with n arrangement, with taxation, &c.; the third, containi with manners and customs, and their dependen climatic conditions; the fourth containing four, wi nomic matters; and the fifth, containing three, with re The last five books, forming a kind of supplemen pecially with Roman, French, and feudal law. Th noteworthy peculiarity of the book to a cursory rea in the section dealing with effects of climate, an indeed was almost the only characteristic which the took in, probably because it was easily susceptible parody and *reductio ad absurdum*. But this th but the least part of the claims of the book to att its vast and careful collection of facts, the novel brilliancy of the generalizations founded on the constructive spirit which penetrates it, its toleran placid wisdom lighted up by vivacious epigram, con escape the most careless reader. The singular sp moderation which distinguishes its views on politi religion was indeed rather against it than in its fa France, and Helvetius, who was as outspoken as h good-natured, had definitely assigned this as the rea his unfavourable judgment. On the other hand, destructive it was sufficiently critical, and it thus enemies on more than one side. Montesquieu was t too English in his ideas by some, the severe de of orthodoxy considered him latitudinarian, an zealous Jansenist informed him that he was "a it was long suspected, but is now positively know the book (not altogether with the goodwill of the was put on the Index, and the Sorbonne projected, it did not carry out, a regular censure. To all the pretor, the author replied in a masterly *défense* there seems to be no foundation for the late and scan stories which represent him as having used Mada Pompadour's influence to suppress criticism. T was that, after the first snarlings of envy and incomp had died away, he had little occasion to complain. Voltaire, who was his decided enemy, was forced at to speak in public, if not in private, complimentarily *Esprit*, and from all parts of Europe the news of arrived.

Montesquieu enjoyed his triumph rather at La Brè at Paris. He was becoming an old man, and, unlike

he does not seem to have preserved in old age the
on for society which had marked his youth. A rather
us description, published long after his death, repre
him as "wandering in his woods from morn to night
a white cotton nightcap on his head, and a vine prop
s shoulder." This, in the florid language of its time
Republican period), is probably only an imaginative
ession of his known interest in managing his estate
he certainly spent much of his later years in the
y, though he sometimes visited Paris, and on one
had the opportunity, which he is likely to have en
, of procuring the release of his admirer La Beaumelle
an imprisonment which La Beaumelle had suffered
instance of Voltaire. He is said also to have been
mental in obtaining a pension for Piron. Indeed,
ent or unlucky men of letters found in him a constant
ctor, and that not merely at the royal expense. Nor did
any means neglect literary composition. The curious
romance of *Arsace et Ismène*, a short and unfinished
se on Taste, many of his published *Pensées*, and much
blished matter date from the period subsequent to
Esprit des Lois. He did not, however, live many years
the appearance of his great work. At the end of
he visited Paris, with the intention of getting rid of
ease of his house there and finally returning to La
. He was shortly after taken ill with an attack of
, which seems to have affected the lungs, and in less
a fortnight he died, on 10th February 1755, aged
sixty. He was buried in the church of Saint Sulpice
little pomp, and the Revolution obliterated all trace
remains.

literary and philosophical merit of Montesquieu and his
on, actual and historical, in the literature of France and of
e, form a subject of rather unusual interest of its kind. At
ginning of this century the vicomte de Bonald classed him
Racine and Bossuet, as the object of a "religious veneration
g Frenchmen." But Bonald was not quite a notable per-
or France, and it may be doubted whether the author of the
des Lois has ever really occupied any such position in his
untry. For a generation after his death he remained indeed
ol and the great authority of the moderate reforming party
nce, and at such times as that party recovered power during
evolutionary period Montesquieu recovered some with it
he tendency of the century and a quarter which have passed
his death has been to reduce the number and position of
arty ever more and more, and Montesquieu is not often quot
n quoted, either by Republicans, Bonapartists, or Legitimists
present day. Again, his serious works contain a certain set
on to a vast number of facts, and the exactitude it be hoped
osterity will not call it the pettifogging strictness of our
challenges the accuracy of these facts. Although he was
the founder, or at least one of the founders of the science of
rative politics and of the philosophy of history, his disciples
and followers in these sciences (and they have outgrown
In France his popularity has always been distinguished com
It is a singular thing that, until within the last few years,
has been no properly edited edition of his works, and nothing
approaching a complete biography of him, the place of the
being occupied by the meagre and rhetorical *Eloge* of the
ntury. He is his chief admirers assert, hardly read at all
nce to-day, and a tolerable familiarity with most modern French
ure enables its possessor to corroborate this by his own
edge, to the effect that no writer of equal eminence is so little
d. The admirers just mentioned attempt to explain this
fessing that Montesquieu, great as he is, is not altogether
ecordingly to French principles. It is not only that he
manian, but that he is rather English than French in his
ought. His work, at least the *Esprit*, is lacking in
n and the almost ostentatious lucidity of arrangement which
ehman demands. His sentences are often enigmatical, and
tive rather than clear. He is almost entirely dispassionate in
s, but he lacks the unswerving deductive consistency which
men love in that science. His wit, it is said, is quaint and
provincial, his style irregular and in no definite *genre*.
e of these things may be allowed to exist and to be defects
ntesquieu, but they are balanced by merits which render
almost insignificant. Of the minor works, which are on the
rather unworthy of their author, nothing need be said here
few *Pensées*, and in detached thoughts of the same kind
scattered about the tolerably numerous letters which have
us, there is much acuteness and point, as also in some of
sentences of the *Considérations* and of the *Esprit*. But no o
put Montesquieu as a *penseur*, or maxim-writer, beside La
foucauld and Joubert, Pascal and Vauvenargues. It is on
principal works that his fame does and must rest. Each
these is a masterpiece in its kind. It is doubtful whe
Lettres Persanes yield at their best either in wit or in gra
pictures of the time to the best of Voltaire's smaller work
they are more unequal. There is, moreover, the great d
between Montesquieu and Voltaire that the former is a
reformer, and not a mere *persifleur* or *frondeur*, to who
finding is more convenient to show the other way than acqu
Of course this last description does not fully or always
Voltaire, but it often does. It is seldom or never appli
Montesquieu. Only one of Voltaire's
head and the author must be truly devoted
to plead for a friend who urged him to
at Montesquieu's earliest compositions
Not only are Montesquieu's recreations
all wrote very good and very humorous
purely literary appreciation. The
not only to the complete absence of
mocking tone of the *Lettres* becomes
with abundance of striking expressions, by
ordinariness of the view, and for the
rocket carries out his plan. The
clause applies with much greater force to the
between a set of disconnected
from a superficial study of the
that Montesquieu's
Montesquieu himself. But the
promise of his earlier
which distinguished
been said to be a kind of
the
the
thread

MONTFLAUROT (?–1666), the
the "three kyngs" of mediæval composition, was born
but little is known of his life. He was ordained at an early age a
to the duke of Montfort and another composition with
under Dufresnoy the duke's music-master
thoroughly mastering the difficu
musical science. He bewailed a contrapuntal
and his own imperfect, but he was a bold
his needs and empirical methods of composition
a lasting influence upon the progress of art. He
the composer who ventured to use unprepared
employing them first in his madrigals, the beauty
they utterly destroyed, but afterwards introduced
into music of another kind with such excellent effe
their value was universally recognized, and all opp
to their use effectually silenced. In 1603 he

eri as "maestro di capella," and in 1607 he produced, marriage of Francesco Gonzaga, his first opera, , in which he employed the newly-discovered dis- ith great dramatic effect. Though he did not invent the ramatic Peri's *Euridice* having been produced at e in 1600 he raised it to a level which distanced temporary competition. His second opera, *Orfeo*, ed in 1608, was even more successful than *Arianna*, s based upon a principle which is held by some critics to embody the only law to which the ic composer owes obedience that of accommodating sic to the exigencies of the scene. In 1613 Monte as invited to Venice, as "maestro di capella" at St Here he composed much sacred music, the greater which is lost, a circumstance the less to be regretted, s *Vespers* and *Masses* bear no comparison with those ed by his predecessors in office. In 1630 he wrote grand opera, *Proserpina rapita*. In 1639 he pro *d'Adone*, and in 1641 *Le Nozze di Enea* and *Arianna*. These later works show him still greatly in of his age, notwithstanding the progress made by mposers since the production of *Orfeo*. Monteverde dained priest in 1633, and he died in 1643 uni respected. Though his free employment of the nt seventh and other unprepared discords put an he school of Palestrina, it led the way to the greatest ment of modern music.

NTEVIDEO, SAN FELIPE Y SANTIAGO DE, the capital republic of Uruguay (Banda Oriental) in South a, lies on the eastern side of a nearly semicircular the northern shore of the estuary of the La Plata, les from Buenos Ayres, with which communication tained by a daily service of steamers. The small la on which the city is built does not rise more feet above the level of the sea; but the headland o, 505 feet high, which forms the western side of , is notable enough on that low lying coast to justify e Montevideo it is crowned by a lighthouse, and d Spanish fort, once of considerable strength. About res is the area occupied by the city proper; the , stretch for miles into the country. The plan both old and the new town is regular, they are separated Calle de la Ciudadela on the line of the old rampart- what Oriental appearance is produced by the low with their flat terraced roofs and *miradores* or watch- from which the merchants look out for ships. A- , the city is overbuilt, and immense wealth has been ed in Italian marbles and other forms of archi decoration. The streets are for the most part well and there is an extensive tramway system. Mare was for some time employed to make gas for light t an epidemic having commenced at the gas yard ks were for a time closed, and when they were re coal gas was substituted. Previous to 1870, when as introduced from a distance of 40 miles, the whole was dependent on the rainfall. In the old town ipal square is the Plaza de la Constitucion, the de of which contain the "cathedral" and the north *cabildo* (law courts, senate houses and prison). The al (as it is usually called, though the bishop is a *in partibus*, and take his title from Meopta in Asia is a somewhat imposing building, consecrated 21st 1804, with a dome and two side towers 133 feet hich form one of the best landmarks of the bay. In of the old ramparts formerly stood the old Spanish which was built by the seven years' forced labour Guarani Indians. From 1835 to 1868 it served as cipal market in the city; in 1877 it was removed area united with the fine Plaza de la Independencia outh western end of the Calle del 18 Julio, a broad street which runs in a straight line right through the town. The new market, covering 2 acres, was bui 1867 at a cost of £86,000, and there are besides the market (cost £55,320) and the Mercado Chico. Th change, constructed after the style of the house at Bord dates from 1864, and cost £32,000. Of note also ar custom-house, the post office (1866), the museum, the p library (founded in 1830 by Dr J. M. Perez Castellano) university (dating from 1849), the Solis theatre (1856) British hospital (established in 1857, present building 18 the Hospital de Caridad (founded by Francisco A. Ma 1825), having an average of 300 patients, the new lu asylum (1877), the Basque church (1858), and the En church (1815), built on the site of a battery taken in by Sir Samuel Auchmuty's forces. Since the beginni

Map of Montevideo.

the century the depth of water in the bay has been allo to diminish 5 feet, and the area has been reduced by construction (1868) of an embankment to carry the rai across it. Dredging has been tried from time to time on too limited a scale. The so called harbour is a spa less than half a mile square off the north west face of town; in 1870 it was reported to be yearly becoming sm and less safe, and vessels are now obliged to anchor fa out. Among modern improvements in the port the noteworthy are the Mana dry docks, opened in 1873, the larger docks, erected in 1877 at a cost of 2,000 dollars, at the foot of the Cerro on the other side o bay. The trade of Montevideo consists mainly in the port of the raw products of the slaughter-house (h hides, hair, tallow, wool, bones), with a certain quanti live stock and preserved meat, and in the import of Euro manufactures. During the five years 1877 1881 the ave value of the exports was £2,303,061, and that of the im £3,169,997. Of the 1041 vessels (tonnage 780,870) w entered in 1879, 285 were English, 157 Spanish, 145 Ita 112 German, and 99 French. The population is large foreign origin, Italian, Spanish, Basque, and French. 1871 the Italians, who had rapidly increased after siege, were about 40,000 strong, and in several quarte the city nothing was to be heard save North Italian dia Even in 1880, after the exodus caused by the confisca of 1875, they numbered 36,300. The greater propo are engaged as petty traders. In 1879 the total popul of the town was 73,879; it had been 92,260 in 1878, 105,296 in 1871, and now (1883), including the envi is 110,167.

Montevideo owes its origin not to the commercial advan of its position but to the jealousy of the Spaniards toward Portuguese, which led Zabala, viceroy of Buenos Ayres, to e fort at this point in 1717. In 1726 the first settlers were i duced from the Canary Islands and Andalusia, and more than

assed before the settlement was declared a port: but by had 6160 inhabitants, and by 1792 was importing to the 2,993,267 dollars, and exporting to the value of 1,150,523. the governor of Montevideo was the first to revolt against nish authorities, and to establish an independent junta: years later, after much disastrous confusion and conflict, the ame the recognized capital of the newly-formed republic la Oriental. Its population, which had been about 36,000 pening of the century, was reduced to 9000 by 1829, and ardly recovered its ground in this respect (31,189 when, Rosas, dictator of Buenos Ayres, wishing to compel annexa Buenos Ayres, commenced the siege which was irregularly ed till 1852, and left the city and the country exhausted ost ruined. By 1860, however, the population had ri to 49,518; and though the Brazilians blockaded the port -5 and reinstated ex-president Flores the prosperity of the s but little impaired. During the Paraguayan war, which ill 1864, Montevideo grew rapidly rich, attracting a large f the trade diverted from Buenos Ayres. Immigrants from all quarters, and extensive investments were made in s of real property. The valuation of the city and suburbs was 11,156,000 dollars in 1860, reached the sum of 000 dollars in 1872. Reckless speculation, political dis and the financial mismanagement of the Government have avily; the value of house property has greatly diminished, mercial activity has been grievously restricted. Since 1881, , Montevideo has been rapidly recovering, and its natural ges are so great that, with better political circumstances of yet higher prosperity may be anticipated.

of Montevideo will be found in Bonelli, *Descrizione della città e del Porto*, &c., 1841; *Brial, the River Plate*, &c., 1861, and the supplemental volume, 1865; *Handbook of the River Plate Republics*, 1865; and Gallenga, *South* 1881. See also Bognacciello, *Delle cagioni che hanno impedito nuovi incrementi di Montevideo nell' Uruguay*, Genoa, 1870; *La Repubblica Uruguay* reports of the municipal junta, and Vadillo's statistical publications.

NTEZUMA. See CORTES and MEXICO.

NTFAUCON, BERNARD DE (1655–1741), critic and , was born of a noble and ancient family at the of Soulage (now Soulatge, in the department of France), on 13th January 1655. Though destined for y, he passed most of his time in the library of the of Roquetaillade (the usual residence of his family), ing books in different languages and on almost every of subject, his studies being directed by a learned of his father, Pavillon, bishop of Alet. In 1672 ered the army, and in the two following years served lunteer in Germany under Turenne. But ill health e death of his parents brought him back to his s life, and in 1675 he entered the cloister of the egation of St Maur, at La Daurade, Toulouse, taking ws there on 13th May 1676. Apart from his vast labours, the remainder of his life presents little to He lived successively at various abbeys at where he specially studied Greek and examined nerous MSS. of the convent library, at La Grasse, Bordeaux; and in 1687 he was removed to Saint in des Prés. From 1698 to 1701 he lived in Italy, in Rome. Returning to Saint Germain, he was member of the Academie des Inscriptions et Belle s in 1719. He died on 21st December 1741.

irst publication, in which he was assisted by Lopin and was the first volume of a never completed series of previously shed *Analecta Græca* (1688). In 1690 appeared his defence terally historical character of the book of Judith. *Hexapla nnaa*, still the best edition of that father, was issued with phy and critical notes in 1698. The first-fruits of his visit were seen in his copious *Diarium Italicum, ex monumentis veterum, bibliothecarum, musæorum, &c., potissimum Italiæ collecta* (1702). The *Palæographia* [illegible] *orbis et progressu literarum Græcarum, et de variis codicum scriptionis Græcæ generibus* (1708) is a standard work, has not yet been superseded: in its own field it is as original *re diplomatica* of Mabillon. In 1713 Montfaucon edited *rum Origenis quæ supersunt* (2 vols. fol.) only recently led by the work of Field; and between 1718 and 1738 he ed his edition of *Joannis Chrysostomi opera omnia* (13 vols ich is hardly an improvement upon that of H. Saville. His *uité expliquée et représentée en figures* (10 vols. fol., 1719 of itself suffice to establish a reputation for colossal dili It was continued by him in *Les Monumens de la Monarchie se* (5 vols. fol., 1729–1733). A complete list of his literary including his numerous contributions to the *Mémoires* of the Academy of Inscriptions, will be found in the *Nouvelle Bi Générale*, s.v. "Montfaucon."

MONTFORT, SIMON DE, EARL OF LEICESTER (c 1265), a great political leader, and sometimes e ferred to as the "founder of the English House o mons," born in France about the beginning of th century, was the fourth and youngest son of Sim de Montfort and of Alice de Montmorency. Of h life and education nothing is known, the first de recorded fact about him being that in April 1230 in England and had attached himself to the ser Henry III., who granted him a temporary pension marks, with a promise of the earldom which his fath held.[1] In the following year he did homage f honour of Leicester, and in 1232 the king confir him all the land with appurtenances which had be to the late earl in England. But, though thus fo admitted to the ranks of the English baronage, he for several years succeed in making way against the dislike in which "aliens" were now held and unti most of his time was spent, in considerable p abroad. In that year however, he attended the marriage to Eleanor of Provence as lord high st and thenceforward began to take part in the bu the royal council. Handsome, talented, and bra gained the love of Eleanor widow of the earl of Pe and sister of the king, to whom he was privately m at Westminster on 7th January 1238, Henry giving away the bride. When the fact became the indignation of the baronage and of the peop almost broken out in open rebellion, and, after Sim with difficulty averted this by propitiating his b in law, Richard, earl of Cornwall, he found it neces to go to Rome to meet the objection which the chur raised on the ground of an alleged previous vow m Eleanor. Having succeeded in obtaining (by brib would seem) the papal sanction to his marriage, returned to England in October, and early next ye to the enjoyment of the royal favour, he had the d of Leicester formally conferred upon him in presen the assembled barons. In June (1239) he asserted h father and high steward at the baptism of Prince Ed but the machinations of his enemies were soon atte successful in bringing about a change in the fickle b of Henry, and when Simon came back to Westmin Advised to attend the churching of the queen th met him with the information that he was an excom cated person, and ordered him to leave the church." with his wife he forthwith went into voluntary e France, but in April 1240 he returned to England was received by the king on a footing of at least o friendship. Of his private and public life duri

[1] Gregory IX. to Montfort, the well-known Albigensian cru to [illegible] sister, Amicia de Beaumont, countess of Devon and co heiress o the Peverels, and [illegible] succeeded to that earldom in 1 to [illegible] was celebrated in the high steward's hall of England, he presence of [illegible] with the title. Soon afterwards he was deprive French possessions under some pretext, the real reason b being his prepotent influence. Dispossessed of the French fiefs ag Albigensian [illegible]. He retired then again towards the end [illegible] however being committed to his nephew [illegible] Earldom. Besides [illegible] between England and France the early years of Henry III made it practically impossible for De Montfort to maintain any hold upon the Duchy [illegible] on the death of Simon IV. in 1218; in 1231, after the p cide of Simon Viscount of Beaumont renounced all r the latter became the full claimant to his next surviving brother's

[2] There is no evidence that Simon actually had been ex cated, but it seems clear that certain payments he had agreed to the bargain arranged had not been punctually attended to, one annoyance had been in this way carried to the king. Th of immoral relations with Eleanor was probably only a conv coarse way of reiterating the ecclesiastical offence for which M fort had already purchased absolution.

ght years very few facts have been preserved. s some ground for believing that he went to the nd in 1240, and a letter is still extant in which nity of the kingdom of Jerusalem ask Frederick ne 1241) to allow Simon de Montfort, earl of r, to act a regent till the arrival of his son Conrad. he accompanied Henry's unsuccessful expedition ce. In the parliamentary history of these years e appears but seldom, but where he is mentioned ariably found on the side of the people resisting arbitrary wastefulness of the king and the exactions of the pope. In 1248 De Montfort ointed for six years the king's "seneschal," or tenens," in Gascony. In this capacity he was dequately supported from home with either men y, he more than once subdued the rebellions s, indeed, but meanwhile his enemies at home trength and encouraged the Gascons in repeated ns and complaint against the seneschal. These re one-sided inquiry, but ultimately in his acquittal, to a demand on his part for reparation, and a con quarrel with the king. Towards the end of 1252 ontfort retired into France, where such was the on he enjoyed as a statesman that, on the death of en regent and in the absence of Louis IX., he wa the office of high steward and a place among the ns of the crown. This, however, he declined, "being e to prove a troublesome friend," and, after a partial recon with Henry, he returned to Parliament in 1254. In owing year he was sent on a secret mission into d, and in 1256 he was one of the king's arbitrators , but in consequence between 1254 and 1258, e to judge by the prominent place he took in the on of the latter named year, must have been in the of parliament. At the Westminster parliament 1258 it was largely upon the carls of Gloucester and Leicester that the reforming half-brother, William nce laid the blame of all the evil under which the was groaning. De Montfort in particular being y him "an old traitor and a liar." With Leicester om the latter leagued for the defence of them and presented their demands at the meeting extorted the appointment of the committee of lours to meet at Oxford and proceed at once with m of the realm. The Provisions of Oxford having ed (October 1258) De Montfort received the ex- the castle of Winchester, where the parliament co its session. He meanwhile apparently holding the of military commander-in-chief, and after the of the barons to London, he was appointed to rules ntary to Scotland. In the early part of 1259 he dly buried with the task of adjusting the terms of with France, which was not settled until the end of . From the date of the conclusion of that peace, divisions in the reforming party, the Lusignans ne to power, and in 1262 he felt himself strong to repudiate the Provisions of Oxford, thus giving ed for civil war. The rallying of the barons, led Montfort, in the west, and his victorious entry into again reduced the king to submission, but only to ce more at once to pronounce the divided state of er's supporters. Louis, consulted as to Mise of Amiens however, rendered another appeal to arms on the the barons' side, and by the victory of Lewes May 1264) De Montfort for the time became master ngland. Taking Henry, his prisoner, along with him don, he summoned thither the parliament, which June, and drew up the constitution or scheme of ent associated with his name, of which the most feature is the new development it gives to the representative system. A still further advance in t development took place in 1265, when borough membe as distinguished from county members, were for the fi time summoned. Meanwhile troubles in the west requir De Montfort's presence in the field, and, by the alliance his rival Gloucester with Roger Mortimer, as well as the escape of Prince Edward, who put himself at the he of the royalist opposition, the great parliamentary lead was placed in serious straits. At Evesham, where he h halted on his march to join his son at Kenilworth, he w surprised by the army of Prince Edward, and after struggle of about two hours was slain on the field of bat (4th August 1265). As regards the personal character De Montfort, it is not surprising to find that contempora opinion was divided; but of his determination, constanc and energy there can be no question, while much is re vealed by the fact that, though in an unauthorized wa his memory was revered in England as a saint and mart offices were drawn up in his honour, his intercession voked, and miraculous virtues attributed to his reli The painstaking labours of recent investigators have tend to hurl into clearer light the purity and nobleness of p pose of Simon de Montfort as a consistent defender of t rights of the governed; on the other hand, it has also come obvious that the representative institutions of E land, though largely helped forward by him, can hardly claimed as his creation. Thus on both sides the statem of Hume that the House of Commons was planted by t man person- hand of this bold and artful conspirator m be rejected as inconsistent with the facts.

Compare Prothero, vol. viii. p. 310 *sqq.*, and see the monogra of Pauli *Simon von Montfort, Graf von Leicester, Der Schöpfer des ersten Parlaments*, Tübingen 1867) and Protheroe, *The Life Simon de Montfort*, 1877), and the literature there referred to.

MONTGOMERY (Welsh, *Sirgrug Tre Faldwyn*), inland county of Wales, is bounded E. by Shropshire, N by Denbigh, N.W. by Merioneth, S.W. by Cardigan, and by Radnor. Its greatest length from south-east to nor west is about 40 miles, and its breadth from east to w about 35 miles. The area is 495,089 acres, or about 7 square miles. The surface is broken and undulati but it is only round the borders of the county that hills reach any great height, the highest summits of different ranges being generally in the adjoining count To the north are the Berwyn chain, stretching into Denbi shire; in the east the Breidden hills, in the south the Ke hill; and in the south-west Plinlimmon, the highest sum of which is in Cardigan. These various mountain ran form the water-bed of the numerous rivers of Montgome shire. With the exception of the Dyfi, which rises n Bala Lake and falls into Cardigan Bay, and the Wye, wh flows south into Radnorshire, all the principal rivers tributaries of the Severn (Welsh, *Hafren*), which rises the east side of Plinlimmon and traverses the whole leng of the county from south-west to north-east. The princi of these tributaries are the Clywedog, the Taranon, Rhiew, and the Vyrnwy. This fine succession of riv valleys broaden out as they reach the great vale of Severn, and the beauty of the scenery is enhanced by abundance of oak and other trees. The Montgomerysh canal which has a length of 27 miles, and passes principal towns, is connected with the Ellesmere ca thus affording water communication with Chester a Shrewsbury.

Montgomeryshire is occupied chiefly by Lower Silur rocks. The boundary between it and Merioneth is form by the Bala beds. In the centre and east, near Llanf and Montgomery, Wenlock shales prevail. In the neig bourhood of Welshpool the Silurian rocks have been f quently dislocated by volcanic masses, one of the m

kable of which is Corndon Hill, rising to a height of feet. In some places the sedimentary rocks have penetrated by trap mingled with shale or schist. the line of dislocation there are frequent deposits tallic lodes, carried there by the heated water rising below. The lead mines of Montgomeryshire are of con ble importance, and at present the metal is wrought en different places. In 1881 the amount of lead ore ed in the various mines was 3132 tons, yielding 2693 l lead and 25,132 oz. of silver the total value being 95. There were also obtained 1111 tons of zinc ore ielding 610 tons of zinc, of a total value of £3231.

ulture. The climate is mild and genial and the soil in the remarkably fertile, especially along the banks of the Severn derable portion on the border of Merionethshire, however d chiefly by heath and moss. The number of holdings has ather decreasing of late years, the decrease being chiefly in below 50 acres in extent, which in 1881 or the last year ing which there is information numbered 7527, while there 850 between 50 and 300 acres and 15 above 300 acres; 1 2 were above 1000. According to the agricultural returns of he total area of arable land was 76,054 acres or nearly one the whole. Of this 53,515 were under crops, 16,111

permanent pasture, 23,882 rotation grass, only 1407 crops 157 acres were under flax, 2 under hops, 2 under er nursery grounds, and 2744 under woad. Of the corn wheat occupied 18,066 acres, oats 23,347 acres, barley, are chiefly Herefords and cross breeds. Pure Herefords s and a few of the old Montgomery breed are reckoned in 1882 of which 21,912 were cows and heifers in milk or in Horses in 1882 numbered 13,975, of which 7060 were used for agricultural purposes. The county was formerly noted ly breed of small horses called *Merlins*, which are still to th. Many good hunters and cart horses are now bred. The of sheep in 1882 was 305,613. On the mountain land centre and west of the county a diminutive breed of sheep *Welsh* is pastured, but those kept in the better watered the principality Shropshire Down. According to the late the land was divided among 1741 proprietors, possessing 2 acres, with a gross annual rental of £3 . Of these, s 49 per cent. possessed less than one acre of 1000 and 2000 acres, and 2 between 2000 and ng, possessed upwards of 5000 acres, viz. Lord Powis 23,515, W. Wynn 17,963, Lord Sudeley 11,[illegible], J. Naylor 9274, arquis of Londonderry 7400.

nufactures. In all the towns the manufacture of woollen especially Welsh flannel, is carried on, and although the ry was lately on the decline it is now reviving.

ministration and Population. Montgomeryshire comprises hundreds, and the municipal boroughs of Llanfyllin 1121 and pool 6710, Llanfyllin Llanidloes Machynlleth Montgomery, Newtown, and Welshpool form the Montgomery district of ghs, with a total population in 1881 of 19,925, and return one er to parliament. One member is also returned for the county. omeryshire is partly in the dioceses of Bangor, Hereford and ph, and contains sixty-eight civil parishes, town ships, or as well as parts of other parishes in Denbighshire counties. From in 1831 the population had increased to 54,551 to 67,235, and 1 to 67,663, but in 1881 it had diminished to 56,618, of whom were males and 27,714 females.

tory. At the time of the Roman invasion, Montgomery was ed by a tribe of the Cymri called Ordovices. Traces of l of the old British camps still remain, the principal being at Dolarddyn, on Breidden Hill, and at Caereinion. There are large number of cairns and barrows. The county was first by the great Roman road, the *Via Watlingensis*, which was joined number of others, but the remains of Roman camps or stations unimportant. After being vacated by the Romans, little is of the history of Montgomery, until Wales was subdivided ree districts at the death of Rhodri the Great. Montgomery en included under Powys, and formed the chief portion of Gwenwynwyn, sometimes called Upper Powys. Powys or Castle, the seat of the rulers of Upper Powys, was founded in Baldwyn, from which the county takes its Welsh name, was ant of the marches; and, for the purpose of holding the di check, a castle was built about the end of the 11th century, after being captured by the natives, was retaken by Roger ntgomery. He gave his name to the castle, and to the surng district of ancient Powys, which was made a county by VIII. in 1536.

ONTGOMERY, the county town, is situated on the declivi of a well wooded hill near the eastern bank of the n, 21½ miles south by west of Shrewsbury, and 187¾ by rail north west by north of London. It is a cle well built town, but somewhat scattered and irre The principal buildings are the parish church of Nicholas (an old cruciform structure) and the town The borough has returned members to parliament the time of Henry VIII., but by the Reform Act of 1 was constituted one of the Montgomery district of bor which together return one member. The populat ne borough (area, 333 acres) was 1194 in 1881.

here are only s[illegible] mantling remains of the old for Montgomery, originally founded in the time of William th quered to overawe the Welsh, and held by Roger de Monte from whom the town takes its name. The castle was enlarged in the time of Henry III. when it was the scen great contest between that monarch and Llewelyn the Gr the 13th century it was held by the Mortimers, from whom it to the house of York. By the crown it was granted in 1 century to the Herberts of Cherbury, but upon the Civil was surrendered by Lord Herbert of Cherbury to the Parlia for [illegible] by whom it was dismantled.

MONTGOMERY, a district in the lieutenant gov ship of the Punjab, lying between 29° 8′ and 31° 1 lats., and between 72° 29′ and 74° 10′ E. long., is bo on the N.E. by Lahore, on the S.E. by the river on the S.W. by Multan, and on the N.W. by Jhang area 5673 square miles. Montgomery district, fo known as Gugaira, occupies a wide extent of th Doab, or wedge of land between the Sutlej and the beautiful stretching across the latter river into the adj Rechna Doab. In the former tract a fringe of cult lowland skirts the bank of either river, but the interior upland consists of a desert plateau partiall grown with bur, lavi-wood and coarse grass, and in places impenetrable jungle. On the farther side of the again the country at once assumes the same desert

The census of 1881 returned the population at 59,[illegible] according to [illegible] Hindus, 1[illegible] Muhamm 27,201 Sikhs [illegible] The Jats, or tribe, form the [illegible] in the district. Th the name of [illegible] in contrast to the pure cultural [illegible] account. Chief [illegible] They pe[illegible] region, with [illegible] Kharif [illegible] by [illegible] of which the chief farmed by the [illegible] of proprietary [illegible] tural tribe [illegible] cows, in the district contain ov inhabitants, [illegible] Montgomery [illegible] town of Montgomery [illegible] the registered [illegible] only, had a popul only. [illegible] Out of a total [illegible] 57 per cent. [illegible] retained [illegible] of the chief crops, brought [illegible] ted, 9[illegible]7 and [illegible] or sesamum, [illegible] cotton, [illegible] 7[illegible] [illegible] [illegible] [

es lie scattered along the river bank, or dot the now barren
s of the central waste, clearly marking the former existence
siderable population. The pastoral tribes of this barren
do not appear to have paid more than a nominal allegiance
ile-lord rulers, and even in later days, when Ranjit Sinh
f the Sikh supremacy as far as Multan, the country yielded
no revenue, and the population for the most part re-
in a chronic state of rebellion. British influence was first
l in the district in 1847, when an officer was deputed to
ummary settlement of the land reve Direct British
ted a ation of Punjab in 1849. The
dent since then was a general rising of the wild clans dur-
mutiny of 1857, several actions being fought bet the
re defeated and dispersed and order restored.

NTGOMERY, a city of the United States, the
of Alabama, is built on a high bluff on the left
the Alabama river, 158 miles north-east of Mobile,
hich it is connected by rail (180 miles) and by a
oat service (330 miles). The State house, rebuilt
l at a cost of $70,000, occupies a commanding
Capitol Hill. There are a city hall, a court house,
o theatres, a large flour mill, a cotton factory, two
s, a fertilizer factory, and several foundries and
e shops. The population was 16,713 in 1880; and,
equence of the marked increase in commercial and
ial activity that date, it is now (1883) esti
at 19,000 ded in 1817, and named after
l Richard Montgomery (1736-75), the town of Mont
became in 1847 the seat of the State Government
of Tuscaloosa. From February 1861 to May 1862
he capital of the Southern Confederation. In 1865
ezed by the Federal forces under General Wilson.

NTGOMERY, Alexander, whose life fell between
nd 1610, was the last of the series of Scottish poets
urished in the 16th century under the patronage of
narchs. With the union of the crowns, and the
rence of James VI. from Edinburgh to London,
favour was withdrawn from Lowland Scotch, it
ally ceased to be a literary language, and no poetry
k was written in the dialect, if we except that of
Ramsay's school, till it reappeared in literature as
strument of the Ayrshire peasant. By a curious
ence, Montgomery seems to have been, like Burns, a
of Ayrshire. A commendatory sonnet from his
xtravagantly flattering, as was the custom of the
as printed with King James's *Essays of a Prentice*
4; he received a pension from the crown a few
ater, fell into disgrace apparently for a time, was
ed in favour, and accompanied his patron to Eng-
As might be expected from the poet of a court
the king himself was a keen critic. Montgomery's
ments poems show a careful attention to form; he
many metrical experiments, and managed many
cated stanzas with skill. The sonnet form, at that
leading fashion in English verse, was also cultivated
Scottish court, and Montgomery's sonnets possess
rable merit. His most successful poem, published
7, and frequently reprinted in Scotland, was the
y of *The Cherrie and the Slae*. The poet, smitten
ad, conceives a longing for some cherries, beautiful
ut growing high up on a steep and dangerous bank,
a roaring waterfall. Shall he climb and win?
and counsel and will urge him to try, dread and
and despair counsel him to be content with the
r fruit of the sloe, which grows within easy reach.
ence, reason, wit, and skill debate the question.
end he resolves to venture for the cherry, with the
help of these last-named powers. The conflicting
s of the poet's adviser are very pithily expressed in
s for and against the adventurous enterprise, and the
tion of the situation is strong and vivid. Mont
y was no unworthy successor to Henryson and
Dunbar in executive finish, but the want of origina
his poems shows that the old impulse was nea
hausted. There are traces of Italian influence
sonnets and love songs, but it was much less po
with him than with his English contemporaries.

MONTGOMERY, James (1771-1854), poet and
nalist, was justly described by Lord Byron, in a fo
to *English Bards and Scotch Reviewers*, as "a man
siderable genius," though it was going far beyond the
to speak of his *Wanderer of Switzerland* (his first
poem, published in 1806) as being worth a th
"Lyrical Ballads." Montgomery was born 4th N
ber 1771, at Irvine in Ayrshire, Scotland. Part of h
hood was spent in Ireland, but he received his edu
in Yorkshire, at the Moravian school of Fulneck,
after the original home of the Moravians, to which s
father belonged. He drifted at an early age into jour
and edited the *Sheffield Iris* for more than thirty
When he began his career the position of a Dissentin
nalist was a difficult one, and he twice suffered impriso
(in 1795 and 1796) on charges that now seem absurdly
and untair. His *Wanderer* was mercilessly ridiculed
Edinburgh Review, but in spite of this Montgomer
lished many poems, which had a wide popularity
West Indies, 1810, *The World Before the Flood*,
Greenland, 1819; *Songs of Zion*, 1822; *The Pelican*
1827. On account of the religious character of his
he is sometimes confounded with Robert Montgomer
much to the injustice of his reputation. The inspirin
of James Montgomery's poetry was the humanitaria
ment which has been such a power in the political
of this century, and the pulse of this sentiment is n
felt beating more strongly than in his verse. His
has thus an historical interest altogether apart fr
intrinsic value as poetry. But this value is far fro
temptible or commonplace. Strictly speaking, Mont
was more of a rhetorician than a poet, but his imag
was bold, ardent, and fertile, and more than one of his
contemporaries owed occasional debts to his vigorous
tion and even to his casual felicities of diction, whi
passages from his poems keep a place in the literatu
is universally read and quoted. At the close of hi
as a journalist, when all parties agreed in payin
respect, he claimed for his poetry that it was at le
imitative, and the claim was just as regarded con
and choice of subjects: but as regards diction and i
the influence of Campbell is very apparent in his
poems, and the influence of Shelley is supreme
Pelican Island, his last and best work as a poe
Lectures on Poetry and General Literature, publis
1833, show considerable breadth of sympathy and
of expression. *Memoirs* of him were published i
volumes in 1856-8. They furnish valuable mater
the history of English provincial politics in th
entury. He died at Sheffield 30th April 1854.

MONTGOMERY, Robert (1807-1855), author
Omnipresence of the Deity (1828), *Satan* (1830), a
Messiah (1832), was the Montgomery ridiculed
nounced in Macaulay's famous essay. As a poet, he d
every word of Macaulay's severe censure; the m
intellectual feebleness—tautologous epithets, a
mixed metaphors, and inapt lines introduced for t
of rhyme are visible in every page of his versi
It should be mentioned that Macaulay's "trouncin
not diminish the sale of his so-called poems; one
works expressly ridiculed reached its 28th edition i
His real name is said to have been Gomery.

MONTH. See Astronomy, vol. ii. p. 80
Calendar.

MONTILLA, a small and unimportant city of S

province of Cordova, 32 miles to the south of the city Cordova, on the Malaga railway, is strikingly situated on hills which command a beautiful and extensive prospect the surrounding country. The manufactures (princi- y weaving) are unimportant, and the trade of the place iefly in agricultural produce. The oil of the surround district is abundant and good; and it is the peculiar our of the pale dry light wine of Montilla that gives ame to the sherry known as Amontillado. The popu on in 1878 was 13,207. Montilla was the birthplace "The Great Captain," and still shows the ruins of the le of his father, Don Pedro Fernandez de Cordova.

MONTLUC, Blaise de Lasseran Massencome, Sieur de (c. 1503–1577), marshal of France, was born at 1503, at the family seat near Condom in the lern department of Gers. He was the eldest son, and family was a good one, but it was large and poor, and, most gentlemen of Gascony, he had to trust for endow- t to his sword. He served first as a private archer and -at-arms in Italy, with Bayard for his captain, fought through the wars of Francis I., and was knighted on field of Cérisoles (1538). Having apparently enjoyed patronage, he was by this time a man of middle age. neeforward, however, his merits were recognized by his ointment to various important posts. His chief feat was famous defence of Siena (1555), which he has told so irably. When the religious wars broke out in France, ntluc, a staunch royalist, held Guienne for the king, excreised severe but impartial justice on Catholics and testants alike. He would have nothing to do with the ssacre of St Bartholomew. Henry III., however, made marshal of France, an honour which he had earned by rly half a century of service and by numerous wound- died at Estillac near Agen in Montluc's commen- ve other soldiers of fortune in his day is due to his *mmentaires* (Bordeaux, 1592), in which he described y years of service. This book, the "soldier's Bible" (or reviary," according to others), as Henry IV. called it, is of the most admirable of the many admirable books of noirs produced by the unlearned gentry of France at that e. It is said to have been dictated, which may possibly ount in some degree for the singular vivacity and turesqueness of the style. Hardly any author excel- ntluc in the clearness with which he brings military rations before the reader. As with most of his con- poraries, his work is didactic in purpose, and he often ses to draw morals for the benefit of young commanders. never tediously. The eloquence displayed in some of speeches is remarkable. These *Commentaires* are to be nd conveniently in the collection of Michaud and joulat, but the standard edition is that of the *Société l'Histoire de France*, edited by M. de Ruble (5 vols. 5-72).

MONTLUÇON, the industrial capital of the centre of nce, sometimes called the French Manchester, is the d of an arrondissement, and the largest town (26,079 abitants in 1881) of the department of Allier. The per town consists of steep, narrow, winding streets, and serves several buildings of the 15th and 16th centuries; lower town, traversed by the river Cher (there convey- o a canal communicating with that along the Loire), is seat of the manufacturing industries, which embrace ss, steel, and iron works, lime-kilns, saw mills, and a ol-spinning factory. The Commentry coal mines are y a few miles distant. There is railway connexion with ulins (50 miles to the east-north-east), Bourges, Limoges, Clermont-Ferrand, and a new line is about to be opened Tours *via* Chateauroux. Of the churches, Notre Dame f the 15th century, St Pierre partly of the 12th, and St l modern. The town-hall, with a library, occupies the site of an old Ursuline convent, and two other conven serve as college and hospital.

Montluçon, which existed as early as the 10th century, w by the English in 1171 and by Philippe Auguste in 1181, the were beaten under its walls in the 14th century. The castle by Louis II., duke of Bourbon, was taken by Henry IV. du religious wars; at present it is occupied as a barracks.

MONTMORENCY, the name of one of the old most distinguished families in France, is derive Montmorency, now in the department of Seine et O the immediate neighbourhood of Enghien and St and about 9 miles to the north-north-west of Paris family, since its first appearance in history in the pe Bouchard or Burchard I., sire de Montmorency in th century, has furnished six constables and twelve m of France, several admirals and cardinals, numerous officers of the crown and grand masters of various k orders, and was declared by Henry IV. to be after the Bourbons, the first house in Europe. Mathieu de Montmorency, received in 1138 the post of constab died in 1160. His first wife was Alix, the natural da of Henry I. of England; his second, Adelaide or A Savoy, widow of Louis VI. and mother of Louis According to Duchesne, he shared the regency of with Suger, during the absence of the latter king second crusade. Mathieu II. had an important in the victory of Bouvines (1214), and was made constable in 1218. During the reign of Louis (1223–1226) he distinguished himself chiefly in the of La Saintonge, Rochelle, Bordeaux). On the ac of Louis IX. he was one of the chief supporters of the regent Blanche of Castile, and was successful in re all the vassa led in 1230. His y son, Guy, in right of his mother became head of the h Montmorency-Laval. Anne de Montmorency (1493 so named, a friend, and, after his godmother Anne of B to the first attain the head title. He was Chantilly in 1493, and was brought up with the d afterward Francis I. whom he followed into Italy in distinguishing himself especially at Marignano. I he became governor of Novara; in 1520 he was pre the Field of Cloth of Gold, and afterwards had ch important negotiations in England. Successful defence of Mezières (1521) and a commander of th troops in the Italian campaign of the same year, made marshal of France in 1522, accompanied Fran Italy in 1524, and was taken prisoner at Pavia in Released soon afterwards, he was one of the negotia the treaty of Madrid, and in 1530 reconducted the sons into France. On the renewal of the war by Francis invasion of France in 1536 Montmorency co the emperor to raise the siege of Marseilles; he afte accompanied the force of France into Picardy, and termination of the Netherlands campaign marched rebel of Ghent. In 1538 to the ratification of year truce, he was rewarded with the office of co but in 1541 he fell into disgrace, and did not re public life until the accession of Henry II. in 15 1548 he repressed the insurrections in the sou particularly at Bordeaux, with great severity, and i Piedmont conducted the war in the Boulonnais, necessit tedly for the surrender of Boulogne on 24th Marc In 1551 his barony was erected into a duchy. Sub wards his armies found employment in the north connexion with the seizure of Metz, Toul, and Ver the French king. His attempt to relieve St Quentin in his defeat and captivity (10th August 1557) and not regain his liberty until the peace of Cateau-Cam in 1559. Supplanted in the interval by the Guises, treated with coldness by the new king, Francis compelled to give up his mastership of the roya

his son, however, being appointed marshal by way
mnity. On the accession of Charles IX. in 1560
ned his offices and dignities, and, uniting with his
enemies, the Guises, played an important part in the
ot even of 1562. Though the arms of his party
ictorious at Dreux, he himself fell into the hands
enemy, and was not liberated until the treaty of
19th March 1563). In 1567 he again triumphed
, but received the death blow of which he died
terwards at Paris. His eldest son, FRANÇOIS de
orency (1530-1579), was married to Diana, natural
r of Henry II., another son, HENRI I. de Mont-
(1531-1614), was constable of France from 1593
II. (1595-1632), son of duke Henry I., succeeded to
e in 1614, having previously been raised by Louis
the office of grand admiral. In 1625 he defeated
ch Protestant fleet under Soubise, and seized the
of Rhé and Oléron, but the jealousy of Richelieu
d him of the means of following up the advantages.
1629 he was allowed to command against the duke
ne in Languedoc; in 1630 he defeated the Piedmon-
d captured Prince Doria at Avigliana, and took
. In the same year he was created marshal. In 1632
d the part of Gaston duke of Orleans, and placed
at the head of the rebel army, which was defeated
shal Schomberg at Castelnaudary (1st September
severely wounded he fell into the enemy's hands,
andoned by Gaston was executed as a traitor at
s on 30th October. The title passed to his sister
se Marguerite princess of Condé.

STORGA, a town of Spain in the province of Corunna
s to the north-north-east of that city, on the Madrid
, stands on a rocky peninsula on the south bank of
adalquivir, here crossed by a fine bridge of four arches
from the 16th century. It is a fortified place, and
hospital, and is one of the best in Andalusia.
st important article of commerce is the oil of the
ding district. The population of the ayuntamiento
293 in 1878.

STPELIER, a town of the United States, the capital
ont since 1805, and the county seat of Washington
since 1811), is situated in 44° 17′ N. lat. and 72°
ong., on the Winooski or Onion river, which falls
ke Champlain. It has a station on the Central
t Railroad and is the western terminus of the
ber and Wells River and the Montpelier and White
Railroads. The State house, in the form of a Greek
th a dome and Doric portico, was erected at a cost
000, to replace the structure burned down in 1857;
the portico stands a marble statue (by Larkin G.
Ethan Allen (1737-1789), the hero of Vermont.
te library contains 20,000 volumes. From 2311
the population had increased to 3219 in 1880.

TPELLIER, chief town of the department of
Hérault, is situated at the junction of several
lines on a small hill rising above the Lez, at its
ce with the Mediterranean, about 480 miles south of
and about 7 miles from the Mediterranean, from
it is separated by the Etangs of Pérols and l'Arnel.
headquarters of the 19th corps d'armée, as the seat
shop of a university and of a court of appeal,
lier is the principal place of lower Languedoc. The
n Peyrou, 675 feet in length by 410 in breadth,
the finest squares in France, occupies the highest
the town, and terminates in a terrace, commanding
ficent view of the coast of the Mediterranean, and
le stretch of country reaching to the Cevennes on
th, to the spurs of the Pyrenees on the south-west,
hose of the Alps on the north-east. On the terrace
ted the reservoir of the town, the water being
brought from a distance of 5 or 6 miles by an aqu
of two tiers of arches, about 70 feet in height. I
centre of the square is an equestrian statue of Louis
To the right and left are promenades, off which the
boulevards converge. The Boulevard Henri IV. to
north leads to the botanical garden, medical college
cathedral; to the east the Rue Nationale leads to
palace of justice, the préfecture, and the citadel. The c
dral, which until 1536 was the church of a Benedi
monastery, suffered severely during the religious wars
about thirty years ago it was restored in the style o
13th century. It has four towers, and is one of the la
churches in southern France, being more than 300 fe
length, 92 in breadth, and 88 in height. The monas
after being converted into the bishop's palace, has
1795 being occupied by the famous medical school
portrait of Rabelais hangs in the gallery of former profe
Connected with the medical school is an anatomical mu
and a rich library. Montpellier also possesses a fa
of science, with several fine collections, a faculty of le
a higher school of pharmacy, an agricultural college
a sericultural institute. The museum contains more
600 paintings, in addition to collections of marbles, bro
and antiquities. The botanical garden, more than 10
in extent, is the oldest in France, having been lai
in 1593. The esplanade, ornamented by fine old
planted by the duc de Roquelaure, formerly gov
of Languedoc, leads towards the citadel. The inner cit
narrow and tortuous streets, but many good houses. A
the public buildings, the principal are the palace of ju
a modern structure, the façade adorned with statu
the statesman Cambacérès and of Cardinal Fleury
barracks, several hospitals, the juvenile seminary, and
central prison for females. There are several le
societies, including an academy of science and lette
antiquarian society, several medical societies, and
for various separate branches of study, including
dialect of Languedoc. The Lez has been deepened
widened so as to connect Montpellier with the Can
Midi and with the sea at Palavas. The town
a considerable trade in wine and brandy. The prin
industrial establishment is a manufactory for wax-ta
candles, and soap, doing business to the amount of £40
per annum. There are also chemical works, cooper
distilleries, &c. The population in 1881 was 56,005.

Montpellier first rose into importance after the destruct
Maguelone by Charles Martel in 737. Its prosperity dates
the beginning of the 12th century, when its school of me
(vol. xv. p. 807) first began to acquire fame. It had a
of law in 1160, and a university was founded by Pope Nichol
in 1289. St Louis (Louis IX.) granted to the town the ri
free trade with the whole of the kingdom, a privilege which g
increased its prosperity. In 1204 Montpellier became a depen
of the house of Aragon, through marriage, and in 1350 it wa
to Philip of Valois. In the time of Charles VIII. it is said to
had 15,000 hearths. It took the place of the bishopric of M
lone in 1536. At the time of the Reformation it became
the most important centres of Protestantism, but was tak
Louis XIII., who erected the citadel commanding the
Several years afterwards Montpellier was partly depopulat
the plague. Of the old fortifications little now remains sav
gate of Peyrou, a triumphal arch of date 1712, opposite the
of the same name.

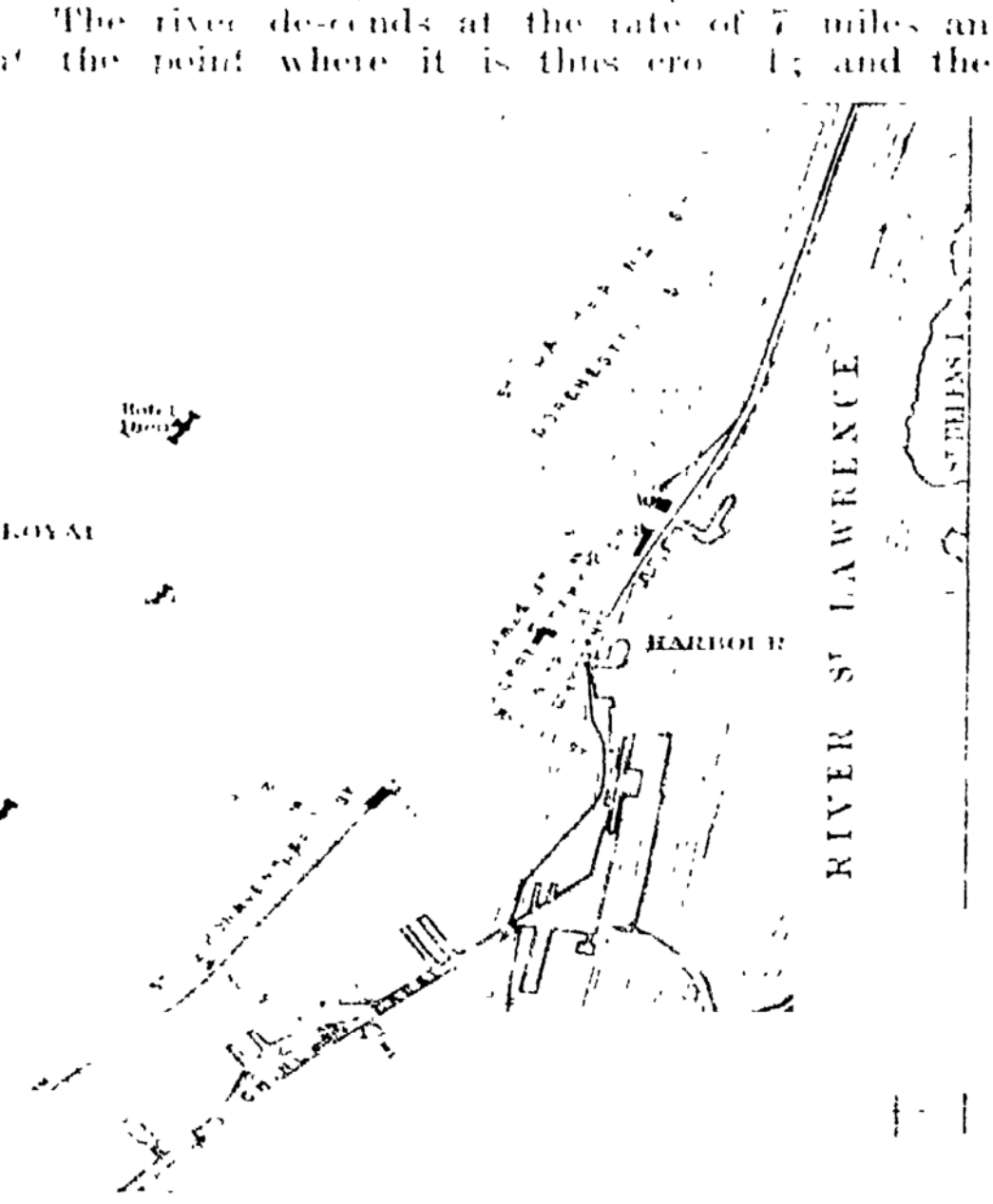
See Germain, *Histoire du commerce de Montpellier antérieurement à l'ou
du port de Cette* (2 vols. 1861) and *Histoire de la commune de Montpellier* (
1851); Aigrefeuille, *Histoire de la ville de Montpellier* (1877).

MONTPENSIER, ANNE MARIE LOUISE D'ORL
DUCHESSE DE (1627-1693), one of the most remar
names on the somewhat arbitrary list of royal and
authors, was born at the Louvre on 29th May 1627.
father was Gaston of Orleans, "Monsieur," the broth
Louis XIII., celebrated for the invariable ill fate
attended his favourites and partisans. Her mother
Marie de Bourbon, heiress of the Montpensier family.

of the blood-royal of France on both sides, and an
s to immense property, she appeared to be very early
ed to a splendid marriage. It was perhaps the greatest
tune of her life that "Mademoiselle" (as her courtesy
ent) was encouraged or thought herself encouraged
k forward to the throne of France as the result of a
gle with Louis XIV., who was, however, eleven years
nior. Ill-luck, or her own wilfulness, frustrated
ous plans for marrying her to various persons of more
s exalted station, including Charles II. of England,
Prince of Wales. She was just of age when the Fronde
out, and, attributing as she did her disappointments
zarin, she sympathized with it not a little. It was
oyever, till the new or second Fronde that she dis-
d in a very curious fashion a temper and courage as
line and adventurous as those of her father Gaston
ways been effeminate and timid. She not only took
al command of one of the armies on the princes'
out she literally and in her own person took Orleans
alade, crossing the river, breaking a gate, and mount
e walls with the applause of the populace of the city,
face of the refusal of the authorities to admit her.
od result, however, came to her party from this
rdinary act, and she had to retreat to Paris, where
ractically commanded the Bastille and the adjoining
of the walls. On the 2d of July (1652) the battle
Faubourg Saint Antoine, between the Frondeurs
Condé and the royal troops under Turenne, took
and the former, being beaten, found themselves in
kward situation, between their conquerors and the
of a city, which, though not exactly hostile to them,
ot nominally on their side, and had closed its gates
st them. Mademoiselle saved them by giving orde
herely for the gates under her control to be opened
r the cannon of the Bastille to fire on the royalists,
was done. Her own residence (and indeed her pro
was the Luxembourg, and here she found herself
g the riots which followed the battle, but in the
of the *émeute* she installed herself in the hôtel de
nd played the part of mediatrix between the opposed
s. Her political importance lasted exactly six months,
id her little good, for it created a lifelong prejudice
st her in the mind of her cousin, Louis XIV., who
forgave opposition to his sovereign power. Nor
he any support to look for from her pusillanimous
, who hastened to make terms for himself,—a matter
ss difficult that his known faithlessness had pre-
l the chiefs of the Fronde from engaging him at
eply in their schemes. Mademoiselle, on the other
was for some years in disgrace, and resided on her
s. It was not till 1657 that she reappeared at
but, though projects for marrying her were once
set on foot, she was now past her first youth. Her
able self-will, moreover, still stood in her way, and
after suitor was rejected for reasons good or bad.
was nearly forty, and had already corresponded
sly with Madame de Motteville on the project of
ishing a ladies' society "sans mariage et sans amour,"
a young Gascon gentleman named Puyguilhem,
wards celebrated as M. de Lauzun, attracted her at
It was some years before the affair came to a crisis.
t last, in 1670, Mademoiselle solemnly demanded the
permission to marry Lauzun. Madame de Sevigné's
on this occasion is one of the most famous of her
tion. Louis, who liked Lauzun, and who had been
ted by Mazarin in the idea that Mademoiselle ought
be allowed to carry her vast estates and royal blood
y one who was himself of the blood royal, or even to
oreign prince, gave his consent, but it was not imme-
y acted on. The pride of the other members of the royal family, and the spite of the king's brother, Mo
who had, after the death of Henrietta of England
offers to his cousin, prevailed with Louis to reser
permission. Not long afterwards Lauzun, for a
cause, was imprisoned in Pignerol, and it was years
Mademoiselle was able to buy his release from the k
settling no small portion of her estates on Louis's ba
The elderly lovers (for in 1681, when Lauzun was re
he was nearly fifty, and Mademoiselle was fifty four
then secretly married, if indeed they had not gone th
the ceremony ten years previously. But Lauzun, a
and brutal adventurer, tyrannized over his wife, an
spirit, which was yet unbroken, at length got the bette
passion. It is said that on one occasion he address
thus, "Louise d'Orleans, tire moi mes bottes," and th
at once and finally separated from him. She lived
ever, for some years after he had achieved his last
ture (that of assisting the family of James II. to
from England, and attempting to defend their ca
Ireland), gave herself to religious duties, and finish
Mémoires, which extend to within seven years of her
(9th April 1693), and which she had begun when s
in disgrace thirty years earlier. These *Mémoires* (A
dam, 1729) are of very considerable merit and in
though, or perhaps because, they are extremely ego
and often extremely derogatory. Mademoiselle write
out art, but with the hereditary ability of her fami
the strongly personal view which she takes of public
is rather an advantage than a disadvantage. They
be found in the great collection of Michaud and Pou
and have been frequently edited apart (G.

MONTREAL, the largest in the Domi
Ca a, its at of and principal
entry, is situated on an island of about 30 miles in
and 7 in breadth, at the confluence of the rivers
and St Lawrence, 45° 30′ N. lat. and 73° 32′ W
It stands at the head of ocean navigation, 160 miles
Quebec, and nearly 1000 miles (980) from the A
Ocean, and lies at the foot of the great chain of
lake, and canal navigation which extends westward t
the great Lakes. Montreal is built upon a ridge of t
the former levels of the river on or at a more ancien
Behind those rises Mount Royal, a mass of trap rock
up through the surrounding lime-stone strata to a he
700 feet above the level of the river. From this r
city derives its name, though its original founder,
Chomedey, sieur de Maisonneuve, in 1642, gave it th
of Ville Marie, where it was d with religious
sism, not as a centre of commercial enterprise, but
seat of a mission which aimed especially at the conver
the native Indians. The modern city of Montreal c
an area of about eight square miles, its principal
running parallel with the river. On the north side
Mountain the Trenton lime-stone approaches the s
and is there quarried for building purposes. Of th
limestone most of the public offices and many of th
class of private dwellings are built. But both bu
wood are largely used for workshops and private h
a humbler class. The western slope of the Moun
occupied by the Côte des Neiges (Roman Catholic
tery, and the Mount Royal (Protestant) cemetery
upper portion of the Mountain, embracing an area
acres, is now laid out as a public park, with tre
shaded by well grown tre From its commandi
and the wide expan e of the valley of the St La
the views on all sides are of great variety and
A well cultivated and wooded country, watered
Ottawa and the St Lawrence, stretches away on
hand, being bounded on the west by the lakes of S
and the Two Mountains, and on the distant hor

acrentian Hills, the Adirondacks, and the Green
ains of Vermont. On the east side the city occupies
pe towards the river St Lawrence, which has here
dth of from one to two miles. Two islands, the
and St Helen's Isles the latter rising to a height
0 feet beautifully wooded, and laid out as a public
occupy the bed of the river immediately below the
e Falls, and between them the river is spanned
great Victoria Bridge. This wonderful triumph
ineering skill is a tubular iron bridge supported
enty four piers of solid ma-onry, with the terminal
ents of the same, and measuring 9184 feet in
The river de-cends at the rate of 7 miles an
at the point where it is thus cro d; and the



Plan of Montre

e constructed with a view to resist the enormou
e of the ice in spring. Near at hand the tower
and dome of numerous churches and public build
s from the general mass of houses. The wharves
ke are crowded with shipping during the season of
tion, for the St Lawrence is navigable to Montreal by
ocean steamers. But immediately above the
river is impeded by a natural dyke of trap and
ne which here arc s the waters in their descent,
g the Lake St Lou at a height of 11 feet above
of M d harb The h
rough a channel of about half a mile wide, with
dity of about 18 miles an hour, forming the Lachine
Louis Rapid Owing to the immense volume of
concentrated in a narrow channel, steamers drawing
t of water are safely navigated down the rapids,
are necessarily present an insuperable barrier to the
of the river The is accordingly surmounted by
of the Lachine Canal, which, commencing at the
f Montreal, passes round the falls by a series of
n a course of nine mile s, to Lake St Louis, opposite
dian village of Caughnawaga The fall of water
in the canal furnishes water-power for saw-mills, boi
engine works, sash, blind, door, edge-tool, and
factories, established on its banks. Sugar refini
also been carried on here with great profit. Wool
cotton mills, silk factories, a large rubber factory, ro
cordage works, boot and shoe factories, &c., are l
organized on an extensive scale. The water sup
Montreal is derived from the river above the city
after passing along an open canal 5 miles in len
is raised to a reservoir excavated out of the solid r
the east slope of the Mountain, 205 feet above the
the harbour.

The circumstance attendant on the foundation of Montr
the marked contrast on its mixed population of French and
give a peculiar character to its religious and benevolent insti
This has led to the multiplication of churches, colleges, c
and religious and charitable foundations, and to a rivalr
zeal of their promoters one result of which is seen in the s
imposing character of many of their buildings. The Metr
Cathedral of St Peter, designed to reproduce on a reduc
the chief features of St Peter's at Rome, was projected by
Bourget after the destruction of his church and palace in t
fire of 1852. It occupies a prominent site in Dorchester
at the corner of Dominion Square; and, when surmounte
projected dome and finished in front with its classic façade
form a striking feature in the general view of the cit
parish church of Notre Dame, on the Place d'Armes,
accommodation for 10,000 worshippers. The Jesuits' Ch
another large church elaborately painted in the interior
is the College of St Mary. Christchurch Cathedral (Pro
is a fine specimen of Decorated Gothic, built externally
native limestone, but with the chief facings and carving
exterior and the whole of the interior of Caen stone.
erected under the direction of Bishop Fulford, the first
bishop of Montreal to whose memory a memorial cross, a
model of the Queen Eleanor crosses, has been erected on th
side of the cathedral. The other churches of the various
ant denominations include St George's, Anglican, St A
and St Paul's (Presbyterian), St James Street Methodist
the Church of the Messiah, Unitarian, &c.

The Hotel Dieu, founded in 1644 for the cure of the s
occupies a building at the head of St Famille Street. A
professed sisters and novices perform the duties of nurs
attendance, and upwards of 3000 sick persons are annually
into its wards. The order of the Grey Nuns, founded in 17
built a new hospital in Guy Street. The professed sisters
religious community, numbering at present 310, receive un
care the aged and infirm and orphan and foundling chil
the French Canadian population. They also undertake
of various asylums and schools in different parts of the city.
real has also a General Hospital, founded in 1822; a Pr
House of Industry, the Mackay Institution for Deaf Mu
Protestant Orphan Asylum, Infants' Home, &c. The c
mixed character of the population of Montreal is furthe
on its separate daily and weekly newspapers in the Eng
French languages, and in its various national societies, of St
St Andrew, St Patrick, St Jean Baptiste, and New England
confining its charitable operations to those of the nationalit
it represents. There are two theatres in Montreal, but the
Catholic clergy have systematically discountenanced the st
the diverse languages have further tended to limit the numb
patronize the drama.

Among the chief civic buildings is the city hall, buil
modern French style, with lofty mansard roofs, and a
pavilion. It affords accommodation for all the municipa
including the waterworks and fire alarm departments, the r
court, the police office, and for the meetings of the city
tion which consists of a mayor and twenty-seven aldermen.
aldermen are elected by each of the nine wards, one of whom
every year. The court house, situated close to the c
between the Champ de Mars and Jacques Cartier Square, is
some classical building where all the law courts hold their
and accommodation is provided for the Advocates' Library
numbers upwards of 10,000 volumes, including a fine coll
books in the department of old French civil law. Bo
Market in St Paul Street is a large structure surmount
dome, which forms a prominent feature in every view of
When it is crowded with the peasants bringing in their
produce, and by the French Canadian city populace as pu
as is the case especially on Tuesdays and Fridays, the scen
striking to a stranger.

Foremost among the educational institutions is the univ
M'Gill College, founded by James M'Gill, a Scotchman, wh
later years of the 18th century engaged in the north-west f

d ultimately became one of the leading merchants in Montreal t his death in 1813 he left his property for the founding of a col ge. The most recent and liberal addition to it is the Peter Red- ath Museum, valued at upwards of $100,000, the gift of a wea tizen. The university embraces the faculties of arts, law, and edicine, and has also a department of practical science. The ollege buildings stand in a pleasant park fronting on Sherbrooke treet, at the base of the Mountain. Theological colleges in con ection with the Church of England, the Presbyterian, Methodist, d Congregational Churches, occupy buildings in the vicinity, and eir students attend the classes at M'Gill College for secular instruc- on. The Seminary of St Sulpice is a theological training school r priests, where the larger portion of the Roman Catholic clergy the province of Quebec have received their training, and also a ollege where a large number of the French Canadian youth obtain eir education. This seminary is held in high esteem, and attracts any Roman Catholic students from the United States. Laval niversity, which has its chief seat at Quebec, has also a branch Montreal, with a large staff of professors, chiefly in theology, w, and medicine. The M'Gill and the Jacques Cartier Normal chools for training teachers for the Protestant and Roman Catholic ublic schools are conducted under the Protestant and Roman atholic boards of public instruction, and model schools attached them afford the requisite practical training for teachers. The incipal public monuments are the column erected in honour of rd Nelson, and a bronze statue of Queen Victoria, by the late arshall Wood, which occupies a good site in Victoria Square.

The commerce of Montreal is well represented by the architec- ral character of its banking establishments and many of the fine ercantile houses. It is also the seat of a large manufacturing dustry. But the most substantial evidence of its importance as commercial centre is its harbour. The solidly built basins, harves, quays, and canal locks extend for upwards of a mile and half along the river-side. In 1849, at a period of depression, the tal value of the imports and exports amounted to £2,013,478 sterling. In 1880 they had risen to £15,633,607 sterling. The usiness of the port at the same date in the export of Canadian rrency, total value of export $26,531,312, of import $49,749,461 stoms duties collected estimated at $8,100,000. The number of a-going vessels in port was 648, of which fully one half were ocean rriers; in addition to which the inland vessels arriving at the ort numbered 6543. The estimated value of real estate in Montreal $65,978,930. The population in 1881 numbered 157,715; in 1 had increased to 140,747, of whom 78,681 were of French and 8,995 of Irish origin. Of the whole number, 103,979 were Roman atholics.

The city returns three members to the Canadian House of ommons, and the same number to the provincial legislature of uebec.

When the first French explorers landed on the island of Montreal nder the leadership of Jacques Cartier in 1535, a large Indian alisaded town existed a little to the west of Mount Royal, and not r from the present English cathedral. To this fortified town the ndians gave the name of Hochelaga, and Jacques Cartier describ as surrounded by fields of grain and other evidences of a settled ative population. The name is now applied to the eastern suburb f the modern city. Sixty years later, when Samuel de Champlain ade his way up the St Lawrence, and climbed to the summit of Mount Royal, the populous native town had disappeared, and only wo Indians were found from whom some obscure hints were derived f war between rival tribes, followed by the destruction of the town nd the extermination or flight of its former occupants. The enmity hus established between the Wyandotts or Hurons of Canada and he Iroquois settled in the valley of the Hudson and south of Lake Ontario was perpetuated throughout the whole period of French ccupation. Champlain took the side of the Hurons, while roquois allied themselves with the Dutch and English settlers on he Hudson. Thus the early history of Montreal is largely occupied ith incidents of Indian warfare. In 1665 the marquis de Tracy rrived from France, bringing with him a regiment of French oldiers, with whose aid the Indian assailants were driven off, and orts erected and garrisoned to repel their incursions, thus ected, Montreal became the centre of the fur trade with the west, nd entered on its history as a commercial city. In 1722 it was ortified with a bastioned wall and ditch, under the directions of De Lery; and the citadel was erected on a height now laid out as alhousie Square. The taking of Quebec by the English under eneral Wolfe in 1759 was followed ere long by the surrender of ontreal. Since that date it has rapidly developed as an impor- ant centre of commercial and manufacturing enterprise. (D. W

MONTROSE, a royal and parliamentary borough and seaport of Forfarshire, Scotland, is situated on the German Ocean at the mouth of the South Esk, on a branch of the Caledonian Railway, 30 miles east-north-east of Dundee, and 38 south-south-west of Aberdeen. Its harbour basin, formed by the estuary of the South Esk, has an about 4 square miles, and is dry at ebb tide, but water there is a depth of about 18 feet at length of the quays and docks is about 1½ miles South Esk is crossed by a suspension bridge here 1829 at a cost of £20,000, and having a length fr points of suspension of 122 feet (with its approach feet). On the links to the east of the town is one finest golfing greens in Scotland. In the High which is of considerable width, and contains sever lofty houses, there are monuments to Sir Robert Peel Joseph Hume, formerly member for the Montrose bo The principal buildings are the parish church one largest churches in Scotland, the town house, the mu and the academy. There is a public library with volumes, and a mechanics' library with 7000 v Besides the staple industry of flax-spinning, the manufactures of linen, sailcloth, sheetings, stare soap, iron foundries, tanning, and brewing are also on. The export trade is chiefly in manufactured agricultural produce, and fish, the principal impo timber and coal. In 1881 the number of ship entered coastwise was 373 of 18,898 tons, the numb cleared 250 of 21,877 tons, the number engaged foreign and colonial trade in the same year was 108 of 31,868 tons, cleared 12 of 10,359 tons. M is also one of the principal fishing stations in Scotla number of registered boats in 1881 being 347 tons, giving constant employment to 697 persons, a sional employment to 300. Montrose joins with A Brechin, Forfar, and Inverbervie in returning one to parliament. The population of the royal burgh as 15,720, and 16,980 in 1881, the population parliamentary burgh in the same years was 14,1 14,975.

Montrose received a charter from David I. in the 12th and was made a royal burgh by David II. in 1357. The destroyed by fire in 1241. It was on the port of Mont Sir James Douglas in 1330 embarked for the Holy Land heart of Bruce, not that Prince Jane Stuart "the Old Pr set sail on 1716 for France after the failure of his enterprise The town and the Erthbride of Andrew Melville, of the great of Montrose, and of Joseph Hume.

MONTROSE, JAMES GRAHAM, MARQUIS OF, 1650), born in 1612, became the fifth earl of Mont his father's death in 1626, educated at St A and in 1629, at the early age of seventeen, he Magdalene Carnegie, daughter of the earl of South 1636, on his way home from a prolonged visit to the rest, he sought an introduction to Charles I., but, as i was frustrated in his hope of obtaining the king's fa an intrigue of the marquis of Hamilton. Not lo the outbreak of the Scottish trouble in 1637 h the party of resistance, and was for some time energetic champion. He had nothing puritanical nature, but he united in the ill feeling aroused Scottish nobility by the political authority g Charles to the bishops, and in the general indign he king's ill-judged scheme of imposing upon Sc liturgy which had been drawn up at the instigatio English court, and which had been corrected in by that Archbishop Laud who now became known land under the nickname of "the pope of Can Montrose's chivalrous enthusiasm eminently qualifie be the champion of a national cause, and the resi Scotland was quite as much national a it was r He signed the Covenant, and became one of the Covenanters. The part assigned to him was the sion of the opposition to the popular cause whi around Aberdeen and in the country of the Gordons times, in July 1638, and in March and June 1639.

Aberdeen, where he thoroughly succeeded in effect- object, on the second occasion carrying off the the Gordons, the marquis of Huntly, as a prisoner burgh.

ly 1639, after the signature of the treaty of , Montrose was one of the Covenanting leaders ated Charles upon the borders. This change of n his part is frequently ascribed to the fascination ng's conversation. In reality it arose from the t his own convictions. He wished to get rid of ops without making presbyters masters of the His was essentially a layman's view of the situa aking no account of the real forces of the time, d at an ideal form of society in which the clergy confine themselves to their spiritual duties, and in e king, after being enlightened by open communi ith the Scottish nation, should maintain law and thout respect of persons. In the Scottish parliament et in September, Montrose attempted to carry out cy, and found himself in opposition to Argyll, who ed himself at the head of the Presbyterian and party, which, by an alteration of the rules that erto regulated the selection of the Lords of the , gave supremacy in parliament to the representa- the middle classes. Montrose, on the other hand, to bring the king's authority to bear upon parlia- defeat this object, and offered him the support of number of the nobles, who were by this time as pposed to the predominance of the Presbyterian eting upon the middle classes as they had before posed to the predominance of the bishops. He Because Charles could not even then consent to the bishops, and because no Scottish party of any ould be formed unless Presbyterianism were estab ecclesiastically.

r than give way, Charles prepared in 1640 to in otland. As usual, he prepared difficulties for those shed to support him. Montrose was of necessity to play something of a double part. In August signed the Bond of Cumbernauld as a protest the particular and direct practising of a few in ords, against the ambition of Argyll. But he took e amongst the defenders of his country, and in the onth he was the first to wade across the Tweed at l of the invaders of England. After the invasion n crowned with success, Montrose still continued sh his now hopeless policy. On 27th May 1641 ummoned before the Committee of Estates charged trigues against Argyll, and on 11th June he was ed in Edinburgh Castle. When Charles visited l to give his formal assent to the abolition of acy, Montrose communicated to him his belief that n was a traitor. It has indeed been alleged, on 's authority, that he proposed to murder Hamilton vii; but this is in all probability only one of Claren ony blunders. His letters to Charles, however, taken in connexion with this so-called incident, the progress of the investigation of this plot. Mon mained in custody, and upon the king's return to l he shared in the amnesty which was tacitly accorded harles's partisans.

time Montrose retired, not voluntarily, from public fter the Civil War in England began he constantly Charles to allow him to make a diversion on Scot At last in 1644, when the Scottish army entered l to take part against the king, Montrose, now a marquis, was allowed to try what he could do. out to invade Scotland with about 1000 men. But wers deserted, and his condition appeared hopeless. however, inspired him with courage. Disguised as a groom, he, with only two gentlemen, started on 18t August to make his way to the Highlands. No enterpris might seem rasher. Highlanders had never before bee known to combine together, but Montrose knew that mos of the clans detested Argyll, not because they were royalis but because Argyll, as the head of the Campbells, was th chief of an aggressive and unscrupulous tribe. Montros did not miscalculate his chances. The clans rallied to hi summons. About 2000 Irish had crossed the sea to assis him. He won battle after battle. He defeated the Cove nanters at Tippermuir on 1st September, and at the Bridg of Dee on 12th September. Rapidity of movement was th distinguishing feature of his generalship. He crossed th mountains deep with a winter's snow into the country Argyll, burning and destroying as he rested for a tim from more active operations. On 2d February 1645 h crushed the Campbells at Inverlochy, whilst the head the house, who was no warrior, looked on at the disast from a boat. The Scottish parliament declared Montros to have forfeited his life and estate as a traitor, but it coul not reach him to execute the sentence. On 19th Februar he captured Elgin, through March he was ravaging Abe deenshire and Kincardineshire, on 3d April he storme Dundee, then on 9th May came the victory of Auldearn, o 2d July the victory of Alford, and on 15th August the gre victory of Kilsyth. Never till after this battle had Mo trose ventured far from the Highland hills. The High landers had the habit of running home after a victory t secure their booty. Now, however, Montrose found himse apparently master of Scotland. In the name of the kin who now appointed him lord lieutenant and captain-genera of Scotland, he summoned a parliament to meet at Glasgo on 20th October, in which he no doubt hoped to reconci loyal obedience to the king with the establishment of non-political Presbyterian clergy. That parliament neve met. In England Charles was in evil case. He had bee defeated at Naseby on 14th June, and Montrose mu come to his help if there was to be still a king to proclai He never had a chance of knowing what Montrose cou do against the "new model" army. David Leslie, the be of the Scottish generals, was despatched against Montros to anticipate the invasion. On 12th September he ca upon Montrose, deserted by his Highlanders and guarde only by a little group of followers, at Philiphaugh. H won an easy victory. Montrose cut his way through t the Highlands; but he failed to reorganize an army. O 3d September 1646 he embarked for Norway.

Montrose was to appear once more on the stage of Sco tish history. In June 1649 he was restored by the exile Charles II. to his nominal lieutenant-governorship of Sco land. In March 1650 he landed in the Orkneys to tak the command of a small force which he had sent on befo him. Crossing to the mainland, he tried to raise the clan but the clans would not rise, and on 27th April he w surprised and captured at Corbiesdale in Ross-shire. C 18th May he entered Edinburgh as a prisoner. On th 20th he was sentenced to death by the parliament, and h was hanged on the 21st, with Wishart's laudatory biograph of him put round his neck. To the last he protested th he was a real Covenanter and a loyal subject. "The Cov nant which I took," he said, "I own it and adhere to i Bishops, I care not for them; I never intended to advan their interest." Something, at least, of Montrose's dream so impossible to realize at that time, has been realized Scotland. Scotland has remained ecclesiastically Presb terian. The political legality which Montrose wished uphold against factions by means of the king has be upheld by means of the political ripeness of the Scotti nation itself. (S. R. G.)

MONT ST MICHEL, a curious rocky islet, consisti

nass of granite about 3000 feet in compass and 165 in height, rises at a distance of nearly a mile from hore in the bay of St Michel, near the mouth of the snon, at the vertex of the angle formed by the coasts rittany and Normandy. The quicksands by which it rrounded, and which stretch far to seaward, are ex l at low water, and highly dangerous to those who re on them without a guide. Recently efforts at nation have been made, and among t other works a way has been constructed connecting Mont St Michel the nearest point of the mainland (near Moidrey); unfortunate consequence of these operations has been some portions of the ramparts of the island have been ed by the altered tidal currents. The fortress-abbey, hich the rock owes its fame, stands upon the more ptuous side towards the north and we t, the sloping n towards the east and south is occupied by dwellings. The strong machicolated and turreted wall by the whole is surrounded is pierced only by a single way. The northward wall of the abbey (La Merveille), g from the 13th century, is of remarkable boldness, 246 feet in length and 108 feet in height, is sup d by twenty buttresses, and is pierced by a variety of ngs. The single street of the island, leading from ne gateway up to the donjon of the fortress, is lined houses, most of them used as lodging houses by rs and pilgrims; it contains an old parish church, the house of Du Guesclin is also pointed out. The y consists principally of two parallel buildings of stories each, that on the east containing hospitium, ory, and dormitory, and that on the west the cellar, nts' hall, and cloister. The knights' hall is a superb of Gothic architecture, measuring 85 feet by 59, three rows of richly-ornamented pillars. The cloister e of the purest and most graceful works of the 13th ry (1228). The church has a number of imperfect ts, and is surmounted by a square tower of the 17th ry, with a statue of St Michael, which was crowned 77. The nave, which dates from the 11th century, is an; but the choir, which collapsed in 1421, has been lt in the flamboyant style. Beneath is a fine crypt.

nt St Michel was a sacred place even in the time of the Druids ame a seat of Christian worship in the 8th century, when a stery was founded upon it (with the usual miraculous accom nents) by St Aubert, bishop of Avranches. It soon became urite resort of pilgrims, not only from all parts of France, but rom Great Britain and Ireland, and even from Italy. It was ered by the Normans, but Rollo on his conversion, made ation. At the time of the Conquest it supplied William of andy with six ships, and received a considerable share of the sh spoils. About this time the monks began to give them to learning and to collect a large library, and in the 12th ry the establishment reached its highest prosperity. It was by the troops of Philip Augustus, who afterwards furnished sums for its restoration (La Merveille). St Louis (Louis IX a pilgrimage to Mont St Michel, and was afterwards very liberal During the hundred years' war it offered a memorable resist to the English; and here, on 1st August 1469, Louis XI uted the order of St Michel, and held a brilliant chapter. A r celebration was held by Francis I. During the religious the Huguenots made repeated unsuccessful attempts to sca rtress; it opened its gates to Henry IV. after his abjuration. 1615 the Benedictine monks of Mont St Michel were re by monks of the Congregation of St Maur; after the Revolu he abbey was used as a prison for political offenders. It is n historical monument; it contains an orphanage, and is under repairs.

ONTSERRAT, one of the Leeward Islands in the Indies, situated 16° 45′ N. lat. and 62° 7′ W. long., miles long and 8 broad in its widest part, and has an of 32 square miles. The uneven and rugged surface asts possibly volcanic origin. Its general appearance ry picturesque, the most interesting natural feature the Souffrière. The island was discovered by mbus in 1493, and received its name either because of its broken appearance or after the mountain in It was colonized by the English under Sir Thomas W in 1632, and was taken by the French in 1664. Re to the English in 1668, it capitulated to the Fre 1782, but was again restored in 1784. It is now sidency under the general government at Antigua, a a legislative council, composed of officials and crown nees. The climate is the most healthy in the West The population (10,087) consists principally of n with several hundred whites. The revenue and ex ture average £5600 per annum. Sugar exports rang 1200 to occasionally 2000 tons. An important in is the cultivation of limes and the manufacture of About 700 puncheons of raw lime juice, 300 hogshe concentrated juice, and an increasing quantity of fresh limes are exported annually. For the three years 1880 the average value of imports was £26,390, of e £32,963. The principal town is Plymouth, lying n along the south west coast.

MONTSERRAT. Thirty miles to the north w Barcelona in Spain there rises a very remarkable mo of grey conglomerate, 24 miles in circumference, and lofticst point (San Geronimo) a little more than 400 in height. From the comparative lowness of the sur ing district, and from its extraordinary configuratio a conspicuous object for many miles around. The mo consists of jagged pinnacles and spires rising abrupt the base of the ma , which is cloven with many clef abounds with teep precipices. It is the *Mons Se* the Romans, the *Monte Serrado* of the Spaniards, thus named either in allusion to it jagged appearan the teeth of a saw, or because the eastern face is s it sawn, which occurred, say the Spanish legends, time of the crucifixion, when the rocks were rent arms of the monastery represent a mountain with resting upon it and penetrating some distance into it. Its pinnacles and pyramids and sharp angular resemble a mountain of hardened tallinic volcanic tuff occurs between Akureyri and Kalmanstunga in I The effect of Montserrat may be realized faintly if we ourselves upon the roof of Milan cathedral, and imag forest of spires magnified a thousandfold. The spire will represent San Geronimo. The result of this contour in the case of Montserrat is to make it one most picturesque places in Europe. Paths wind alo faces of the precipices, ascending to bare grey su descending to sheltered valleys filled with evergree flowers. The Pyrenees are seen in one direction, the another, while the Llobregat winds at the foot mountain through the village of Moni-trol. Manre other villages are seen scattered over the plain; an covered with a warm red soil alternate with rich v Street says of Montserrat: "After much experie mountains, it strikes me more each time that I se among the very noblest of rocks."

The monastery, a great pile of buildings, stands narrow platform on the edge of a vast chasm in the face of the mountain. It owes its existence to an of the Virgin, said to have been carved by St Luk brought to Barcelona by St Peter in 30 A.D. Wh Moors invaded the province in 717, the image was to Montserrat and hidden in a cave. In 880 Gon bishop of Vich, was attracted to the cave by sweet and smells, and there found the image, which he dete to take to Manresa. But at a certain spot on the mo the image refused to proceed further; there it was quently deposited, and a chapel was erected to con A stone cross near the walls of the monastery still the spot where the image refused to move. Ron chapel a nunnery was built, and in 976 this was c

nverted into a Benedictine monastery. Philip II. he present church. In 1835 the monastery was sed and despoiled of the vast treasures which had lated during the Middle Ages. But the buildings lowed to remain, as well as a few of the fathers to nge of the Virgin's shrine. At present they number hundred years ago there were 76 monks, 28 lay- , 25 singing boys, together with surgeon, physician, vants. The possessions then consisted of numerous , besides great quantities of plate and jewels, includ- ilver lamps.

a Señora de Montserrat, Patrona de Cataluña, is one of the lebrated images in Spain, and her church is visited annually than 80,000 pilgrims. It is a small carved wooden image, ly handsome, but the colour of a "negro woman," and pos- agnificent robes and jewels. It has been visited by numbers igns and high ecclesiastics, and by millions of Catalonians. mber 1881 it was solemnly crowned by Leo XIII., who sent from Rome for that purpose. Quantities of *ex votos* are at the shrine: wax models of injured or diseased limbs, of ships, pictures and clothes, jewels and silver hearts, elebrity and piety of Montserrat merited, and did the of devotees. Ignatius Loyola laid his sword upon the altar gin and, placing himself under her protection, started from at to commence his new life. Many eminent Spaniards, the world, have retired to this monastery to end their days. formed solitary hermitages perched among the rocks. Of ese were fifteen, seven of which once formed a *via sacra* t the summit of San Geronimo. They were destroyed by the but the ruins of some of them still remain. From all the magnificent, one is indeed placed on the edges of pre almost macabre isolation. There are also caves in the mount ne of which were formerly occupied by monks. The most st of these are the cave of the Virgin, in which the *Santa* remained hidden until found by Condemit, and the cave Juan Garin, a notorious sinner, who ended his days in the of a voluntary penance at Montserrat. At Collbato on the st side of the mountain, near the base, there are also some ious caves.

NTUCLA, JEAN ETIENNE (1725–1799), a learned athematician, was the son of a merchant, and was born s in 1725. He attended the college of the Jesuits native city, and was early distinguished for his us memory and his aptitude for mathematics. At of sixteen he removed to Toulouse to prosecute the f law, and after taking the usual degrees he re- to Paris. There his conversational powers, his solid tion, and his acquirements as a linguist soon intro im to the notice of the learned. In the society of lert and Lalande his taste for mathematical studies firmed and stimulated. After publishing two anony- treatises on the *Quadrature of the Circle* and on the *tion of the Cube*, he gave to the world in 1758 the t of his great work, *The History of Mathematics*, ng after this his merits were recognized by the ment, and he was promoted to several important He was appointed intendant secretary at Grenoble , secretary to the expedition for colonizing Cayenne , and "premier commis des bâtiments" and censor r mathematical books in 1765. During the next five years his time was divided between his official and the study of his favourite science. The Revolu n overthrew deprived him of his income, and left him t destitution. The offer in 1795 of a mathematical r one of the schools of Paris was declined on account nfirm health, and he was still straitened circumstances in 1798 when he published a second edition of the rt of his *History*. He also enlarged Ozanam's *matical Recreations*, afterwards published in English Hutton (4 vols., Lond., 1803). About four months his death (December 1799) a pension of 2100 francs nferred upon him. His *History of Mathematics* was ed by Lalande and published at Paris in 1799-1802 4to).

his work was the first history of mathematics worthy of the name. It is characterized alike by elegance of style and by of treatment. Montucla rarely fails in candour, and never in of sympathy; he lived at a time when it would have been able to treat mathematics "as a French science," yet he with justice be accused of Chauvinism. The study of the of mathematics has greatly revived of late years, espec Germany, and numerous monographs on special departmen appeared, in which, as was to be expected, many defects positive errors in Montucla's work have been pointed ou taken as a whole, it stands as yet unsuperseded, unrivalled to its admirable style and enduring quality, to be compar Gibbon's *Decline and Fall of the Roman Empire*.

MONZA (locally Monscia), a city of Italy in th vince of Milan, at the branching of the railway for and Como, lies on the Lambro, a tributary of t mainly on the right bank, in a healthy and att situation. Of the mediaeval fortifications little r save the Porta d'Agrate. The cathedral of St Baptist is the principal object of interest: Theode basilica was enlarged at the close of the 13th cent throwing the atrium into the main building, a present marble façade was erected about the mid the 14th by Matteo da Campione. On the lef side of the front rises an incongruous brick built 278 feet high, erected by Peregrini. Within the are the iron crown of Lombardy (removed by A in 1859, and since restored) and the relics of Theod comprising her crown, fan and comb of gold, a golden hen and seven chickens, representing Lom and her seven provinces. Next to the cathedral in importance come the church of Santa Maria in and the Broletto or old palace of the commune, styled the Arengario, the former (founded in 1357 rich Bramantesque façade, reckoned one of the best of terra-cotta work in Lombardy, and the latter is on a system of pointed arches, and has a tall square terminating in machicolations surrounding a sharp cone. San Michele was the scene of the corona Conrad III. in 1128, and San Gerardo (formerly Ambrogio) is named after the patron saint of Gerardo dei Tintori, who founded the first local hosp 1174. The royal palace of Monza (1777), with its sive gardens and park, lies not far from the town banks of the Lambro. Cotton goods and felt hats staple products of Monza industry; then dyeing, building, and a publishing trade. The population city was 15,150 in 1871, and that of the commune in from 24,661 in 1861 to 28,012 in 1881.

Local antiquarians claim for Monza (Modoecia or Modoetia) of a Roman colony, but it cannot have been a place of cons till it attracted the discerning eye of Theodoric, and, thoug a favourite residence with his immediate successors, its portant association are with Theodelinda (see vol. xiv. During the period of the republics Monza was sometim pendent, sometimes subject to Milan. The Visconti, w mately became masters of the city, built a castle in 1325 now occupied by the Palazzo Durini. In the cours history Monza has stood thirty-two sieges, and been repeated ferced, notably by the forces of Charles V. The countship 1796 was purchased in 1546 by the wealthy banker Dur remained in his family till the Revolution.

MOOLTAN. See MÚLTÁN.

MOON, THE. The subject of the moon divide into two separate branches, the one concerned with t stitution of the lunar globe, the other with its m For the first subject the reader is referred to the ASTRONOMY (vol. ii. p. 801 *sq.*); the present article fined to the second, which is commonly called the *Theory*.

The lunar theory does not yet form a well- body of reasoning and doctrine, like other bran mathematical science, but consists only of a se researches, extending through twenty centuries o and incapable of being welded into a consistent

state of things arises from the inherent difficulties complexities of the subject, and from the fact that no method or system has yet been discovered by which he difficulties can be surmounted and all the com ties disentangled. Hence each investigator, when he lesired to make any substantial advance beyond his cessors, has been obliged to take up the subject from w point of view, and to devise such method as might to him most suitable to the special object in hand. historical treatment is therefore that best adapted ve a clear idea of the results of these investigations. ancient and modern histories of the subject are quite nt, the modern epoch commencing with Newton. The epoch made by Copernicus did not extend to the case ne moon at all, because in every investigation of the n's motion, modern as well as ancient, the motion is red to the earth as a centre. Hence the heliocentric m introduced no new conception of the motion, except of taking place round a moving earth instead of round ed one. This change did not affect the consideration ne relative motion of the earth and moon, with which the lunar theory is concerned. The two stages of unar theory are therefore (1) that in which the treat was purely empirical, (2) that in which it was founded nally on the law of gravitation

is in the investigation of the moon's motion that the ls of ancient astronomy are seen to the best advan

In the hands of Hipparchus (see ASTRONOMY, vol 749) the theory was brought to a degree of precision h is really marvellous when we compare it, either other branches of physical science in that age, or the remarks and speculations of contemporary non tific writers. Whether this was wholly the work of parchus, or whether he simply perfected a system dy devised by his predecessors, it is now impossible to but, so far as certain knowledge extends, the works of predecessors did not embrace more than the deter tion of the mean motion of the moon and its node ough the general fact of a varying motion may have ascertained, the circumstances of the variation had ably never been thoroughly investigated. The dis ries of Hipparchus were:

The Eccentricity of the Moon's Orbit. He found that moon moved most rapidly near a certain point of its , and most slowly near the opposite point. The law his motion was such that the phenomena could be re nted by supposing the motion to be actually circular niform, the apparent variations being explained by the thesis that the earth was not situated in the centre of rbit, but was displaced by an amount about equal to one tieth of the radius of the orbit. Then, by a well-known f kinematics, the angular motion round the earth would ost rapid at the point nearest the earth—that is, at *ee*—and slowest at the point most distant from the —that is, at *apogee*. Thus the apogee and perigee ne two definite points of the orbit, indicated by the tions in the angular motion of the moon.

The Motion of the Perigee and Apogee. As already ed, the perigee and apogee are at the ends of that eter of the orbit which passes through the eccentricity ted earth, or, in other words, they are on that line h passes through the centre of the earth and the centre o orbit. This line was called the *line of apsides*. On paring observations made at different times, it was d that the line of apsides was not fixed, but made a plete revolution in the heavens, in the order of the of the zodiac, in about nine years.

The Numerical Determination of the Elements of the n's Motion. In order that the two capital discoveries mentioned should have the highest scientific value it was essential that the numerical values of the el involved in these complicated motions should be fix precision. This Hipparchus was enabled to do b eclipses. Each eclipse gave a moment at which the tude of the moon was 180° different from that of t and the latter admitted of ready calculation. As the mean motion of the moon to be known and the to be fixed, three eclipses observed in different pa the orbit would give as many true longitudes moon, which longitudes could be employed to det three unknown quantities the mean longitude at epoch, the eccentricity, and the position of the By taking three eclipses separated at short interval the mean motion and the motion of the perigee wo known beforehand, from other data, with sufficient a to reduce all the observations to the same epoch, an to leave only the three elements already mention known. In the hands of a modern calculator the p would be a very simple one, requiring little more th solution of a system of three equations with as ma known quantities. But without algebra the solutio long and troublesome, and not entirely satisfactory it was probably correct within the necessary limit errors of the observation. The same three elements again determined from a second triplet of eclipses remote an epoch as possible, the difference in the l of the perigee at the two epochs gave the annual of that element, and the difference of mean longitud the mean motion. Such was the method of deter the elements of the moon's motion down to th Copernicus.

The determination of the eccentricity from [illegible] described, led to an important error in the resulting valu eccentricity, owing to the effect of the neglected eve to know from our modern theory that the two principal in the [illegible] true [illegible]

[illegible] centre)

where q [illegible] and D [illegible] moon from the [illegible] D 180 very nearly, and $2D$ 3 [illegible] 1 27 more, and so is the same [illegible] centre, and is confounded with [illegible] The value of the [illegible] of centre derived from eclipses is the [illegible] 29 1 2, 5 0. Therefore the eccentricity found by Hipparchus and Ptole only 5, and was more than a degree [illegible] than the true valu

The next important step in advance was the di of the "evection," which is described by Ptolem ASTRONOMY, vol. iii. p. 760) as if made by himse view of the bad habit which Ptolemy had of mak own observations [illegible] previous [illegible] arrived at were sometimes in error, we must view such a di by him as quite exceptional, and as best explainable large magnitude of the outstanding error. Altho just shown, the erroneous eccentricity found by Hipp would always represent eclipses, so that the erro never be detected by eclipses, the error was entirely d when the moon was in quadrature. Comparing equations already written with that found by Hipp we see that the latter required the correction

$$\begin{aligned} &[\text{illegible}]\ \sin q \cos(2D - g), \\ &[\text{illegible}]\ \cos 2D \sin q + \sin 2D \cos q. \end{aligned}$$

At quadrature we have D 90, $2D$ 180°, and $\cos 2D$ 1 and $\sin 2D$ 0. The omitted inequ at these points of the orbit have therefore the 2·51 $\sin q$, a quantity so large that it could not ha detected by careful observations with the instrumen an inequality as this, superposed upon the eccentric of the moon, was very troublesome to a trigonometr no way of representing the celestial motions exc geometrical construction. The construction propo Ptolemy was so different from those employed

s of the planets, and with that so intricate, that little attaches to it

student of Arabian science may find much to interest the astronomical speculations of the Arabs, but this do not seem to have furnished anything in the way ective theory. In the fourth book of *De Revolu-*, where we find the lunar theory of Copernicus, no later than Ptolemy is referred to. Moreover, as intimated, the work of Copernicus in this particu ction forms little more than an episode in the his the subject. The working hypothesis of the great of modern astronomy was borrowed from the , and was that the celestial motions were all either or compounded of circular motions. The hypo f equal circular motions, though accepted by Ptolemy e, was so strained by him in its applications that s left of it in the *Almagest* (the Arabic translation *gnitudes*). But, by taking the privilege of compound ular motions indefinitely—in other words, of adding cycle to another—Copernicus was enabled to repre e planetary and lunar inequalities on a uniform though his heavens were perhaps worse "scribbled an those of Ptolemy. To one epicycle representing ation of the centre he added another for the evection. e represented the latitude of the moon both at nes and oppositions. But the third inequality, ion," which attains its maxima at the octants and at all four quarters, was unknown to him. To Brahe is commonly and justly ascribed the discovery variation. Joseph Bertrand of Paris has indeed the discovery for Abu l'Wefa, an Arabian astro and has made it appear probable that Abu l'Wefa detected in quadrature the moon's motion which we now to have been the variation. But he has not on the part of the Arabian, any such exact de n of the phenomena as is necessary to make clear n to the discovery. Ast and Tycho, although overed the fact, he could add nothing in the way of ive theory. To the double epicycle of Copernicus obliged to add a motion of the centre of the whole orbit round a circle whose circumference passed the centre of the earth, two revolutions round being made in each lunation. Kepler, by intro a moving ellipse having the earth at its focus, was to make a nearer approach to the truth than any predecessors. But the geometrical hypothesis by e represented the inequalities due to the action of sun no greater epoch in the progress of science the geometrical constructions of his predecessors y therefore dispose of the ancient history of the eory by saying that the only real progress from ha to Newton consisted in the more exact deter n of the mean motions of the moon, its perigee line of nodes, and in the discovery of three new ities, the representation of which required geometri tions of increasing complexity with every step. modern lunar theory commenced with Newton, and s in determining the motion of the moon deductively e theory of gravitation. But the great founder of mechanics did not employ the method best adapted to the desired result, and hence his efforts to con a lunar theory are of more interest as illustrations wonderful power and correctness in mathematical ng than as germs of new methods of research. He ed perfectly in explaining the elliptic motion of two ly attracting bodies round their common centre of by geometrical constructions. But when the prob

(full title, *De Revolutionibus Orbium Cœlestium Libri VI.* lio, Norenberg, 1543)

lem was one of determining the variations from the e motion which would be produced by a third body constructions could lead only to approximate results. path to modern methods was opened up by the Conti mathematicians, whose great work consisted in red the problem to one of pure algebra. The chasm be the laws of motion laid down by Newton and a pr of algebra seems so difficult to bridge over that it is while to show in what the real spirit of the modern m consists. We call to mind the statement of Newton' two laws of motion: that a body uninfluenced by any moves in a straight line and with uniform velocity for and that the change of motion is proportional to the impressed upon the body and in the direction of force. These two laws admit of being expressed in braic language thus. Let us put m the mass of a ma point; x its distance from any fixed plane whatev the time; X the sum of the components of all the acting upon the point in the direction perpendicular fixed plane, it being supposed that each force is re into three mutually perpendicular components, one of is perpendicular to the fixed plane, then the differ equation

$$m\frac{d^2x}{dt^2} = X$$

expresses Newton's first two laws of motion with a pleteness and precision which is entirely wanting statements in ordinary language. The latter can thing more than lame attempts to express the equat language which may be understood by the non-m matical reader, but which bear the same relation algebraic equation that a statement of the operati the Bank of England in the symbolic language of a of savages would bear to the bank statement in po shillings, and pence. By taking two other planes, p dicular to each other and to the first plane, we have equations like the one last written. The law of gravi and Newton's third law of motion enable us to sub for X and the other forces the masses and coordina the various attracting bodies. Thus the data of the pr are expressed by a triplet of three equations for each a ing body. The integration of these equations is a prob pure algebra, which, when solved, leads to expressions give the position of each body in terms of the time, which is wanted. The special form which it is nec to give the equations has not been radically changed the century and a half since this method of researc opened out. The end aimed at is the algebraic expr of all the quantities involved in the form of an i series of terms, each consisting of a constant coef multiplied by the sine or cosine of an angle incr uniformly with the time. It is indeed a remarkabl that, notwithstanding the great advances which m mathematics has made in the discovery of functions general than the old-fashioned sines and cosines e mentary trigonometry, especially of elliptic function the form of development adopted by the mathematici the last century has remained without essential chan

It will be instructive to notice the general and simple p of the trigonometric functions to which is due their great ance in the problems of celestial mechanics. It may be ex thus: *If we have any number of quantities, each of which pressed in the form of a trigonometric series in which the increase uniformly with the time, then all the powers and p of these quantities, and all their differentials and integra respect to the time, may be expressed in series of the same form* theorem needs only an illustration by an example. Let ou tities be X and Y, and let us suppose them expressed in the

$$X = a\cos A + b\cos B + c\cos C +, \text{ \&c.}$$
$$Y = a'\sin A' + b'\sin B' + c'\sin C' +, \text{ \&c.},$$

in which we may suppose that the quantities $a, b, c,$ &c., c towards zero. In forming their product, the first term

$A \sin A'$. But we have $\cos A \sin A' = \frac{1}{2}\sin(A'+A) - \frac{1}{2}\sin(A'-A)$. Hence the product XY will be of the form

$\frac{1}{2}aa'\sin(A'+A) + \frac{1}{2}aa'\sin(A'-A) + \frac{1}{2}ab'\sin(A'+B') + \&c.$,

is another type of the same general form. Moreover, if those the angles A, B, &c., to increase uniformly with the that is, to admit of expression in the form

$$A = \alpha + ml, \quad A' = \alpha' + m'l, \ \&c.$$

have, by integrating,

$$\int XY\,dt = -\frac{aa'}{m+m'}\cos(A'+A) - \&c.,$$

again, is a trigonometric series of the same general form, admits of being manipulated at pleasure in the same way original expressions A and B. The property does not to the elliptic functions, and in consequence, notwithstanding the great length of the trigonometric series, no attempt sum them has been successful.

efforts to express the moon's motion by integrating ferential equations of the dynamical theory may be d into three classes. (1) Laplace and his immediate ors found the problem so complex that they ought to olify it by reversing its form, instead of trying from ming to express the moon's coordinates in terms of ne, they effected the integration by expressing the terms of the moon's true longitude. Then, by a l of the series, the longitude was expressed in terms time. Although it would be hazardous to say that ethod is unworthy of further consideration, we must that its essential inelegance is such a temporary fact study, and that it holds out no promise of development. (2) By the second general method on's coordinates are obtained in terms of the time direct integration of the differential equations of , retaining the algebraic symbols which express the of the various elements. Most of the elements are numerical fractions: e, the eccentricity of the moon about 0·055; e', the eccentricity of the earth's orbit, 0·017; γ, the sine of half the inclination of the moon's about 0·046; m, the ratio of the mean motion of oon and earth, about 0·075; and the expressions for gitude, latitude, and parallax appear as an infinite nometric series, in which the coefficients of the sines ines are themselves infinite series proceeding according the powers of the above small numbers. This was applied with success by Poetcoulant and Sir W. Lubbock, and afterwards by Delaunay. It be remarked that the solution by the first method s in the same form as by this one after the true de is expressed in terms of the mean longitude. the method just mentioned the series converge so and the final expressions for the moon's longitude long and complicated that the series has never been far enough to insure the accuracy of all the terms, especially the case with the development in powers he convergence of which has often been questioned when numerical precision alone is aimed at, it has found best to avoid this difficulty by using the cal values of the elements instead of their algebraic s. This method has the advantage of leading to re rapid and certain determination of the numerical of the several coefficients of sines and cosines. It disadvantage of giving the solution of the problem or a particular case, and of being inapplicable to hes in which the general equations of dynamics have plied. It has been employed by Damoiseau, Hansen, ry.

methods of the second general class are those most of study. And among these we must assign the nk to the method of Delaunay, developed in his *du Mouvement de la Lune*, because it contains a which may yet develop into the great desideratum of al method in celestial mechanics. To explain it, st call to mind the general method of "variation of elements," due to Lagrange. This method is applic cases in which a problem of dynamics can be com solved when any small forces which come into p left out, but which does not admit of direct solutio these forces are included. Omitting the small commonly called "disturbing forces," let us supp problem of the motion of a body under the influenc "principal forces" completely solved. This wil that we have found algebraic expressions for the nates which determine the position of the body i of the time, and (in the case of a material point) constant quantities, to which we may assign va pleasure. Then Lagrange showed how, by sup these constant quantities to become variable, th expressions could be used for the case in which th of the disturbing forces was included. In other wo effect of the disturbing forces could be determi assume them to change the constants of the first a mate solution into very slowly varying elements.

In the researches on the lunar theory before De the principal force was taken to be the attraction of th upon the moon, and the disturbing force was that the sun's attraction. When the action of the ear was included the moon would move in an ellipse, in ance with Kepler's law. The effect of the sun could be allowed for by supposing this ellipse to b able and variable. But when it was required to the variation the problem became excessively comp owing to the great number of terms required to the sun's disturbing force. Now instead of pass the elliptic to the disturbed motion by one single step, Delaunay effected the passage by a great num easy steps. Out of several hundred periodic ter sum of which expressed the disturbing force of th he first took one only, and determined the variat the Keplerian ellipse on the supposition that thi was the only one. In the orbit so the variable el of the ellipse would be expressed in terms of six ne stants. He then showed how these new constant be taken as variable instead of the elements of the ellipse. Taking a second term of the disturbing fo expressed the new constants in terms of a third set tant, and so repeated the process until all the te the disturbing force were disposed of.

Among applications of the third or numerical m the most successful yet considered is that of H His first work appeared in 1857 under the title *Mond-Tafeln, oder Tafeln des Mondes* and contained an exposition of his processes and p methods of computation. During the twenty years he devoted a large part of his energies to the m computation of the lunar inequalities, the determ of the elements of motion, and the preparation tables for computing the moon's position. In the branch of the work he received material and fr British Government which published his tables, c completion in 1872. The computations of Hans published one seven years later by the Saxon Society of Sciences.

It is interesting to compare the results of Hans Delaunay that there are some outstanding discrep which, though too small to be of great practical impo are of sufficient magnitude to demand the atten those interested in the mathematical theory of the It is therefore desirable that the numerical ineq should be again determined by another entirely different This is the object of Sir G. B. Airy's *Numerical Theory*, which is not yet completely published, sufficiently far advanced to give hopes of an early tion. The essence of Sir George's method con

with a provisional approximate solution (that of
ay be ing accepted for the purpose), and substituting
ec tions for the moon's coordinates in the fundi-
differential equations of the moon's motion a dis-
by the sun. If the theory were perfect, the two
each equation would come out equal. As they
ome out exactly equal, Sir George put the problem
hem. What corrections must be applied to the
ons for the coordinates that the two sides may be
qual? He then shows how these corrections may
d by solving a system of equations.

ve al methods which we have described have for their
the determination of the motion of the moon
under the influence of the combined attraction
f sun. In other words, the question is that of
dated "problem of three bodies" in the special
the bodies, the sun has a much greater mass than
of the moon, and at a much greater distance from them than
from each other. All methods lead to a solution of the
eral t a which we shall now describe. Let us put m for the
mass of the moon, m' of the sun, n for the moon's mean
angular velocity, n' for the sun's mean angular velocity
from the earth, a for the moon's mean distance from the earth,
a' for the sun's mean distance from the earth, e for the
eccentricity of the moon's orbit, e' for the eccentricity of the
earth's orbit, γ for the inclination of the moon's orbit to the
ecliptic. When no account is taken of the
the moon moves round the earth in an ellipse, and
in such a manner that the radius vector drawn from the earth
describes areas proportional to the times. In order
the moon's motion from this simple elliptic motion, we must
the moon's position in its orbit at any time, and the
whose nodes and perigee are at rest. All the other ele
of the orbit, viz. its eccentricity, and
duly constant, because the
other disturbing forces
to the actual motion of
the ellipse, which may
ner each term of which
form

can be determined or literally expressed in the expansion
are the
Mean anomaly must be both reckoned in
same longitude and parallax for the same epoch and
and at the same we had have term of the form

$$\quad \quad \quad \

most difficult and intricate of celestial mechanics, and no satisfactory general method of attacking it has yet been found. The causes of difficulty are two in number. First, the disturbing force of the planets is modified by that of the sun in such a way that the ordinary equations of disturbed elliptic motion are no longer rigorous, and hence new and more complicated ones must be constructed. And, secondly, the combination of the four bodies, earth, sun and planet lead to terms of a nature such that it has hardly been found possible to calculate them. The question has, indeed, been raised whether the rotation of the moon on its axis, and hence the unit of time, may not be subject to small irregular changes of a nature to produce apparent cosmical changes in the motion of the moon. But it has recently been found, from a discussion of the observations of Mercury in 1677, that, although such inequalities may exist, they cannot be of a magnitude necessary to account for the observed [illegible] period in the moon's motion.

The following is a summary of the present state of the lunar theory. (1) The inequalities or corrections due to the direct action on the moon may be regarded as quite satisfactory, at least when Hansen's method has been followed. (2) The secular variations by the same method. (3) The analytical theory need not be considered by finding some remedy for the slow convergence of the series by which it is expressed, but a numerical treatment may be found more satisfactory. (4) The perturbations of the planets on the moon, which method is [illegible] to be tried. With these the theory [illegible] to.

MOORCROFT, William (c. 1770–1825), traveller in Asia, was born in Lancashire about 1770. He was educated as a surgeon in Liverpool, but on completing his studies he resolved to devote himself to veterinary surgery. After studying the subject in France, he began it practice in London. In 1795 he published a pamphlet of directions for the medical treatment of horses, with special reference to glanders, and in 1800 a *Cursory Account on the Methods of Curing Horses*. Having been offered by the East India Company the inspectorship of their Bengal stud, Moorcroft left England for India in 1808. Under his care the stud was greatly improved; in order to perfect the breed, he resolved to undertake a journey into Central Asia to obtain a stock of Turkoman horses. In company with Captain William Gray, and encumbered with a stock of merchandise for the purpose of establishing trade relations between India and Central Asia, Moorcroft left Josmath, well within the Himalayas, on 26th May 1812. Proceeding along the valley of the Dauli, they reached the summit of the frontier pass of Niti on 1st July. Descending by the towns of Dabalí and Shortope, Moorcroft struck the main upper branch of the Sutlej near its source, and on 5th August arrived at the sacred lake of Manasarowara. Returning by Bhutan, he was detained some time by the Gurkhas, and reached Almorah in November. This journey only served to whet Moorcroft's appetite for more extensive travel, for which he prepared the way by sending out a young Hindustani, who succeeded in making very extensive explorations. In company with this young man and George Trebeck, Moorcroft set out on his second journey in October 1819. His enterprise was looked upon rather coldly by the directors, who merely allowed him his pay for a time, all the expenses being borne by Moorcroft himself. By way of Almorah and Ladakh, Lahore was reached on 6th May 1820. On 14th August the source of the Byash (Hyphasis) was discovered, and subsequently that of the Chenab. Leh, the capital of Ladak, was reached on 24th September, and here several months were spent in exploring the surrounding country. A commercial treaty was concluded with the Governor of Ladák, by which the whole of Central Asia was virtually opened to British trade. Kashmir was reached on 3rd November 1822, and by the Pir Panjal mountains to Rajáwárí on 4th June 1824, Cabul on 20th June, and by Khulm, Kunduz, and Balkh Moorcroft arrived at Bokhara on 27th February 1825. Everywhere he bought horses for the company, and endeavoured to establish friendly relations. At Andkho in Cabul Moorcroft was attacked with fever, of which he died on 27th August 1825, Trebeck surviving him only a few days. It was not till several years afterwards that his papers were obtained by the Royal Asiatic Society, and published under the editorship of Horace Hayman Wilson in 1841 under the title of *Travels in the Himalayan Provinces of Hindustan and the Punjab; in Ladakh and Kashmir, in Peshawar, Kabul Kunduz, and Bokhara, from 1819 to 1825*. Though published after the traveller's death, the narrative was a valuable contribution to a knowledge of Central Asia, and remains a classic. Its value as *Asiatic Researches* has been fully recognised by Moorcroft of his last journey in the *Transactions of the Royal Asiatic Society*, vol. i., a paper on the Punjab sheep.

MOORE, Edward (1712?–1757), miscellaneous poet, dramatist and fable-writer, was the son of a chandler and tea-dealer of Aberdeen, where he was born in 1712. He was the author of the thrilling domestic tragedy of *The Gamester*, originally produced in 1753 with Garrick in the leading character, and still in the repertory of acting plays.

Despite the strong [illegible] on contemporary [illegible] from stage or pulpit. The literary merit of the play is great, but it is powerfully constructed and full of impressive incident, and the career of Beverley the gambler is modelled on Fielding's Captain Booth and affords great scope for the actor. Moore also wrote two comedies. *The Foundling* (1748), which he produced clever imitations of Gay and Gray's Ballad Opera, with the assistance of Lyttelton, Chesterfield, and Walpole conducted *The World* (1753–56), a periodical during the decade of the revival of periodical essay writing. *The World* followed Johnson's *Rambler* and was followed by *The Connoisseur*, which had a rival *The Idler* and *The Connoisseur* [illegible] died at London on 1st March 1757.

MOORE, Sir John (1761–1809), born at Stirling in 1761, was one of the most prominent writers of novels and romances in the latter part of the 18th century. His novel *Zeluco*, published in 1789, produced a powerful impression at the time, and might even through the poetry of Byron, have an abiding influence on literature. The novel would nowadays be called a psychological novel. It is a study of the motives of a moral monstrosity, the selfishness and unprincipled profligate. It is full of incident, and is never pronounced into tedious reflection, but allowed to intercept the progress of the story, which [illegible] main plot is connected with many interesting episodes. The character took a great hold of Byron's imagination, and probably influenced the latter in some of its many aspects as well as his poetry. It is not too much to say that the common opinion that Byron intended *Childe Harold* to be [illegible] cannot be cleared of its large element of falsehood without a study of Moore's *Zeluco*. Moore seems to have intended the Childe to be a poetical Zeluco, and the most striking features of the portrait were undoubtedly taken from that character. At the same time it is obvious to everybody acquainted with Moore and Byron that the moody and impressive [illegible] of the character of Zeluco, fascinated him. He felt himself to be a Zeluco, although he was at [illegible] very different man. Moore's other work [illegible] marked individuality, but his sketches of society as he saw it in France, Germany, Switzerland, Italy, and Holland furnish valuable materials for the social history of his countrymen Burnett and Boswell. He was a shrewd, penetrating, and in the main unprejudiced observer, with something of a natural historian's interest in the [illegible] species, and he had exceptional opportunities of obser-

as a doctor by profession, and the son of a Stirling clergyman. After taking his medical degree at ow, he served with the army in Flanders, then was ed to the household of the English ambassador at . Here practised for five years in Glasgow, next led on the Continent for five years with a young ere, called for some years as a physician in Lon e accompanied Lord Lauderdale to Paris in 179? and d some of the principal scenes of the Revolution. e of them came under his observation, while his pro pre served him in an unusual degree from flippant His work attest great shrewdness and sagacity of ent, and how no small skill in literary presentation. ed at London in 1802

OORE, Sir John (1761-1809), the only English al who has gained lasting fame by the conduct of a t, was the son of Dr Moore (the subject of the pre notice), and was born at Glasgow on 13th November It was by appointment a tutor to the young duke amilton which procured for John Moore educational tages by which he profited so much as to be called r life the most cultivated officer in the army. It hen the fashion for young noblemen to travel from to court, and Moore accompanied his pupil and the to all the chief capitals in Europe, until he was ly ordered in 1777 to join the 51st regiment, in he had been appointed an ensign. He learned his t Minorca, and in 1779 was appointed lieutenant and ter in a new regiment recently raised by the duke n Gordon, with which he served in America till the pe of 1783. In 1784 Moore, though but twenty-three year was returned to the duke of Hamilton's member Parliament for the united borough of Selkirk, Peebles, Lanarkshire. In parliament he does not seem to have d his mouth, though he always voted with the Govern t but he made many influential friends, notably the duke k and Pitt. In 1786 he was promoted to a majority 51st regiment, and in 1787 he became lieutenant Ireland to expend his time in performing. He soon got gnment to his order, and in 1792 sailed with it to Gibraltar. He was too late to assist at Toulon, engaged thence in the operations in Corsica, and ably distinguished himself at the taking of Calvi the expulsion of the French. Moore became very in with Paoli and many of the leading Corsican patriots, rimacy was so obnoxious to Sir Gilbert Elliot, the y, that Moore was ordered to leave the island in forty hours. Sir Gilbert's hasty conduct by no means met approval in London, and Moore was gazetted both a ner'al, and ordered to proceed with his brigade to t Toulon. In April 1796 he reached Barbadoes, ere became the right hand of Sir Ralph Aber the commander-in-chief. The first enterprise was quest of the island of St Lucia, which was com ished by an agent of Victor Hugues with a force of Caribs, negroes, and Frenchmen. The key e was carried, and about impregnable height the Morne Fortune, which was at last stormed, though ere it fell, by the valour of brigadier-generals Moore ope, who was to be commended on not yet more memor held. After the success, Sir Ralph left the island, ppointed Moore governor and commander-in-chief fficult post he found his government, owing to the of Caribs and negroes in the woods; but just as on the point of triumphing he fell ill of yellow fever, s ordered home. In 1798 he was well and again to be on active service, and he accompanied his friend ombe over to Ireland, where he received the com of the Bandon district. In the Irish rebellion of he distinguished himself by his activity in saving Wexford from destruction after the battle of Vinegar H His services were in universal request, and Abercrom insisted upon his serving with him in the expedition to Holder in 1799, where he did creditably all that was cred ably done in that ill-managed expedition. On his ret from Holland he was made colonel of the 52d regime and in 1800 accompanied Abercromby to the Mediterran as major-general.

Throughout the Egyptian expedition he commanded reserve, and especially distinguished himself at the bat of Alexandria, when he was wounded in three places, a behaved with such distinction that he was recognized u verally as the greatest English general, now that Ab cromby was gone. The short interval of the peace Amiens did not injure Moore's prospects, and in 1803 was appointed commandant of the camp at Shorncli Here he proved his greatness as an organizer, for it at this time that he organized those light regiments wh were to form the reserve in his own campaign and light division in the Peninsular War. While at Shornel he renewed his intimacy with Pitt, who was then resid at Walmer Castle and who on his return to office ma Moore a knight of the Bath, and consulted him on ev military project. Fox, when he succeeded to office, show the same appreciation of Moore, and in May 1806 appoin him second-in-command to his brother, General Fox, w was ordered with a strong force to Sicily to supersede John Stuart. Moore won but little credit at this time, there was none to gain, but employed his time, accord to Napier, in falling in love with Miss Fox, to whe however, he never proposed, because to be accepted for position and not for himself. In 1807 he was able to esc from the intrigues of the Sicilian court, and was orde to Portugal, which he reached too late to make any defe of Lisbon, already in the possession of the French. then went home, and had four months' rest, the last ever had. In May 1808 he was ordered with a force 13,000 men to Sweden to assist the king against the un forces of France and Russia. The mad conduct of Swedish king, however, who even went so far as to deel Sir John Moore under arrest when he refused to acquie in his plans, ruined any chance of successful co-operati and the French general made his escape and returned England. He was at once ordered to proceed with division to Portugal, where Sir Arthur Wellesley h already landed, but the appointment of Dalrymple a Burrard to the chief command was even more of a slig on Moore as a general of European experience than Wellesley, whose laurels had hitherto been won in Ind He regarded himself as personally insulted by the ministe and especially by Lord Castlereagh, but deemed it his du to go where he was ordered. He met his reward; for wh after the excitement caused by the Convention of Cint Dalrymple and Burrard went home, he was left in co mand of the largest English army since the commencem of the war. Wellesley had appreciated him, and in interesting letter (published in the *Wellington Despatch* had expressed his desire to use his own great politi influence to reconcile him to the ministers and the minist to him.

Now began the glorious three months on which Moor reputation as a soldier and a statesman must rest. T Spaniards, flushed with their former success at Bayl recalled Napoleon, who had in person crossed the Pyrene as another Dupont, and loudly summoned Moore to a sh in their coming victories. Moore knew better what w the value of Napoleon's genius, but he had been command to assist the Spaniards, and therefore gave the order advance. His army marched in four distinct divisio and on 13th November 1808 he concentrated at Sa

manca, where he waited to see what would happen. He heard that a subsidiary force under Sir David Baird had arrived at Coruña, and ordered it up to join him. At Salamanca he remained a whole month watching the triumphant successes of Napoleon and his lieutenants, and learning how little Spanish reports or Spanish valour were to be relied on. Though irritated by the menaces and abuse of Frere, the English minister to the junta, he waited till the 13th December, hearing duly of Spanish defeats, and then he determined to draw off upon his own small force the weight of Napoleon's power, and thus give Andalusia the winter in which to organize an army and prepare for another Bayler. With this intention he advanced through Toro and Mayorga, where Baird joined him, to Sahagun. He judged rightly that Napoleon would never advance into Andalusia and leave the English behind him, but that he would turn all his power against them. Having once drawn Napoleon's attention to himself, he began his famous retreat and fell back quickly, fighting every day and resolutely with success. He now could test the military spirit he had tried to form at Shorncliffe, for the reserve under Sir Edward Paget consisted entirely of his own light regiments. To detail each step of the retreat and every skirmish would be but to rewrite Napier; suffice it to say that, with great loss of life and material, Moore reached Coruña on 12th January 1809. But the fleet to take the army home was not there, and the English would have to fight Soult, whose army was even more weakened and demoralized than Moore's, before they could embark. It was on 16th January that Moore fought his last battle; he fell early in the day, and knew at once that his wound was mortal. His last hours were cheered with the knowledge of victory, but were spent in recommending his old friends, such as Graham and Colborne, to the notice of the Government. Sir H. Harding's description of the scene is in its way inimitable, and in it must be studied how a modern Bayard should die in battle, every thought being for others, none for himself.

It may be possible in the face of his heroic death to exaggerate Moore's actual military services, but his influence on the British army cannot be overrated. The true military spirit of discipline and of valour, both in officers and men, had become nearly extinct during the American war. Abercrombie, who looked back to the traditions of Minden, was the first to attempt to revive it, and his work was carried on by Moore. The formation of the light regiments at Shorncliffe was [illegible] new French tactics, and it was left to Wellington to show the success of the experiment. Moore's powers as a statesman are shown in his despatches written at Salamanca, and he had the truest gift of a great man, that of judging men. It may be noticed that, while Wellington perpetually grumbled at the bad qualities of his officers and formed no school, Moore's name is associated with the career of all who made their mark. Among generals, Hope, Graham, Sir F. Paget, Hill, and Craufurd, all felt and submitted to his ascendency, and of younger officers it was ever the proud boast of the Napiers, Colborne, the Beckwiths, and Barnard that they were the pupils of Moore, not of Wellington. Nay more, he inspired an historian. The description of Moore's retreat in Napier is perhaps the finest piece of military history in the English language, not only because the author was present, but because his heart was with the leader of that retreat, and, if Napier felt towards Wellington as the soldiers of the fourth legion felt towards Cæsar, he felt towards Moore the personal love and devotion of a cavalier towards Montrose.

The great authority for Moore's life is the *[illegible]* by his brother, J. C. Moore (1873); see also *Narrative of the operations of Sir John Moore in Spain*, by his brother, J. C. Moore (1809, with plans 1809), Napier's *Peninsular War*, Bk. iv., and his *Life of Sir Charles Napier*. For various references to Moore's retreat, see Charmilly, *Narrative* (1810), and Sir Lewis Tonyn, *Life of the Rt. Hon. J. H. Frere* (published anonymously by his widow). Consult also Wilson, *Campaign in Egypt*, for Moore's services there, and the *Life of Gilbert Elliot, First Lord Minto*, for the squabble in [illegible] (H. M. S.)

MOORE, THOMAS (1779–1852), born at Dublin on 28th May 1779, fairly shares with Lord Byron the honour of being the most popular poet of his generation. Whatever may be thought now of the intrinsic qualities of his verse, this much cannot be denied. The most trustworthy of all measures of popularity is the price put upon a writer's work in the publishing market, and when Moore's friend in negotiating the sale of the unwritten *Lalla* claimed for the poet the highest price that had up time been paid for a poem the publisher at once a Moore was then in the heyday of his reputation, but years later publishers were still willing to risk the sands on his promise to produce. Much of Moore's was due to his personal charm. Thus at least ga the start on his road to popularity. There is not extraordinary incident in the history of our literatu the *in tantamount* sense with which the son of a Dublin grocer just out of his teens, on his first London, captivated the fashionable world and est himself in the course of a few months a coveted favourite. The youth once called at St George Channel to keep terms at the Middle Temple, carrying with [illegible] manuscript of *Odes and Epistles*, which he w published by subscription in a very short time crucified but the fashionable world, among [illegible] had also secured the personal patronage of the prince o to dedicate the work to him. The money proved [illegible] collected and the dedicatory verse would not also enabled the poet to visit his native [illegible] Moore [illegible] were of the most fortunate kind. He charmed all w met, and [illegible] he was not a precocious, with nothing more than such bright sayings own age. The prince and not the boy, was [illegible] mind, but he came nearer than anybody else in time to be hoped Percy Bysshe Shelley [illegible] To find a parallel to him we must look back to the pal of Provençal song, *[illegible]* and *jong* Arnaud Daniel and Bertran, whose varied po entertainment made them welcome guests wherev went. It was not merely the fashionable world young adventurer captivated. The landlady of his [illegible] in London, a country woman of his own, offered to his disposal all the money of which he had the co

The fragment of autobiography in which Moore a deftly coloured picture of his early life in Dublin into the secret of the coming miracle of [illegible] que. Last rival against the claim of his social s ties in Little Ormond Street had much in comm the streets to which he was introduced in Londo was born in the proscribed sect of Catholics, who, apart from the [illegible] society of the Castle produced a clo among their numbers [illegible] and those, from the fir was no danger to the more talented parents of ge country. It was upon the whole a gay life in Catholic though the conspiracy of the United Irishmen w quietly formed beneath the surface. Amateur th was one of their favourite diversions, and gifts of and singing were not likely to die for want of a Moore's schoolmaster was a leader in the entertai a writer of pleasant [illegible] and incidenta and favourite age to be. Thomas Moore was o how busy, evidently encouraged all his exercises, l affection for mother at home. Before he left s had acquired fame in his own circle as a song wr had [illegible] in the *Anthologia Hibernica*, ve Zoël on love. The was in 1793. In that year the pr against Catholic entering Trinity College was and next year Moore took advantage of the new A score of the first Catholic entrants, he had an ex stimulus to work, and there industriously acqui classical scholarship with which he won the he learned Whigs as Lansdowne and Holland, w charmed fashionable ladies with the grace of hi Young Moore's social atmosphere was, of cours charged with patriotism and hatred of the ex

de pote to Some of his closest friends in Trinity
ep in the on policy of 1798. But even for his
-m a costume position which he never sought to
Moore found plenty of sympathy among the
olitical leaders, when he made their acquaintance in
year of the century.
e was hardly established in London society in the
t of the century, and from that time the keynote of
r life was the ruling passion of his life and its
nt the standard of his work. In his letter to his
which are delightful prose here and how the
ming side of Moore's character he wrote to his
ds and with warm affection in his latest week
him, even in 1806, declaring himself interested
ocle s and pamphlets and protesting his
at any moment to exchange all his fame for
new and solid wish. But he never did make the
e even for more potent attractions than the fame
wealth. He could not bear the thought of being buried
a honorable drawing room without uneasy longings
unity and ease, the beauty, the society, the bright
to be stable life wholly devoted to poetry and ol
ndations. When he met and courted the company
ance s and to be sure good people swept at their
was too ti id to affect indifference, he was in the
between delight and dread home to record the
t to his relatives or that not to posterity in his
. It produced what pert that he was fritter me away
ne and do nothing. In every letter he betrayed how
at in conduct was more highly worthy of a good
become that to get a lucrative appointment from
ntal legend he must keep himself in evidence
et to make his own self be noticed as the man that
s own verses. But he proved wholly incapable not
rtled either with settled care or with other pur
He lived in the happy present and he liked
able company for its own sake and no wonder
how he was petted and feted, and asked for sweets
that great men never seem to grow out of and
se whom they make the companions of their epicurean
n in Moore's mind. It was seemed to connect his
own case. Through Lord Moira's influence he was
ed secretary of the admiralty court in Bermuda in
He went there to take possession, but soon on five
of West Indian society, pleasure parties and
beauty-bound romances excite, and he appointed a
and returned to London, after little more than a
by his habit of omnivorous reading in Trinity Col
library. Throughout his literary life he retained this ha
of out of the way reading and clever display of it. Mo
had really abundance of miscellaneous scholarship as
a great quickness in the anabogical application of
knowledge, and, though he made sad havoc of quanti
when he tried to write in Greek, there was probably
scholar of his time who would have surpassed him in
interpretation of a difficult passage. He seems to h
spent a great deal of time in the libraries of the g
houses that he frequented, Monta, Lansdowne, and Holl
were all zealously rare and book collectors. It might
a fool. What bad "pronouncing, warmest child," whose, "c
book were women-books," to do with obscure medi
grammarians, the doctors, and commentators? Bu
would seem that Moore took the hint for many of
lyrics from books and knowing the great wealth of ta
among mediæval Latinists, turned often to them as h
quarter to which to look for one happy word play or im
that might serve as a stave for his own. He pu
of course, were concerned with the product and not w
the process of manufacture and "Little's Songs" a
became the rage in every drawing room. He found
scenes in Virginia when he landed there on his way
Bermuda. And not only were his songs sung but
poems were read, passing rapidly through many editi
The bulk of them were simple lyrics, gracefully flue
and sometimes wittily conceited, the lyrist-model b
the amatory poets of the Fifth century from Ca
to Rochester, Carew, the only eminent poet of
century with whom Moore will bear comparison.
he took a pleasure that can be given to his amatory lyri
that he knew his audience wrote directly for them,
placed them more than any of his competitors.
publication of 1806 was savagely reviewed in the *E*
arterly by Jeffrey, who accused him of a deliberate de
to corrupt the mind of innocent maidens with his wa
tunes, and who had in consequence to figure in a ludic
attempt at a duel ludicrous in its circumstances, the
Moore was ferociously in earnest. We may well ac
Moore of the diabolic intention attributed to him,
Jeffrey's criticism of his poetry as poetry was just enou
The only parts of the volume that Jeffrey praised
the satirical epistles. The verses saved in these epi
Moore printed afterwards in his *Corruption, Intoler*
(1808), and *The Sceptic*, a philosophical satire (1809),
a license he kept to the heroic couplet and the ma
of Pope he could not give full scope to his peculiar po
accentuation. It may be remarked in passing that the r
of the hostile meeting with Jeffrey is a striking evid
of the impressiveness of Moore's personality; in the co
of a few minutes' conversation he changed a bitter e
into a lifelong friend. Of all the poetical enterprises
Moore undertook, either at this period or later, none
so exactly suited to his powers as the task proposed to
by the publisher Power of supplying fit words to a colle
of Irish melodies. The first number appeared in 1807
it was so successful that for twenty-seven years afterw
a volume would be issued. It was one of Moore's most re
occupations and his steadiest source of income, Power
ing him an annuity of £500. Six numbers of Irish mel
were published before 1815; then they turned to sa
song and national airs, issuing also four more numbe
Irish melodies before 1834. Moore entered into this
with his best and most practised powers and with al
heart. From his boyhood he had been in training fo
The most characteristic moods of Irish feeling, grave
gay, plaintive and stirring, were embodied in those
and their variety touched the whole range of Moore's
tive spirit, carrying him far beyond the shallows o

rious Anacreontic sentiment, namby pamby when not rient; he wrote with full inspiration, unreserved sty, and thoroughly roused faculty. Divorced from the sic, many of them are insipid enough, but they were er meant to be divorced from the music; the music meant, as Coleridge felt when he heard them sung by poet himself, to twine round them and overtop them the honeysuckle. Moore accomplished this with uisite art. His most conspicuous failure may be ed to his habit of taking a humdrum point not an otional incident but some unromantic intellectual con-. Hence arose intellectual discord upon which and ifectly harmonized tunes, which even the music can dly gloss over.

The recent desertion of the Whigs must for ever cut them from all hope of office for many years to come and ore from his last hope of a more sincere, when Lord rd also was practically withdrawn from them. There was once a marked increase in his literary fertility, and he ke ground in a new field, which he cultivated with emigrate success—political squibwriting. Moore was apable of anything like rancour, but he felt the disappointment of his hopes enough to quicken his fancy and spur the edge of his wit. The prince regent he held nd and patron, who was used to have lavished all Lord ras's appointment for personal favourites, was his ss. The prince's defects and foibles, his fatness, his ge whiskers, his love for artifice and circumstance, for ared dresses and practical jokes, were ridiculed with the nte of clever hands. Moore opened fire in the *Morning ron*, and crowned his success in New Year (1813) with nn volume of "Intercepted Letters, or *The Twopenny Post* ". A very little knowledge of the groups of the time bles us to understand the delight with which Moore's ies were received in the year which witnessed the rcrcommitment of Leigh Hunt for more outspoken attacks the regent. Moore received every encouragement to k the new vein. He was at one time in receipt of egular salary from the *Times*; and his little volumes squibs published at intervals, *The Fudge Family in Paris*, 1818; *The Journal of a Member of the Parliament ately*, 1820; *Fables for the Holy Alliance*, 1823, *Odes Cash, Corn, Catholics, and other Matters*, 1828, *The lges in England*, 1835 went through many editions. prose *Memoirs of Captain Rock* (1824) may be added he list. Moore's only failure was *Tom Crib's Memorial Congress* (1819), for which he had made an elaborate ly of thieves' slang. It was of course on the side of Whigs that Moore employed his pen, and his favourite ies were the system of repression in Ireland and the abilities of the Catholics. He made rather too certain aim for his pasquinades when he spoke of "laying the on the back of the blood and the oppressor. It was exactly a lash or a scourge that he wielded. It was happy, airily malicious ridicule of personal foibles that strength lay; he pricked and teased his victims with rp and tiny arrows. But, right as his hand was, he was ly entitled to the enthusiastic gratitude of his country for his share in effecting Catholic emancipation.

The disappointment of 1812, which diverted Moore's career as a squib-writer, nerved him also to a more ained effort in serious verse than he had before attempted. *Lalla Rookh* would never have been written he author's necessities had not compelled him to work. keep himself at the oar, he contracted with the Longs to supply a metrical romance on an Eastern subject, ch should contain at least as many lines as Scott's *eby*, and for which the publishers bound themselves to three thousand guineas on delivery. The poem was published till May 1817. Moore, as was his habit, made most laborious preparation, reading himself into familiarity with Eastern scenery and manners, retired to a cottage in Derbyshire, near Lord Moira's at Donnington Park, that he might work undisturbed sate from the distractions of London society; "amid the snows of a Derbyshire winter" as he patently elaborated his voluptuous pictures of scented valleys, gorgeous gardens, tents, and and hours of ravishing beauty. The confidence publisher was fully justified. Moore's contemporaries were dazzled and enchanted with *Lalla Rookh*, indeed a wonderful *tour de force*. There was not margin or attraction in it that an ordinary Englishman under could without a load note. He lets humour work the correctness of the local colouring and the manners were circulated of Oriental natives who would not that Moore had never travelled in the East. Moore's success in realising Oriental character thoroughly, of dress and description. If the work an Irish patriot betrayed by an informer, his priestly surrounded Catholic maiden bravely, even rapturously, his Melesanna a melodramatic stage monster, they are richly covered with Oriental trappings their identity is considerably disguised. Of the tale put into the mouth of Feramorz, the "Veiled Prophet the least said is to Moore's credit. Like a carpet merchant, Moore understood the enthusiasm with which Moore's tales were received at "the best that we have had and we even become the boast of Europe with achieved the success, but neither started literature launched but the enterprise could have only extended reputation. He deliberately sacrificed the higher of poetry for accuracy of costume and effect, rhyme and rhythm, and he had his reward. Oriental in the *Lalla Rookh* publishers would hardly be popular than *Lalla Rookh*. The extent of the manufacture was known by the care with attended to successive editions, which were printed from Turk to evade a chorus of imposts which were to impede the flow of the work. Immediately on completion of *Lalla Rookh* Moore obtained his to Sloperton Cottage in Wiltshire, to be near Lansdowne and the library at Bowood, his next project being a life of Sheridan. His plans were interrupted by the emergence of the necessity of his at Bermuda, which he knew already mentioned in avoid arrest for the debt contracted at Paris. He continued till November 1818, when the affair was promised. His friends lamented that the attractive Paris occupied so much of his time; but, though he certain almost daily records of visits to operas and testify to the extent and variety of his social life, was by no means lost. He wrote steadily of quite diverse kinds, he also composed the *Epicurean* and accumulated materials for his prose of the *Epicurean* a vast amount of production considering his love and, must have habits of composition. during the stirring political and social excitement of the years, few men could in the mid-st of literature and although he has left brilliant part in conversation, we can see from a of his diary with his published writings, that his eyes open to fact and written-up which he made his own. The starting of the drawing room much bee as butterfly. On his return to England turned work steadily at his memoir of Sheridan, *Captain Rock* as a *jeu d'esprit* by the way. The S triumphantly dispatched in the autumn of 1825, next important work was the *Life of Byron*.

of this was publi hed early in 1830, and the second ly by the end of the ame year In 1831 he com memoir of Lord Edward Fitzgerald, for which he n collecting material for some time. Moore's hie' call for no comment, except that they were and conscientious pieces of work. He spent ab try in the collection of characteristic anecdotes, ch ir portion in society gave him exceptional arty Hi connexion with the burning of Byron graphy is too complicated a qu tion to be di here Hi own version of the circumstance is hi diary for May 1824.

s a misfortune for the comfort of the la t twenty Moore - life that he allowed himself to be drawn project for writing the "History of Ireland in *s Cyclopaedia*. Scott and Mackintosh dabbled companion volumes on Scotland and England with tle trouble, but Moore had neither their historical nor their despatch in writing. Laborious con n and precision are a fatal combination for who undertake a new kind of task late in life. tory sat like a nightmare on Moore for fifteen nd after all we left unfinished on the melancholy of hi power in 1845. From the time that he d himself with it Moore did very little else, beyond casional ode and song, the last flashes of hu and the *Travels of an Irish Gentleman in Search om*, although he had frequent offers of more e and, it might have been thought, more congenial Moore character had a deeper madder and than he often cut credit for, and his tenacious ce in the last task was probably due to an ible ambition to connect himself as a benefactor hi tory of his country, by opening the eyes of lish people to the mis-government of Ireland. It supplemental altogether, the lighter irony of *Captain* as much more effective than the minute carefully l details of the history. Moore last years were l by the weakness and misconduct of his sons, and untary embarrassments. An annual pension of as conferred upon him in 1835, and he had always l large sums for his work, but, while waiting for ecure which never came, he had contracted an nate habit of drawing upon his publishers in e. After the death of his last child in 1845, Moore a total wreck, but he lingered on till 26th February The diary, which he seems to have kept chiefly ught be the means of making some provision for , and which contains so many touching expressions ffection for her, was edited by Lord John Russell letters and a fragment of autobiography in 1853. he charge of vanity has often been brought against ry from the writer's undue fondness for tokens of pliments paid him by distinguished personages and e embassy. But only vanity that is annoyed by slavish sanctimoniousness. (W. M.)

OOBIIN the large or white-vented bird, often called ben and sometimes Gallinule, is most commonly in England. An earlier name was Moat hen, which propriate in the days when a moat was the ordinary of most considerable houses in the country. It is *Hiaatia chloropus* of ornithologists, and almost too own to need description. About the size of a small hen, but with the body much compressed (as is ith members of the Family *Rallidae*, to which it), its plumage above is of a deep olive brown, so to appear black at a short distance, and beneath

to be confounded with "Moor-cock" or "Moor fowl," names in general use for the Red Grouse (vol. xi. 221).

non-grey, relieved by some white stripes on the fla with the lower tail coverts of pure white, - these last b very conspicuous as the bird swims. A scarlet fron especially bright in the spring of the year, and a red ga on the tibia of the male render him very showy. The often frequenting the neighbourhood of man, the M hen seems unable to overcome the inherent stealthy ha of the *Rallidae*, and hastens to hide itself on the l alarm; but under exceptional circumstances it may induced to feed, yet always suspiciously, with tame du and poultry. It appears to take wing with difficulty, may be often caught by an active dog; but, in realit is capable of sustained flight, its longer excursions b chiefly performed by night, when the peculiar call no utterer is frequently heard as the bird, itself invisibl the darkness, passes overhead. The nest is a mass flags, reeds or other aquatic plants, often arranged much in the manner almost always near the water's edge, whe chamber can be most essentially chosen; but should a mill sluice gate, or boat house afford a favourable site, ad large will be taken of it, and not unfrequently the be of a tree at some height from the ground will furnish place for a cradle. The eggs, from seven to eleven in numb resemble those of the Coot (vol. vi. p. 511), but are sma lighter, and buffier in colour, with spots or blotche reddish brown. In winter, when the inland waters frozen, the majority of Moor hens betake themselve the tidal rivers and many must leave the country enti though a few seem always able to maintain their exist however hard be the frost. The common Moor he extensively spread throughout the Old World, being fo also at the Cape of Good Hope, in India, and in Japan. America is represented by a very closely allied form *galeata*, so called from its rather larger frontal helm, an Australia by another, *G. tenebrosa*, which generally w the white flank markings. Both closely resemble *G. c* ept in general habits, as does also the *G. pyrrhorho* Madagascar, which has the lower tail-coverts buff inste white. Celebes and Amboyna possess a smaller cog species, *G. henicleptes*, with red legs; tropical Africa the smallest of all, *G. angulata*; and some more that h been recognized as distinct are also found in other r or less isolated localities. One of the most remarkab these is the *G. nesiotis* of Tristan da Cunha," which wholly lost the power of flight concomitantly with shortening of its wings and a considerable modificatio its external apparatus, as well as a strengthening of its pe gizzle and legs.[4] A more extreme development in direction appears to be exhibited by the singular *Habro nithe* of Jilolo,[5] and to some extent by the *Pareudr rallina* of Samoa, but at present little is known of eit or other form, such as the common *Gallinula* (*Eryt phoenicura*, and *Gallinula cristata* of India, as well as South American species placed in the genus *Porphyr* there is not room to speak; but mention should be m of the remarkable Australian genus *Tribonyx*, contai three species,[6] which seem to be more terrestrial aquatic in their haunts and habits.

Allied to all these is the genus *Porphyrio*, including bird so named by classical writers, and perhaps a d other species often called Sultanas and Purple W hens, for they all have a plumage of deep blue, becoming violet, green, or black in parts, but preser the white lower tail-coverts, so generally character

[1] *Proc. Zool. Society*, 1861, p. 260, pl. xxx.

[2] A somewhat intermediate form seems to be presented by Moor-hen of the island of St. Denis, to the north of Madagascar (*Zool. Society*, 1867, p. 1036), hitherto undescribed.

[3] *Op. cit.*, 1860, p. 365, pl. clxxii.

[4] *Op. cit.*, 1871, p. 25, pl. ii.

[5] *Ann. Nat. History*, ser. 3, xx. p. 123.

group; and their beauty is enhanced by their scarlet nd legs. Two, *P. albus* of the Ethiopian Region and South-American *P. paradisea*, are of small size. Of the r species, *P. cristatus* is the "Porphyrio" of the an s, and inhabits certain localities on both sides of the terranean, while the rest are widely dispersed within ropics, and even beyond them, as in Australia and Zealand. But this last country has produced a more gerated form, *Notornis*, which has an interesting and aps unique history. First described from a total skull rof. Owen,[1] and then thought to be extinct, an example soon after taken alive," the skin of which (with that feather procured like the first by Mr Walter Mantell) be seen in the British Museum. Other bird-remains from time to time noted by Prof. Owen,[2] but it began feared that the bird had ceased to exist,[3] until a third ple was taken about the year 1879 the skin and most ne bones of which, after undergone examination in Zealand by Dr Buller and Prof. T. J. Parker,[4] found way to the museum of Dresden, where Dr A. B. Meyer vered the recent remains to not the fossil, and while keeping for the latter the name *antalli* gives the former that of *N. hochstetteri*. What s to have been a third species of *Notornis* formerly bited Lord Howe's Island, but is now extinct (see s, vol. iii. p. 732, note). Whether the genus *Aptornis*, ich Prof. Owen has described the remains from New nd, was most nearly allied to *Notornis* and *Porphyrio* ot here be decided. Prof. T. J. Parker (*loc. cit.*) con- s it a "development by degeneration of an ocydromine" (see OCYDROME). (A. N.)

OOSE. See DEER, vol. vii. p. 21.

ORADABAD. See MURADABAD.

ORAL PHILOSOPHY. See ETHICS, vol. viii. p. 574.

ORATIN, LEANDRO FERNANDEZ DE (1760–1828), rish dramatist and poet, was the son of N. F. Moratin noned below, and was born at Madrid on 10th March . His poetical and artistic tastes were early deve l, but his father, keenly alive to the difficulties of the ry calling, caused him to be apprenticed to a jeweller. he age of eighteen Moratin surprised friends by ing the second prize of the Academy for a heroic poem e conquest of Granada, and two years afterwards he eted still more general attention by a similar suc s *Lección Poética*, a satire upon the popular poets of lay. Through Jovellanos he was now appointed secre- to Cabarrus on his special mission to France in 1787, during his stay there he diligently improved his oppor ies of becoming acquainted with the contemporary ch drama, and of cultivating the acquaintance of men tters. Of the literary friendships he then formed the important was that with Goldoni, indeed, Moratin uch more correctly styled "the Spanish Goldoni" than Spanish Molière." On his return to Spain Florida ca presented him to a sinecure benefice in the diocese Burgos; and in 1790 his first play, *El Viejo y la* (The Old Husband and the Young Wife), a highly ned but somewhat dreary verse comedy in three acts- en in 1786, but delayed by objections of the actors, was at length produced at the Teatro del Principe success was only moderate. *El Café* or *La Comedia* on the other hand, given at the same theatre two afterwards, at once became deservedly popular, and considerable influence in modifying the public taste is a short prose comedy in two acts, avowedly int to expose the follies and absurdities of the contemp dramatists of the school of Lope de Vega, and to secu commanded the support of the moderns, and it is still with pleasure for the simple ingenuity of its plot, the liveliness of its and the easy grace of its style to the student of literature it throws much useful li the contemporary state of the Spanish drama, and o reforming aims of the author and his party. In the year (1792) Floridablanca was disgraced, but M at once found another patron in Godoy, who provide with a pension and the means for foreign travel. He a rapidly passed through France into England, where he the free and somewhat incorrect translation of *A* which was printed in 1798, but which has never been formed. From England he proceeded to the Low Cou Germany, Switzerland, and Italy, and on his return Pyrenees in 1796 he received a lucrative post at the P Office. His next appearance in the dramatic field not take until 1803, when *El Barón* was first publicly exhibi its present form. It never fully weathered a determ attempt to damn it, and still keeps the stage. It followed in 1804 by *La Mojigata* ("The Female ente"), of which imperfect manuscript copies had to circulate as early as 1791. It was favourably re as on the whole it deserved to be by a public whic now at one with the author as to the canons of hig an attempt to suppress it by means of the Inquisit alleged religious grounds (*La Mojigata* being an imit a somewhat feeble one, of Molière's *Tartuffe*) was fully frustrated. Moratin's last and crowning triumph the department of original comedy was achieved in when *El Sí de las Niñas* ("The Girl's Yes") was perf night after night to crowded houses, ran through s Spanish edition in a few years, and was soon trans into several foreign languages. In 1808, on the fall o Prince of the Peace, Moratin found it necessary to Spain, but shortly afterwards he returned and con to accept the office of librarian under Joseph partook of that step, which, as the event proved, perma alienated from him the sympathies of his country compelled him to spend almost all the rest of his exile. In 1812 in *Lucas del Campo*, *Hartos*, a trans and adaptation, to the more dignified and stately S standard of Molière's *Les Précieuses*, was produc Madrid, and in 1813 *El Médico a Palos* (from *Le M Malade*) at Barcelona. From 1814 to 1828 M lived in France, principally at Paris, and devoted h to the preparation of a planned work on the history Spanish drama (*Orígenes del Teatro Español*), which tantalizingly topsheet of the period of Lope de Vega died at Paris on 21st June 1828.

[illegible] of his *Obras sueltas* in the ye published at Paris in 2 vols. The best as well as most [illegible] comparatively little more t [illegible] by the Royal Academy of the Italian Cont [illegible] edition of the works is that published by the Spanish A of History, in four vols. at Madrid in 1830–31, as vol. of [illegible] *Autores Españoles*.

MORATIN, NICOLÁS FERNÁNDEZ DE (1737– Spanish poet, was descended from an old Biscayan and was born at Madrid in 1737. He was educa the Jesuit college in Calatayud, and afterwards s law at the university of Valladolid. He then rece appointment in the service of Queen Elizabeth, the of Philip V., which enabled him to see much of the

[1] *Proc. Zool. Society*, 1848, p. 7, *Trans.*, iii. p. 59, pl. [illegible]

[2] *Proc.*, 1850, pp. 209-214, pl. xxi., *Trans.*, ix. pp. 69-71, pl.

[3] Thus the leg-bones and what appeared to be the sternum were bed and figured by him (*Trans.*, iv. pp. 12, 13, pl. [illegible]); the pelvis and another femur (viii. pp. 369, 375, pls. xlvi. xlvii.); the supposed sternum subsequently proved not to be that of *nus*, and Professor Owen's attention being called to the fact he ed the error (*Proc.*, 1882, p. 689) which he had previously "inclined to believe" (*Trans.*, viii. p. 120) he had made. Notwithstanding the evidence, which it must be allowed pre l some incongruities, offered by Mr Mackay (*Ibis*, 1867, p. 141, *Trans. N. Zeal. Inst.*, xiv. pp. 238-258.

me statesmen, poets, and men of letters; and
ely he became the leading spirit of the club of
men which frequented the Fonda de San Sebastian
luded Ayala, Cadahalso, Iriarte, Conti, and others.
2 he left the court, and was called to the bar; four
terwards he succeeded Ayala in the chair of poetry
Imperial College. He died on 11th May 1780.
e became at an early period of his life a convert to the
of those who, such as Montiano and others, were attempt
to the native romantic drama from the Spanish stage and
literary efforts were devoted to the cause of the atrical
In 1762 he published three small pamphlets, entitled
ro al Teatro Español. The Truth told about the Spanish
which he severely criticized the old drama generally, and
ly the still flourishing "autos sacramentales." They were
cessful that the exhibition of "autos sacramentales" was
ed by royal edict three years afterwards (June 1765). In
also published a play entitled *La Petimetra*, the Petite
s, or Female Fribble, the earliest Spanish comedy
vowedly on French model. He was preceded by Ignacio
which Lope de Vega and Calderon never were ambitious
Neither the *Pensativa*, however, nor the *Lucrecia*, an
tragedy in imitation of Seneca's manner, but with the conventional
French stage ever claimed the honour of a public repre
Two subsequent tragedies, *Hormesinda* (1770) and
el Inca (1777), were exhibited with partial success. In
1781 he published a collection of short prose essays, chiefly lyrical,
a title of *El Pensador*, and in 1782 a short didactic poem on
Obligaciones del Hombre. His *Sepelio* (a burlesque on the
ion of his ships by Cortes), *Los Nombres de Cristo*, *La Gruta*,
Salud, without success, for a prize offered by the Academy in
not published until after his death (1781). His poetry
ised by Ticknor as "the noblest poetry of Spain produced
during the 18th century," is now remembered chiefly
on account of its personal allusions. A volume of *Obras Póstumas*, with a life, was published
lona in 1821, and reprinted at London in 1826. See also
ndo de Cádiz Española, vol. ii. 1846.

MORAVIA (in German MÄHREN), a margravate and
and in the Cisleithan part of the Austrian Hungarian
lies between 15° 5′ and 18° 15′ E. long., and 48°
50′ 10″ N. lat. Its superficial extent is about
quare miles. Physically Moravia may be described
ountainous plateau, sloping from north to south, and
d on three sides by mountain ranges of considerable
ht. On the north it is separated from Austrian and
n Silesia by the Sudetes, which attain a height of
et in the Altvater or Schneeberg, and sink gradually
s the west, where the valley of the Oder forms a break
n the German mountains and the Carpathians. The
e the dividing range between Moravia and Hungary,
ho te an average height of 3000 to 4000 feet. On
t are the so-called Bohemian Moravian mountains,
g the elevated east margin of Bohemia and descend
terraces, but without clearly-defined ridges, to the
arch. Branches of these different ranges intersect
ole country, making the surface very irregular,
towards the south, where it consists of fertile and
e plains. Owing to this configuration of the soil
mate varies more than might be expected in so small
a so that, while the vine and maize are cultivated
ely on the southern plains, the weather in the
ainous districts is somewhat rigorous. The mean
temperature at Brünn is 48° Fahr. The harvest
he mountainous portion of Moravia is about five weeks later than
the south. Almost the whole of Moravia belongs
a-in of the March or Morava, from which it derives
e, and which, after traversing the entire length of
ntry in a course of 140 miles and receiving
ts tributaries (Thaya, Hanna, &c.), enters the Danube
Pressburg. The Oder rises among the mountains
north-east of Moravia, but soon turns to the north
s the country. With the exception of a stretch of
ch, none of the rivers are navigable. Moravia is
e of lakes, but contains numerous large ponds.
re also several mineral springs.

Nearly 97 per cent. of the soil of Moravia is produ
arable land occupying 53, gardens and meadows
pasturage 9, and forests 26 per cent. of the total.
one of the chief corn growing regions of the Austrian e
and also produces excellent hemp, flax, potatoes, veget
and fruit. The following table shows the amount
chief crops in 1881 :—

Wheat	154,480 qrs.	Leguminous crops	27,8
Rye	1,242,480 „	Beet (for sugar)	11,533,3
Barley	981,190 „	Flax	47,1
Oat	1,197,150 „	Hemp	6,2
Maize	48,100 „	Fruit	1,106,5
Potatoes	1,271,800 cwt.	Wine	2,869,4

Large quantities of hay and other fodder, besides
clover, teasel, madder, fennel, &c., are also raised. The
on the slopes of the Sudetes produce abundance of exc
timber. The live stock of Moravia in 1880 consis
122,858 horses, 677,807 cattle, 158,852 sheep, 20
swine, and 116,880 goats. The breed of sheep
Carpathians is of an improved quality, and the horse
in the fertile plains of the Hanna are highly este
Geese and poultry are also reared. In 1880 Moravi
tained 83,140 beehives, and the produce of wax and
may be estimated at 3500 to 4000 cwts.

The mineral wealth of Moravia, consisting chie
coal and iron, is very considerable. In 1881 the pr
included 392,625 tons of anthracite coal, 50,665 t
lignite, 5700 tons of iron ore, 1713 tons of graphit
smaller quantities of alum, potter's clay, and roofing
The mines give employment to 4500 persons, an
annual value of the raw minerals produced is
£370,000. The amount of raw and cast iron pro
by the ironworks and foundries in 1880 was 40,000
and the value about £320,000.

In point of industry Moravia belongs to the fo
provinces of the empire. The principal manufa
are woollen, cotton, linen, and cast iron goods, beet-
leather, and brandy. Its woollen cloths and flanne
manufacture of which centres in Brünn, have long
celebrated. The linen manufacture is decreasing
portance as cotton manufactures develope. The qu
of sugar made from beetroot is steadily increasin
1880 about 600,000 cwts. of sugar were produced in
seventy factories. About 10 per cent. of the total value
manufactures of Austria, representing an annual amo
£13,000,000 to £15,000,000, falls to the share of Mo
The trade of Moravia consists mainly in the excha
the various raw and manufactured materials above
tioned for colonial produce, salt, and raw manufac
material. The lack of navigable rivers or canals is
pensated by good roads and an extensive railway s
The most important commercial towns are Brünn for
factures and Olmütz for live stock.

In educational matters Moravia compares favo
with most of the Austrian states. It contains 10 gym
10 real gymnasia, 13 real schools, numerous schoo
special purposes, and nearly 2000 lower schools. T
university of Brünn is now represented by a tec
academy, and a theological seminary. Of children of s
going age 79 per cent. attend school regularly. In
about 16 per cent. of the Moravian recruits could
their names, as compared with the extremes of 8
cent. in Lower Austria and 1¼ per cent. in Dal
Fully 95 per cent. of the inhabitants are Roman Ca
under the ecclesiastical jurisdiction of the archbish
Olmütz and the bishop of Brünn, while about 2 pe
are Jews, and 3 per cent. Protestants.

Moravia sends 36 members to the Austrian reic
9 of these representing the landed proprietors, 1
towns and chambers of commerce, and 11 the peas

ial affairs are managed by the landtag, consisting Roman Catholic archbishop and bishops, 30 repres es of the landed gentry, 37 representatives of the and chambers of commerce, and 31 representatives country districts. There are six courts of justice first instance in Moravia, and one of the second e (at Brünn), whence appeal lies to the supreme at Vienna. For military and judicial purposes a is united with Austrian Silesia.

avia belongs to the group of old Slavonic states have preserved their nationality while losing their l independence. Upwards of 70 per cent. of the ants are Slavs, who are scarcely distinguishable heir Bohemian neighbours. The differences in between the two countries are very slight, and are gradually lost in a common literary language. The of Czech, however, is usually reserved for the ians, while the Slavs of Moravia and West Hungary ed Moravians and Slovaks. The Czechs have lost f their ancient tribal names, but the Moravians are vided into numerous secondary groups (Hovaks, s &c.), differing slightly in costume and dialect easants usually wear a national costume. In the f Moravia are a few thousand Croats, still preserving ners and language after three centuries' separation eir kinsmen in Croatia, and in the north-east are ns Poles. The Germans form about 26 per cent. population, and are found mostly in the towns and border districts. The Jews are the best educated inhabitants, and in a few small towns form a tal the population. Their sympathies generally lie e Germans. In 1880 the population was 2,153,107, g an increase of 136,133 since 1869. Moravia is he most densely populated part of Austria-Hungary, portion being 252 persons per square mile. About ent. of the births are illegitimate. The chief towns nn, the capital and industrial centre (82,660 inha), Olmütz, a strong fortress defending the "Moravian (20,176 inhabitants), Znaim, and Iglau.

y.—At the earliest period of which we have any record was occupied by the Boii, the Celtic race which has per d its name in Bohemia. Afterwards it was inhabited by the e Quadi, who accompanied the Vandals in their westward n; and they were replaced in the 5th century by the Rugii ili. The latter tribes were succeeded about the year 550 by Lombards, and these in their turn were soon forced to retire n overwhelming invasion of Slavs, who, on their settlement ok the name of Moravians (German, *Mähren* or *Mähren* river Morava. These new colonists became the permanent nts of this district, and in spite of the hostility of the n the east founded the kingdom of Great Moravia, which siderably more extensive than the province now bearing e. Towards the end of the 8th century they aided Charle n putting an end to the Avar kingdom, and were rewarded ving, part of it, corresponding to North Hungary, a chief rman emperor, who-e supremacy they disacknowledged less for their other possessions. After the death of agne the Moravian princes took advantage of the dis on his successors to enlarge their territories and assert their dence, and Rastislaus (*circa* 850) even formed an alliance Bulgarians and the Byzantine emperor. The chief result liance with the latter was the conversion of the Moravians tianity by two Greek monks, Cyril and Methodius, from Constantinople. Rastislav finally fell victim to f Louis the German, who blinded him and forced him is days as a monk, but his successor Svatopluk (*circa* 890) ally vigorous, and extended the kingdom of Great Moravia der on the west and the Gran on the east. At this period med a strong probability of the junction of the north- and south-eastern Slavs, and the formation of a great power to the east of the German empire. This prospect was dissipated by the invasions of the Magyar hordes in century, the brunt of which was borne by Moravia. The were encouraged by the German monarchs and aided by nsions and mismanagement of the successors of Svatopluk, a short time completely subdued the eastern part of Great The name of Moravia was henceforth confined to the district to which it now applies. For about a century the sion of this marchland was disputed by Hungary, Polan Bohemia, but in 1029 it was finally incorporated with Bo and so became an integral part of the German empire. T the close of the 12th century Moravia was raised to the dig a margravate, but with the proviso that it should be held of the crown of Bohemia. It henceforth shared the fort this country and was usually assigned as an appanage to members of the Bohemian royal house. In 1410 Jobst, m of Moravia, was made emperor of Germany, but died a few after his election. In 1526, on the death of Louis II of Hu Moravia came with the rest of that prince's possessions i hands of the Austrian house. During the Thirty Years' W depopulation of Moravia was so great that after the peace of phia the states general published an edict giving ever permission to take two wives, in order to repeople the cou After the Seven Years' War Moravia was united in one pr with the remnant of Silesia; but in 1849 it was made a se and independent crown land. The most noticeable feature of Moravian history has been the active sympathy of its inha with the anti-Teutonic home rule agitation of the Bohemians. See Bohemia.

Authorities.—Dudik, *Mähren's allgemeine Geschichte* (Brünn, 1860-66); *Die Markgrafschaft Mähren geographisch-statistisch-topographisch dargestellt* (Brünn, 1836-39); Dlouhý, *Dějiny země Moravské* (Brünn, 1872); *Codex diplomaticus et epistolaris Moraviæ* (Brünn, 1836-54); Trnka, *Die Verfassung Mährens* (Vienna, 1872); *Catalogue of the Imperial Statistical Commission* (Vienna).

MORAVIAN BRETHREN, The, are a society of trans whose history can be traced back to the year and their origin found among the reformation movemen Bohemia which followed the martyrdom of John Hu the council of Constance. The beginnings of the Boh Brethren (for that was their earlier name) are som obscure. The followers of Huss broke up into two la one of which, the Calixtines, was willing to acknow allegiance to Rome, provided the "compacts" of the c of Basel permitting the Lord's Supper *sub utraque* were maintained, and in the end it became the na church of Bohemia; the other, the Taborites, refus terms of reconciliation, and appealed to arms. Se from both these were many pious people who were c to worship God in simple fashion, in quiet meetin prayer and Scripture reading, like the *Gottesfreun* Germany, and who called themselves *Brethren*. Boh historians have conclusively shown that the Brethren sent the religious kernel of the Hussite movement, a not come either from the German Waldenses or fro Taborites. Before 1457 many of these quiet Chri were known as the Brethren of Chelcic, and were followers of Peter Chelcicky, a Bohemian, whose rel influence, strongly Puritanic in its character, seems to been inferior only to that of Huss. In that year the true leader, Rokyzana, willing to protect them, per his nephew Gregory to gather them together at Kun near Senftenberg, and form them into a community. meantime was really the foundation of the Brethren or *Unitas*, and its founder Gregory announced that h his companions received and taught the rejection of of the military profession of all official rank, title endowments, and of a hierarchy. They did not p communism, but they held that the rich should g their riches to the poor, and that all Christians shou as nearly as possible in the fashion of the apostoli society at Jerusalem. At the synod of Lhota Reichenau, in 1467, they constituted themselves a church separate from the Calixtine or national chu Bohemia. They appointed ministers of their own c and with the guidance of the Lot, and had an org tion and discipline of their own; at their head was a b who, it is said, received ordination from the Wa Waldenses, but apostolic succession among the Br is one of the most obscure part of their history.

The constitution of the society was revised at a synod held at Lhota under the direction of Luke of P who may be regarded as their second founder. T

ation enabled the society to grow rapidly. In the
years of the 16th century the *Unitas* included nearly
congregations in Bohemia and Moravia with 150,000
rs, and, including Poland, embraced three provinces
emia, Moravia, Poland. Each province had its own
, and synod, but all were united in one church and
ed by the general synod.

Lutheran movement in Germany awakened lively
among the Brethren, and some unsuccessful at
were made under the leadership of Augusta to
ith the Lutheran Church (1528-1546); but when
Jesuit reformation reached Bohemia the Brethren
themselves more in sympathy with it than with the
an. The Jesuit anti-Reformation, instigated by
and his brothers Matthias and Ferdinand, found
thren a prosperous church, but the pitiless persecu
ich followed the unsuccessful attempt at revolution
the whole Protestantism of Bohemia, and in 1627
ing local churches there had ceased to exist. About
e time the Polish branch of the Unity, in which
efugees from Bohemia and Moravia had found a
was absorbed in the Reformed Church of Poland. A
udies, however, especially in Moravia, held religious
in secret, preserved the traditions of their fathers,
spite of the vigilance of their enemies, maintained
correspondence with each other. In 1722 some of
ett home and property to seek a place where they
worship in freedom. The first company, led by
n David, a mechanic, settled by invitation from
Zinzendorf on his estate at Berthelsdorf near Zittau,
ony. They were soon joined by others (about 300
within seven years), and built a town which they
Herrnhut. The small community at first adopted
stitution and teaching of the old *Unitas*. The epis-
had been continued, and in 1735 David Nitschmann
nsecrated first bishop of the Renewed Moravian
. The new settlement was not, however, destined
mply a revival of the organization of the Bohemian
n. Zinzendorf, who had given them an asylum,
ith his wife, family, and chaplain to live among
ugees. He was a Lutheran who had accepted
s pietism, and he wished to form a society distinct
ational churches and devoted to good work. After
gotiation a union was effected between the Lutheran
and the adherents of the ancient *Unitas Fratrum*.
grants at Herrnhut attended the parish church at
dorf, and were simply a Christian society within
theran Church (ecclesiola in ecclesia). This pecu-
is still to some extent preserved in the German
of the church, and the Moravian Brethren regard
ves as a church within the church, or the Brethren's
gation within the Evangelical Protestant churches,
nables them to do evangelistic work without pre
ng. The society adopted a code of rules in 1727,
lained twelve elders to carry on pastoral work,
the revival of the *Unitas Fratrum* as a church.

Statistics.—The Unity of Moravian Brethren at present em
three provinces—German, English, and American. Each
has its own government by synod and provincial elders'
ces; but it forms with the other two one organic whole, and
ore under the control of a general government also. The
synod which governs the whole church, meets every ten
Herrnhut, and is attended by delegates from all the pro-
and from the missions. The elders' conference of the Unity
entres board which superintends all the provinces and the
The present constitution dates from 1857, when the old
tion of the *Unitas Fratrum* was remodelled.

Ministers and Worship.—The ministry comprises bishops, presbyters,
ons. The bishops alone ordain, but they are not
They are appointed by the general synod, or by the
nference of the Unity, and have official seats both in the
of the provinces where they preside, and in the general
Unordained assistants in the ministry, whether men or
women, are formally set apart as acolytes. The worship
geal. Special services are used on the festivals of the eccle
year, on the "Memorial Days" 1st March, 12th May, 1
30th June, 6th July, 13th and 21st August, 16th Septemb
October, and 13th November. Love feasts are still held,
lot was long and the use of the lot in the election of ministe
in marriage have fallen into disuse. The use of the lot in m
was abolished in 1818.

Doctrine.—The Moravian Church has no formal creed,
doctrine is found in the catechisms, in the Easter morning
and in the *Synodal Results*, embracing the following points
by the synod of 1879: (1) that Scripture is the only rule
and practice, (2) the total depravity of human nature, (3)
of God the Father, (4) the real Godhead and the real humi
Jesus Christ, (5) our reconciliation unto God, and our justi
before Him, through the sacrifice of Jesus Christ, (6) the
of the Holy Ghost and the operations of His grace, (7) good
as the fruit of the Spirit, (8) the fellowship of believers
another in Christ Jesus, (9) the second coming of the Lord
and the resurrection of the dead unto life or unto condemna

Work.—(1) *Home Work in the Three Provinces.* This
two divisions, educational work, pecu
mission agencies. In the German
there is a peculiar home mission called the *Diaspora*, whi
from 1729. Its object is missionary. It seeks to excite a
spiritual life by means additional to those provided by th
lished churches, and does not make proselytes nor strive
members from other Protestant churches. The work is carr
Denmark, in Norway and Sweden, in the various parts of G
in the Baltic provinces of Russia, in Poland, and in Switz
In the English province home mission work is conducted
principle of establishing preaching stations in populous place
may ultimately become congregations connected with the
There is also a society for propagating the gospel in Irelan
work in the American provinces is of the same kind.
Brethren have always paid special attention to education
province has a theological college, and there are in the th
nces forty-seven boarding-schools for boys and girls not c
with the Moravian Church. At these school nearly 250
are educated.

(2) *The Foreign Missions.*—The Moravian Church since its r
ation by Zinzendorf has been a missionary church *par e*
The third jubilee of missions was celebrated in 1882. T
period began with 1732, when two men, Leonard Dober an
Nitschmann, were sent to preach to the negroes of St T
where it ended in 1789, the church had 167 brethren an
occupying 27 stations. In 1832 the church had to record
converts under the direction of 209 missionaries at 11
The latest statistics show 115 stations with 317 additional
ing-places, 7 normal schools with 70 scholars, 215 day scho
15,616 pupils, 215 teachers, and 634 monitors, 94 Sunday
with 13,355 pupils and 884 teachers, 314 missionaries (m
female) 1471 native assistants, and 76,646 converts.

(a) *The Bohemian Mission.*—The Brethren early made mi
excursions from Herrnhut and Silesia through Bohemia and
and since 1862 this itinerating work was largely increas
1869 it was resolved to re-establish the church in these cou
at birth, and the first congregation was inaugurated in
1870. It now contains four congregations, and in 1880
legal sanction.

(b) *The Leper Mission* was begun in 1822 in South Afr
carried on there till 1867, when the English Government a
a chaplain to do the work. The Leper Home in Jerusa
established in 1867, and formally taken over by the elders
ence of the Unity in 1881.

Statistics—

The Three Home Provinces		*Foreign and Bohemian M*	
Bishops	10	Bishops	
Presbyters and Deacons	291	Missionaries	
Communicants	18,871	Female Agents	
		Native Ministers and Assistants	
		Native Agents	
		Communicants	

Bohm Brüder, 2 vols., Prag., 1
Geschicht d. böhm. Brüder, Pt. 1882; Holmes, *History of the United*
2 vols. London 1 Bost, *Hist. de l'Eglise des Frères*, 2 vols.,
from Late Oberth, *Church Constitution of the Bohe*
in Brüder (T

MORAYSHIRE. See ELGIN, vol. viii. p. 129.

MORBIHAN, a department of western France,
of part of Lower Brittany, lies on the Atlantic se
between 2° 2' and 3° 15' W. long., and between 47°
48° 12' N. lat., being bounded S.E. by the departm
Loire-Inferieure, E. by that of Ille-et-Vilaine, N. b

d, and W. by Finistère. Its chief town, Vannes, miles west south-west of Paris in a direct line and nal. From the Montagnes Noires on the northern the western portion of Morbihan lopes southward s Finistère, watered by the Quimperlé, the Blavet s affluent the Scorff, and the Auray, the eastern , on the other hand, dips towards the south east in the n of the course of the Oust and its feeders, which o the Vilaine. Though the Montagnes Noires con highest point (975 feet) in the department, the most orographic feature of Morbihan is the dreary, tree reamless tract of moorland and marsh known as the of Lanvaux, which extends west north west to east) with a width of from 1 to 3 miles for a distance miles between the valley of the Claie and that of the fluents of the Oust). A striking contrast to this is afforded by the various inlets of the sea, whose are clothed with vegetation of exceptional richness, g trees, rose laurel, and aloes growing as if in . The coast line is excessively irregular; the of the Vilaine (the longest river of the department), ninsula of Rhuys, the great gulf of Morbihan (from om which the department takes its name, and the of the Auray, the long Quiberon peninsula attached mainland by the narrow isthmus of Fort Penthièvre, ep branching estuary of Etel, the mouths of the and the Scorff uniting to form the port of Lorient, nally, on the borders of Finistère the mouth of the ollow each other in rapid succession. Off the coast slands of Groix, Belle-Isle, Houat and Hoedik. Vessels 13 feet can ascend the Vilaine as far as Redon, vet is canalized throughout its course through the ment, and the Oust, as part of the canal from Nantes t, forms a great waterway by Redon, Josselin, Rohan, ntivy. The climate of Morbihan is characterized t moisture and mildness, due to the influence of the ream

2625 square miles forming the department, nearly one s occupied by moors (*landes*), arable soil forming little more hird part of the whole, meadows a tenth, and woodland th. The horses number 30,000, horned cattle 250,000, 2,000, pigs 60,000, goats 6000, and beehives 76,000. In agricultural produce comprised 5,761,630 bushels of rye 11,170 bushels of wheat, and considerable quantities of eat, oats, potatoes, peas and beans, chestnuts, beetroot, lza, and flax are grown. A little wine also is made, but l liquor of the district is cider manufactured to the extent 13 million gallons per annum). The sea ware gathered e coast helps greatly to improve the soil. Outside of there is little industrial activity in Morbihan, though leather, preserved foods, paper, and chemical products from the sea are all manufactured. Salt marshes give ment to 100 hands and yield on an average 9892 tons of l slate, kaolin, iron ore, and granite are also worked. The and curing of sardines and the breeding of oysters form ness of many of the inhabitants of the coast who also fish ovies, lobsters, &c., for running. There are 154 miles of in the department, and it was intended (1883) that the line ntes to Brest should have branches from Auray to St Brieuc, Quiberon, and from Questembert to Ploërmel. Morbihan d into four arrondissements, — Vannes, Lorient, Ploërmel, tivy — 37 cantons, and 249 communes. The population in s 521,614.

epartments contain so many localities interesting for their l associations. Besides the megalithic monuments of (2800 inhabitants) (*q.v.*) and of Locmariaquer (2050) mentioned Sarzeau (5720) with its castle of Sucinio, one ncient dukes of Brittany, Josselin (2710) with the tomb er de Clisson, constable of France, and of his second wife ite de Rohan, the castle of the Rohans, and in the neighbourolumn in memory of the "Combat of the Thirty;" Guémené d the château of the Rohan Guémené family; Le Palais the chief place in Belle-Isle, containing the château of (Louis XIV.'s superintendent of finance) and the hospital by his wife. Quiberon (2380) is associated with the disaster rench émigrés; Hennebont (6050) has a magnificent railway over the Blavet, and La Roche Bernard (1230) a suspension bridge over the Vilaine, 616 feet long and 108 feet above tides.

MORDAUNT, CHARLES. See PETERBOROUGH, E

MORDVINIANS, more correctly Mordva or M are a people numbering about one million, of origin, belonging to the Ural Altaic family, who the middle Volga provinces of Russia and spread detached communities to the south and east of Their settlement in the basin of the Volga is antiquity. One of the two great branches into they are divided, the Vorse (now Erzya), is men by Ptolemy as dwelling between the Baltic Sea a Ural mountains, whilst the Aorses of Asia occup the same time the country to the north east of the between the Volga and the Jaxartes. Their king to have come with 200,000 horsemen to aid Mith in his wars. Strabo mentions also the Aorses as ants of the country between the Don, the Caspian and the Caucasus. The name of Mordvs is met for the first time by Jordanes, and they were under the same name to the Russian annalist Nestor Russians made raids on the Mordvs in the 12th c and after the fall of Kasan they rapidly invade colonized their abode. The Mordvs now occup Russian provinces of Simbirsk, Penza, Samara, and Novgorod, as well as those of Saratoff and Tamboff their villages are dispersed among those of the Ru and they constitute only 10 to 12 per cent. of the lation in the four first-named provinces, and from 6 per cent. in the last two. They are unequally buted over this area on ethnographical islands, a stitute as much as 93 to 11 per cent. of the popula several districts of the governments of Tamboff, Sim Samara, and Saratoff, and only 2 or 3 per cent. districts of the same provinces. A small number of are found also in the provinces of Ufa, Orenburg, Astr and even in Siberia as far east as the river Tom are divided into two great branches, the Erzya a Moksha, differing in their ethnological features and language. The southern branch, or the Moksha, darker skin and darker eyes and hair than the no A third branch, the Karatayev, is due to mixtur Tatars, whilst a fourth branch, mentioned by authors, is, according to Mareoff, but a local na pure Mordvs. Their language is considered by M. A as the third branch of the Western Finnish family, t other branches being the Lapponian and the Baltic F which last embodies now the languages of the Ka the Tavastes, the Wotes, the Wespes, the Esthes, a Lives. The Mordvs are for the most part com Russified even the Moksha who consider themse the only pure Mordvs, yet they have well main their ethnological features, and can be easily disting even when living completely as Russians. The nearly quite forgotten their own language, only women remembering it among the Mokshas; bu have maintained a good deal of their old nationa especially the women, whose profusely embroidered original hairdress, large earrings which sometim metal, bon-bons, and numerous necklaces covering chest and covering of all possible ornaments ca tinguish them from Russian women. They have dark hair, but blue eyes, generally small and rather The cephalic index of the Mordvs is very near to the Finns. They are brachycephalous, or sub brachy lous, and a few are mesaticephalons. They are fine rather tall and strong, and broad chested. Their chi pation is agriculture; they work harder and (in th of the Mokshas) are more prosperous than their neighbours. Their capacities as carpenters we

in Old Russia, and Ivan the Terrible used them to ridges and clear forests during his advance on Kasan. sent they manufacture in their villages great es of wooden ware of various sorts. They are also asters of apiculture, and the commonwealth of bees ppears in their poetry and religious beliefs. All s are unanimous in recognizing their honesty, y, and sympathetic character, it is noticed also y have remarkable linguistic capacities, and learn eak not only Russian but also several Finnish nish dialects. Nearly all are Christians; they baptism in the reign of Elizabeth, the Nonconn- have recently made many fervent proselytes among But they still preserve very much of their own thology, which they have adapted to a certain ex the Christian religion. They have preserved also, ly the less Russified Moksha, the practice of kid g bride, with the usual battles between the party ridegroom and that of the family of the bride. The of trees, water (especially of the water divinity avoms marriage), the sun or Shkay, who is the chief , the moon the thunder, and the frost, and that to the home divinity Karda. Orko can be seen in e among them, and a small stone altar or flat overing a small pit to receive the blood of slaughtered can be found in very many houses. Their burial s are of a quite pagan character. On the fortieth r the death of a kinsman the dead is not only d to return home but a member of his household, in his dress, plays his part, and, coming from the speaks in his name. The practice of animal sacrifice deep rooted among the Mokshas, who continue to he warm blood of immolated animals.

Mordvy have always been a great attraction for Russian s. Strahlenberg, Georgi, Pallas, and especially Lepekhin ntier about them. Melnikoff has published in several periodicals extracts from his notes, but the number of smaller books have appeared in periodicals, enumerated by Mainoff in the *Izvestia* of the Russian Geoal Society for 1877. Investigated by the Geographical Society study of this race, Mainoff has recently made extensive ological researches into the habits of their customs and -law. The results are published, but not yet in full, in *ia* of the Russian Geographical Society for 1878, and in *odnai Sbornik* for 1879 and *Otechestvennye Zapiski* for 1878 re to appear in full in the *Memoirs* of the Society.

RE, HANNAH (1745-1833), who was born at Stapleton Bristol in 1745, may be said to have made three ions in the course of her long life: first, as a clever riter and witty conversers in the circle of Johnson, ds, and Garrick; next, as an animated writer on and religious subjects on the Puritanic side; and s a practical philanthropist. She was the youngest of the five daughters of Jacob More, a scion of a Norfolk family, who taught a school at Stapleton ucestershire. The sisters established a boarding at Bristol in 1767. Hannah's first literary efforts astoral plays, suitable for young ladies to act, d in 1773 under the title of *A Search after ess*. Metastasio was one of her literary models; pera of *Regulus* she based a drama *The Inflexible*, published in 1774. An annuity from a wealthy set the young lady free for literary pursuits. erses on Garrick's *Lear* led to an acquaintance, lore was taken up by the great female Maecenas, ontague; and her unaffected enthusiasm, simplicity, , and wit won the hearts of the whole Johnson great lexicographer himself being especially fascie- Miss More was petted, complimented, and enged to write. Her ballad, *Eldred of the Bower*, was and quoted by the highest living authorities; e wrote for Garrick the tragedy *Percy*, which was acted with great success in 1777. Another drama *Fatal Falsehood*, produced in 1779 after Garrick's was less successful. In these dramas she borrows Shakespeare situation, imagery, and phraseology greater freedom than modern criticism would tol but they are written with great vigour, freshness effect. Her *Sacred Dramas* appeared in 1782, and the sprightly octosyllabic poems *Bas Bleu* and (1786) mark her gradual transition to more serious of life, which were fully expressed in prose in her *Th on the Manners of the Great* (1788), and *An Estimate Religion of the Fashionable World* (1790). She had been overpowered by the flattering reception given fashionable society; she had received its attentions misgivings and reservations never touching cards, ke Sunday strictly, and preferring company where she have serious conversation; and finally, soon after Ga death, she set herself against theatre going and pretence. There is great uniformity of tone and to her ethical books and tracts. *Strictures on Female tion* (1799), *Hints towards forming the Character Young Princess* (1805), *Celebs in Search of a Wife* nominally a story, 1809), *Practical Piety* (1811), *tian Morals* (1813), *Character of St Paul* (1815), *Sketches* (1818). The tone is uniformly animated writing fresh and vivacious; her favourite subjec minor immoralities, the thoughtless self indulgence infirmities which are rather indirectly than directly ha She was a rapid writer, and her work is consequ discursive and formless, but there was an originali force in her way of putting commonplace observ piety that fully accounts for her extraordinary popu An interesting episode in her literary life was her years' labour in writing spirited rhymes and prose t the *Cheap Repository* series (1795-1798) to counter doctrines of Tom Paine and the influence of the Revolution. Two million of these rapid and sketches were circulated in one year, teaching the p rhetoric of most ingenious homeliness to rely upo virtues of content, sobriety, humility, industry, rev for the British constitution, hatred of the French in God and in the kindness of the gentry. Perhap noblest testimony to Hannah More's sterling wort her indefatigable philanthropic work, her long con exertions to improve the condition of the children benighted districts in the neighbourhood of her c residences at Cowslip Green and Barley Wood, limited her aims strictly, as a good churchwoma anti-Revolutionist, to teaching them to read good and trying to raise their moral tone, but no philanth ever laboured at greater self sacrifice or with purer m In her serene old age, philanthropists from all parts world made pilgrimages to see the bright and amiable lady, and she retained all her faculties till withi years of her death, dying at Clifton on 7th Sept 1833, at the mature age of eighty seven.

MORE, HENRY (1614-1687), one of the most re able and interesting of the "Cambridge Platonists born at Grantham in Lincolnshire in the year 1614. father was "Alexander More, Esq., a gentleman estate and fortune," highly spoken of by his son attributes to his father his own poetical tastes and ge love of learning from his early youth. Both his and mother, he further tells us, were "earnest follow Calvin," but he himself "could never swallow that doctrine." As soon as he went to Eton he gave h up to what he considered a more genial and encou train of religious thought. From his boyhood in th playing fields he was a philosophical and religious dr and he describes his moods of religious reverie in

resting manner.[1] His communings and ecstasies have
orbid taint; they are the natural carriage of a strangely
d spirit. "From the beginning all things in a manner
flowing to him," and his mind, according to his own
ng, "was enlightened with a sense of the noblest
ries in the morning of his day." In 1631 he went
ambridge, and was admitted at Christ's College about
time Milton was leaving it. He "immersed himself
er head and ears in the study of philosophy," and fell
a time into a sort of scepticism, from which, however,
was delivered by a study of the "Platonic writers."
was fascinated especially by Neo-Platonism, and this
nation never left him. The *Theologia Germanica* also
ted a great and permanent influence over him. He
red upon a course of spiritual self-discipline which
e "all his previous studies seem of comparatively no
e, and gradually light as well as peace came to him.
got "into a most joyous and liberal state of mind,"
h he described in a Greek epigram, as he had formerly
ribed his state of mental and spiritual darkness in the
e manner. He took his bachelor's degree in 1635, his
er's degree in 1639, and immediately afterwards was
en fellow of his college. In the position he may be
to have remained all his life. Many offers of preferment
t were made to him, but he refused them all, with one
ption. Fifteen years after the Restoration, he accepted
ebend in Gloucester cathedral but only to resign it in
ur of his friend Dr Edward Fowler, afterwards the
known bishop of Gloucester. He had no ambition,
steadily declined all attempts to draw him towards
ic life. He would not even accept the mastership of
ollege, to which, it is understood, he would have been
rred in 1654, when Cudworth was appointed. He
many young men of a refined and thoughtful turn
ind around him, but among all his pupils the most
esting was a young lady of noble family, a "heroine
l," as his biographer (Ward) says, "of an extraordinary
re." This lady is supposed to have been a sister of
Finch, afterwards earl of Nottingham, a well known
sman of the Restoration. She afterwards became
y Conway, and at her country seat at Ragley in
wickshire More continued at intervals to spend "a
iderable part of his time." She and her husband both
tly appreciated him, and amidst the woods of this
ant retreat he composed several of his books. There
ason to think that the spiritual enthusiasm of Lady
way was a considerable factor in some of More's
ulations, none the less that she at length passed from
religious pupilage into the ranks of the Quakers
eptible to all the excited impulses of her time, this
became the friend not only of More and Penn but of
n van Helmont and Valentine Greatrakes, mystical
maturgists who played a considerable part amid the
ing enthusiasms of the 17th century. Ragley became
tre not only of devotion but of wonder working spirit
m.[2] "Many happy days," More says, he spent in this
radise," and its fantastic mysticism had more allure
s for him than he himself realized. His genius suffered
onsequence, and the play of rationality which distin-
ues his earlier is much less conspicuous in his later
s. He was a voluminous writer both in verse and
e, and the mere list of his works would occupy more
e than we can give to it. Many of his productions
now unreadable; but the *Divine Dialogues*, published
668, may be still read with pleasure. It is animated
sometimes even brilliant, with less prolixity and
ession than his other productions, while it has also
the advantage for modern readers that it embodies
general view of philosophy and religion. Most
characteristic principles may in fact be gathered fr
The year in which he composed the *Divine Di*
may be said to mark the highest point of his intel
activity. His *Manual of Metaphysics* and elaborate
ise on Jacob Boehme and Spinoza were sub equ
this, but the elasticity and freshness of his philos
genius are less buoyant in these efforts, and the pro
mystical elements which were a weakness in his
constitution from the first grew as his years adv
He represents more than any other member of the
the mystical and theosophic side of the Cambridge
ment. His lofty rationality, the rationality of wh
himself had spoken earlier in noble language, was
evaporate in him in intellectual reverie and dream
Neo-Platonic extravagance, which lay hidden in the
from the first came in his writings to a head and
in pure phantasy. A set of favourite ideas, who
merely guided but dominated the reason. What
More can never be spoken of save as a spiritual eve
significant figure in the history of British philosop
robust and manly and in some respects less learne
Cudworth but more interesting and fertile in thoug
more sweet, angelic, and genial in character. From
to age he developed himself attuned with more hap
buoyant temper. The presence of nature filled hi
rapture, he wished he could be always *solus rus*.
ing abroad after his studies his sallies towards
would be often inexpressibly raw things, beyond w
could convey to other. His own thoughts were
a never ending source of pleasurable excitement
mind moved with great rapidity and at a lofty el
so that, as he says, he seemed "all the while to be
air." This mystical glow and elevation were th
features of his mind and character, a certain tran-p
radiancy of thought which carried him beyond the
life without rating him to any false or artificial
for his humility and charity were not less conspicuo
his piety. The last ten years of his life are withe
special record, and he died on the morning of 1st Sep
1687, and was buried in the chapel of the college h
so well, where within less than a year his friend Cu
was to be laid beside him.

Before his death More issued complete editions of his w
Opera Theologica in 1675 and his *Opera Philosophica* i
The chief additions for the latter were Ward, *Life*, p. 140; th
latio Generalissima" prefixed to the *Opera Omnia* 1679
general account of the nature and scope of his writing
Immortality pub
1664. The collection of his *Divine*
Poems, 1647,
he has composed his chief po
and a portion
of which he considered
at the time
even in Principal Tulloch's
Platonists.

MORE, THOMAS (1478–1535), lord chancellor, a
of the most distinguished Englishmen of his century
born in Milk Street in the City of London, 7th F
1478. He received the rudiments of education
Anthony's School in Threadneedle Street, at that
under Nicolas Holt held to be the best in the city
was early placed in the household of Cardinal J
archbishop of Canterbury. Admission to the ca
usually was esteemed a high privilege, and was so
a school of manners and as an introduction to the
by the sons of the best families in the kingdom.
Thomas More obtained admission through the influ
his father, Sir Thomas, then a rising barrister and
wards a justice of the Court of King's Bench. Th
prognostication of future distinction is attributed
case of More to Cardinal Morton, "who would of
the nobles sitting at table with him, where young
waited on him, whosoever liveth to see it shall

[1] "Prefatio Generalissima" prefixed to his *Opera Omnia*, 1679.
[2] The place and its religious marvels are glanced at in the romance
Jehan Inglesant (chap. xv.).

l prove a notable accession [1]. At the proper age
g More was sent to Oxford, where he is said vaguely
ave had Colet, Grocyn, and Linacre for his tutors
More himself says that he had Linacre for his master
Greek. Learning Greek was not the matter of course
it became. Greek was not as yet part
arts curriculum, and to learn it voluntarily was ill
d upon by the authorities. Those who did so were
ected of an inclination towards novel and dangerous
of flanking their rite on the Continent and slowly
n, their way to England. More's father, who intended
to make a career in his own profession, took the
he removed him from the university without a
e and entered him at New Inn to complete at
the study of the Law. The young man had been
in a state of humiliating dependence on money
ers, having had no allowance made him, and having
to apply to his father even for a pair of new hose,
the old worn out. This system was pursued
parents not from niggardliness but on principle,
Thomas More in later years often spoke with appro
n of the severe discipline, as having been a means of
ne him from the vulgar dissipations in which his
student indulged. After completing a two years'
in New Inn, an Inn of Chancery, More was admitted
bruary 1496 at Lincoln's Inn an Inn of Court. "At
time the Inns of Court and Chancery preserved the
blance of a well constituted University, and, through
sons under the name of readers and exercises under
name of moots, law was systematically taught
plicitly. In the professional trade More early
shed himself, so that he was appointed reader in Law
rnival's Inn, but he would not relinquish the studies
had attracted him in Oxford. We find Lupset
g a lecture to audiences of "all the chief learned of
ty of London". The subject he chose was a com
son between theology and the humanities, hence St
ustine's *De Civitate*. In this lecture More sought be
pound the theology of his author than to set forth
philosophical and historical contents of the treatise
ecture room was a church, St Lawrence Jewry, placed
s disposal by Grocyn, the rector.

nowhere about this period of More's life two things
ened which gave in opposite directions the determin
mpulse to his future career. More was one of those
susceptible natures which take more readily and
eagerly than common minds the impress of that
they encounter on their first contact with men
principal forms of thought and feeling were at that
conflict, rather unconscious than declared, on Eng
d. Under the denomination of the "old learning,"
atment of the Middle Ages and the idea of church
ity was established and in full possession of the
ion, schools, the universities, and the learned profes
The one that was advancing in the opposite direc-
thout being without the consciousness of a hostile purpose,
he new power of human reason animated with the
d sentiment of humanism. In More's mind both
hostile influences found a congenial home. Each
stium of supremacy, and in his early years it seemed
the humanistic influence would gain the final victory.
t the age of twenty he was seized with a violent
s of devotional rapture. He took a disgust to the
and its occupations, and experienced a longing to
himself over to an ascetic life. He took a lodging
he Charterhouse, and subjected himself to the disci
of a Carthusian monk. He wore a sharp shirt of
next his skin, scourged himself every Friday and
other fasting days, lay upon the bare ground with a
under his head, and allowed himself but four or five ho
sleep. This access of the ascetic malady lasted but a sh
time, and More recovered to all outward appearance
balance of mind. But he never entirely emancipa
himself from the sentiment of devotion, though in la
life it exhibited itself in a more rational form. E
when he was chancellor he would take part in chu
services, walking in their processions with a surpl
This, however, was at a later time. For the moment
balance of his faculties seemed to be restored by a revi
of the antagonistic sentiment of humanism which he
imbibed from the Oxford circle of friends, and speed
from Erasmus. The dates as regards More's early
are uncertain, and we can only say that it is possible t
the acquaintance with Erasmus might have begun dur
Erasmus's first visit to England in 1499. Tradition
dramatized their first meeting into the story given
Cresacre More,[2] that the two happened to sit oppos
each other at the lord mayor's table, that they got i
an argument during dinner, and that, in mutual astoni
ment at each other's wit and readiness, Erasmus
claimed, "Aut tu es Morus aut nullus," and the ot
replied, "Aut tu es Erasmus, aut diabolus!" Reje
me, this legend, which bears the stamp of fiction upon
face, we have certain evidence of acquaintance betwe
in a letter of Erasmus with the date "Oxfo
29th October 1499." If we must admit the correctness
the date of *Ep.* 14 in the collection of Erasmus' *Epistl*
we should have to assume that their acquaintance
began as early as 1497. Ten years More's senior, a
master of the accomplishments which More was ambitio
to acquire, Erasmus could not fail to exercise a power
influence over the brilliant young Englishman. Mo
unconscious demeanour, quick intelligence, and winn
manners fascinated Erasmus from the first, and acquai
ance rapidly ripened into warm attachment. This cont
with the prince of letters revived in More the spirit of
"new learning," and he returned with ardour to the stu
of Greek, which had been begun at Oxford. The humanis
influence was sufficiently strong to save him from wreck
his life in monkish mortification, and even to keep h
for a time on the side of the party of progress. He
gained no inconsiderable facility in the Greek langua
from which he made and published some translatio
His Latin style, though wanting the inimitable ease
Erasmus and often offending against idiom, is yet
copiousness and propriety much above the ordinary La
of the English scholars of his time.

More's attention to the new studies was always sub
dinate to his resolution to rise in his profession, in wh
he was stimulated by his father's example. As early
1502 he was appointed under sheriff of the city of Lond
an office then judicial, and of considerable dignity.
first attracted public attention by his conduct in t
parliament of 1504, by his daring opposition to the kin
demand for money. Henry VII. was entitled, accordi
to feudal laws, to a grant on occasion of his daughte
marriage. But he came to the House of Commons fo
much larger sum than he intended to give with his daught
The members, unwilling as they were to vote the mon
were afraid to offend the king, till the silence was brok
by More, whose speech is said to have moved the Hou
to reduce the subsidy of three fifteenths which the Gove
ment had demanded to £30,000. One of the chamberla
went and told his master that he had been thwarted by
beardless boy. Henry never forgave the audacity; b
for the moment, the only revenge he could take was up

[1] Roper, *Life*, p. 3. [2] *Life*, p. 93.

e's father, whom upon some pretext he threw into the
er, and he only released him upon payment of a fine
£100. Thomas More even found it advisable to with-
s from public life into obscurity. During this period
etirement the old dilemma recurred. One while he
oted himself to the sciences, "perfecting himself in
ic, arithmetic, geometry, and astronomy, learning the
ch tongue, and recreating his tired mind with the viol,"
anslating epigrams from the Greek anthology; another
e resolving to take priest's orders.

rom dream of clerical celibacy he was roused by
ing acquaintance with the family of John Colt of
Hall, in Essex. The "home-bred and well-governed"
he daughters attracted him, and the rich humorous
him to prefer the second he married the eldest, not
g to put the affront upon her of passing her over in
ur of her younger sister. The death of the old king
07 restored him to the practice of his profession, and
hat public career which his forensic powers so fitted
. From this time there was scarcely a cause of import
in which he was not engaged. His professional in

e amounted to £400 a year, equal to £4000 in present
ey, and, "from viewing the relative profits of the law
the value of money probably reckoned as high a
on as £100,000 at the present day" (Campbell). It
not long before he attracted the attention of the young
and of Wolsey. The Latin verses which he pre-
ed to Henry on the occasion of his coronation did not
ive particular notice, amid the crowd of congratulatory
. But the zeal with which he pleaded before the
Chamber in favour of the Crown v. the Pope recom-
ded him to the king's favour, and marked him out for
loyment. More took part in this case professedly
rown. Henry even was present in person at the trial,
the good sense not to resent the defeat, but took the
sel to whose eloquence it was due into his service. In
More was made one of the regent's knights, and
n a member of the privy council. He was repeatedly
loyed on embassies to the Low Countries, and was for a
time stationed at Calais as agent in the shifty nego-
ions carried on by Wolsey with the court of France.
1519 he was compelled to resign his post of under-
ff to the city and his private practice at the bar.
521 he was appointed treasurer of the exchequer, and
he parliament of 1523 he was elected speaker. The
ce of this officer rested nominally with the House
lf, but in practice was always dictated by
Thomas More was pitched upon by the court on this
sion in order that his popularity with the Commons
ht be employed to carry the money grant for which
sey asked. To the great disappointment of the court
e remained firm to the popular cause, and it was greatly
ng to his influence that its demands were reduced
n this occurrence may be dated the jealousy which
cardinal began to exhibit towards More. Wolsey
le an attempt to get him out of the way by sending
as ambassador to Spain. More defeated the design
a personal appeal to the king, alleging that the climate
ld be fatal to his health. Henry, who saw through
artifice, and was already looking round for a con-
ular successor to Wolsey, made the gracious answer
he would employ More otherwise. In 1525 More
appointed chancellor of the duchy of Lancaster, and
pains were spared to attach him to the court. The
g frequently sent for him into his closet, and discoursed
him on astronomy, geometry, and points of divinity.
s growing favour, by which many men would have
carried away, did not impose upon More. He dis-

[1] Roper, *Life*.

couraged the king's advances, showed reluctance to
the palace, and seemed constrained when there.
the king began to come himself to More's house at Ch
and would dine with him without previous notice. H
mention one of these visits, when the king after di
walked in the garden by the space of an hour, hol
his arm round More's neck. Roper afterwards cong
lated his father-in-law on the distinguished honour w
had been shown him. "I thank our Lord," was the r
"I find his grace my very good lord indeed, and I be
he doth as singularly favour me as any subject within
realm. Howbeit, son Roper, I may tell thee I hav
cause to be proud thereof, for if my head would win
castle in France, it should not fail to go." As a
resource More tried the expedient of silence, dissemb
his wit and affecting to be dull. This had the de
effect so far that he was less often sent for. But
not alter the royal policy, and in 1529, when a succe
had to be found for Wolsey, More was raised to
chancellorship. The election was prompted by More's
reputation, but it was also a repudiant of the moderate
which the policy of the court was then understood
was a concession to the rising popular party, to whi
was supposed that More's politics inclined him.
public favour with which his appointment had
received was justified by his conduct as judge in
Court of Chancery. Having heard causes in the fore
between eight and eleven, after dinner he sat again
receive petitions. The meaner the suppliant was
more affably he would speak to him, and the more spe
he would dispatch his cause. In this respect he form
great contrast to his predecessor, whose arrears he
cleared off. One morning, before told by the officer
there was not another cause before the court, he ord
the fact to be entered on record, as it had never happ
before. He not only refused all gifts, such as had
usual, himself, but took measures to prevent any o
connexion from interfering with the course of ju
One of his son-in-law, Heron, having a suit in the
cellor's court, and refusing to agree to any reason
accommodation,
fronate tailor to his children that ever was in the wo
More thereupon made a decree against him.

Unfortunately for Sir Thomas More, a lord chanc
is not merely a judge but has high political functio
perform. In entering More to that eminent po
ing had not merely considered his professional di
nity had counted upon his avowed liberal and reform
tendencies. In the *Utopia*, which, though written ea
More had allowed to be printed as late as 1516, he
spoken against the vices of power and declared for
preference of religion, creed with a breadth of philosop
view of which there is no other example in any En
man of that age. At the same time, as he could n
suspected of any sympathy with Lutheran or Wick
heretics, he might fairly be regarded as qualified to
the party which aimed at reform in state and c
within the limits of Catholic orthodoxy. But in the
mind the public questions of reform were entirely su
the proposed case of the divorce. The divorce was a
question which Thomas would not yield. And, as he
that the marriage with Anne Boleyn were determined
he petitioned the king "to be allowed to resign the
seal, alleging failing health. With much reluctance
royal permission was given and the resignation acce
10th May 1532, with many gracious expressions of
will on the part of the king. The promise held o
future bounty was never fulfilled, and More left offi
he had entered it, a poor man. His necessitous con
was so notorious that the clergy in convocation voted

ent of £5000. Thu he peremptorily refu-ed, either
nself or for his family, declaring that he "had rather
all cast into the Thames." Yet the whole of his
e after re-igning office did not exceed £100 a year
hereto he had maintained a large e-tabli hment, not
e princely .cale of Wolsey, but in the patriarchal
n of having all his son-in-law, with their families,
he-ted. When he re-igned the chancellorship he
h children and grandchildren together to explain
hese circumstance. "If we wi-h to live together,"
, "you mu t be content to be e mtributors together.
y counsel is that we fall not to the lowe t rate in t:
ll not, therefore, descend to Oxford fare, nor to the
New Inn, but we will begin with Lincoln's Inn
where many right worshipful men of great account
ood years do live full well: which if we find our
the fir-t year not able to maintain, then we will in
ext year come down to Oxford fare, where many
learned and ancient father and doctors are continu
onver-ant, which if our purse fetch not to main
either then may we after, with bag and wallet, go
me together, hoping that for pity some good folks
ve us their charity."

e was now able, a he write to Erasmu, to return
life which had always been hi ambition, when, free
om affairs and public affairs, he might give himself up
favourite studies and to the practice of his devotion
e Chelsea interior Erasmus has drawn a charming
e, which may vie with Holbein's celebrated canvas,
household of Sir Thomas More.

o his built, near London, stood the Thomas a more's yet
thou mansion. There he lived accompanied by his numerous
, including his wife Alice and his second wife, Jane Mid-
ton, and their husband with children and children. There
any man living so ill-creative to his cheerfulness as he, and he
his old wife as well as he were a girl of fifteen. Such, the
ce of his disposition, that whatsoever happeneth that could
helped, he ever therein put his whole pleasant endeavour, though the
ing possible had been done. In Morus's house you would
t Plato's Academy we might rightly call it, only, whereas in the
y the disputations touched upon learning and the power of
es, the house of Chelsea was rightly termed a school of Christian
. In it is none idle man or woman, but reading or studying
eral arts, yet is there no place of piety. There is never any
le, the head of the house seeketh it not by clerk's carriage
rebukes, but by gentle and amiable manner. Every
r is busy in his place, performing his office with alacrity,
ober mirth wanting."[1]

More was too conspicuous to be long allowed to
the happiness of a retired life. A special invitation
nt him by the king to attend the coronation of
Boleyn, accompanied with the gracious offer of £20 to
new suit for the occasion." More returned to attend,
ore that moment was marked out for vengeance
t attempt made to bring him within the meshes
law only recoiled with shame upon the head of the
. They were maladroit enough to attack him on
t vulnerable side, summoning him before the privy
l to answer to a charge of receiving bribes in the
-tration of justice. One Parnell was put forward
plaint of a decree pronounced against him in favour
contending party Vaughan, who he said had pre
a gift cup to the chancellor. More stated that he had
d a cup as a New Year gift. Lord Wiltshire, the
s father, exultingly cried out, "So, did I not tell
my lords, that you would find this matter true?"
my lords," continued More, "having pledged Mrs.
an in the wine wherewith my butler had filled the
returned the cup to her." Two other charges of a
ature were refuted as triumphantly. But the very
y of the accusations must have betrayed to More
the bitter determination of his enemies to compass
destruction. Foiled in their first ill directed atten
they were compelled to have recourse to that tremend
engine of regal tyranny, the law of treason. A bill
brought into parliament to attaint Elizabeth Barton
nun, who was said to have held treasonable langua
Barton turned out afterwards to have been an impos
but she had duped More, who now lived in a superstiti
atmosphere of convent and churches, and he had gi
his countenance to her supernatural pretensions.
name, with that of Fisher, was accordingly included
the bill as an accomplice. When he came before
council, it was at once apparent that the charge of trea
could not be sustained, and the effort of the court age
were directed to draw from More some approbation of
king's marriage. But to this neither cajolery nor thr
could move him. The preposterous charge was urged t
it was by his advice that the king had committed him
in his book against Luther to an assertion of the po
authority, whereby the title of "Defender of the Faith"
been earned, but in reality a sword put into the po
hand to fight against him. More was able to reply t
he had warned the king that this very thing might happ
that upon some breach of amity between the crown
England and the pope Henry's too pronounced asser
of the papal authority might be turned against him.
"therefore it were best that place be amended, and
authority more tenderly touched." "Nay," replied
king, "that it shall not, we are so much bound to the
of Rome that we cannot do too much honour unto
What ever impediment be to the contrary, we will
forth that authority to the utmost, for we have rece
from that see our crown imperial," "which, added M
"all his grace with his own mouth so told me, I ne
heard before." Anything more defiant and exasperat
than this could not well have been said. But it could
be laid hold of, and the charge of treason being
ridiculous to be proceeded with, More's name was str
out of the bill. When his daughter brought him
news, More calmly said, "I' faith, Meg, quod differ
non interest that which is postponed is not dropt."
another time, having asked his daughter how the co
went, and how Queen Anne did, he received for answ
"Never better, there is nothing else but dancing and sp
me." To this More answered, "Alas, Meg, it pitieth
to remember into what misery, poor soul, she will sho
come; these dances of hers will prove such dances t
he will pum our heads off like footballs, but it will no
long ere her head will dance the like dance." So the spe
ium in the *Life* by More's great grandson; but in the
trustworthy record, the life by his son-in-law Roper, Mo
reply ends with the words, "she will shortly come." In t
as in other instances, the later statement has the appe
ance of having been an imaginative extension of the ear

In 1534 the Act of Supremacy was passed, and
oath ordered to be tendered. More was sent for
Lambeth, where he offered to swear to the succession,
steadily refused the oath of supremacy as against his
science. Thereupon he was given in charge to the sh
of Westminster, and, persisting in his refusal, was
days afterwards committed to the Tower. After a c
and even cruel confinement (he was denied the use of
and ink) of more than a year, he was brought to trial be
a special commission and a packed jury. Even so M
would have been acquitted, when at the last mom
Rich, the solicitor general, quitted the bar and presen
himself as a witness for the crown. Being sworn,
detailed a confidential conversation he had had with

[1] *Ep.* 426

[2] Cresacre More, p. 231.

prisoner in the Tower. He affirmed that, having himself admitted in the course of this conversation "that there were things which no parliament could do," viz., no parliament could make a law that God should not be God, Sir Thomas had replied, "No more could the parliament make the king supreme head of the church." By this act of perjury a verdict of "guilty" was procured from the jury. The execution of the sentence followed within the week on 7th July 1535. The head was fixed upon London Bridge. The vengeance of Henry was not satisfied by the judicial murder of his friend and servant, he entered on the confiscation of what small property More had left, expelled Lady More from the house at Chelsea, and even set aside arrangements which had been legally executed by More, who foresaw what would happen before the commission of the alleged treason. More property was settled on Prince Elizabeth, afterwards queen, who kept possession of it till her death. At his death Sir Thomas More was in the fifty-eighth year of his age. He was twice married, but had children only by his first wife. His eldest daughter Margaret married to William Roper, is one of the foremost women in the annals of the country for her virtue, her intelligence, and various accomplishment. She read Latin and Greek, was a proficient in music, and in the sciences, so far as they were then accessible. Her devotion to her father is historical, she gave him not only the tenderest affection of a daughter but the highest admiration and sympathy of a soul great as his own.

It is unfortunate for More's reputation that he ... as a champion of party and sectarian ... strained not entirely to the liberties and ... of the country. Apart from the partisan use which ... made of ... More ... the noble mind of England, ... who bore the ... of a tyrant whose policy he disapproved or whose ... he despised. If his language ... servile than became a freeman, we must remember that ... the courtly style of the period and must not ... literally phrases of compliment. It is however, impossible to deny that More's policy in later life did not ... the more liberal convictions of his earlier years. His view and feelings ... under the combined influences of his professional practice and of public employment. In the *Utopia* published in 1516, he not only denounced the ordinary vices of power, but showed a ... of sentiment which went far beyond the most ... to be found among his contemporaries, pronouncing not merely for toleration but ... even to the philosophical conception of the indifference of religious creed. It was to this ... and not merely to the ... on the administration of Henry VII., that we must ascribe the popularity of the work in the 16th century. For, as a romance the *Utopia* has little interest in the ... of incident or of character. It does not ... his keen ... anticipate the economical doctrine of Adam Smith, and much of it is ... without being either witty or ingenious. Mackintosh ...

"It insinuates a variety of doctrines and ... a multiplicity of projects, which the writer regards with almost every possible degree of approbation and shade of assent, from the ... serious and entire belief through gradations of ... to the slightest probability, where the lowest are scarcely more than exercises of ingenuity, and to which some wild paradoxes are appended, either ... or as an easy mean, if necessary ... disavowing the ... interpretation of the whole of this Platonic fiction."

The *Epistola ad Dorpium* ... a later date ... inclines More emphatically on the side of the new learning. It contains a vindication of the study of Greek, and of the desirability of ... the text of the Greek Testament, views which at that date ... an enlightened understanding to enter into, and which were condemned by the party to which More afterwards attached himself. At the most he can be doubtfully exculpated from the charge of having tortured men and children for heresy. He ... himself that he inflicted punishment for religious opinion ... only ventures to say in his friend's defence "that while he was chancellor no man was put to death for these pestilent opinions, while so many suffered death in France and the Low Countries."

The *Life of Sir Thomas More* was written by his son-in-law Roper about the end of Mary's reign. It was preserved in MS. during the reign of Elizabeth and handed about in copies, many of which were carelessly made. It was not given to the press till 1626, with the date of Paris. Reprints were made by Hearne (1716), by Lewis (1729, 1731), and by Singer (1817, 1822). Roper's life is the source of all the many subsequent biographies. More's *Life* in MS. (Harleian 6253), anonymous, but by Nicolas Harpsfield, was also written in Mary's reign. All that is material in this MS. is taken from Roper. Another anonymous *Life* ... written in 1599, printed in Wordsworth's ... chiefly compiled from Roper and Harpsfield. The preface ... Stapleton (*De Thomæ ...*) ... (*Tres Thomæ*, Douay, 1588) ... Roper (certainly) ... could find ... through ... and letters ... to the writings of his contemporaries. Cresacre More ... Thomæ, compiled ... about the year 1626. He ... but, according to the editor ... *Life of Sir Thomas More* ... how little proof ... an independent authority. ... and Stapleton. The additions ... application of Roper ... derive miracles. The whole ... which the love of the ... upon poor. The author ... that he has received ... after the ... Alfred Gibbs's ... Compositions of the last ... Cresacre More. *Life* ... other ... have been ... the body ... Hayes, who ... Poor, and ... his *De Thomæ* ... by Rainaldi, Cocquelines, ... Charles Butler, ... by Bouvier, ... *Utrecht* ... More ... there ... tion. He was ... and ... exposed himself to the ... the great epidemic of 1562 ... food. There he ... Prayers and ... satirical scroll called *Dicta* ... Some years ... entirely ruined his ... death that he ... published selling the copyright for £4 ... copies of the book. It was ... but, as has happened ... which happened ... required to ... excessive. More's ... poets, has a ... especially ... literary, is not ... religious, and ... as *La Fonte* ... sweetness, and he had a ... and poetry which ... or, to speak honestly, with more ... severance, he might ... miserable destitution which was his lot.

MOREAU, Hégésippe, a ... but considerable talent, was born at Paris ... 1810, and died in the hospital at La Charité on the ... December 1838. In his early youth he put it, ... very ill off migrated to Provins, where the mother ... into service and the father took to the post of usher ... public school. Both died in the ... tute which afterwards ... Hégésippe ... fairly educated and was ... pretensions to ... poet. He went to Paris ... 1830, and appears to have ... there, though for the most part ... or was driven by ... alternate hard hits and cheap distinction which ... in France by the name of Bohemianism. In More ... there is no doubt that the ... tion. He was habitually ... exposed himself to the ... the great epidemic of 1832 ... food. There he ... satirical scroll called *Dicta* ... entirely ruined his ... death that he ... published selling the copyright for £4 ... copies of the book. It was ... but, as has happened ... which happened ... required to ... excessive. More's work, like that of many other ... poets, has a ... especially ... literary, is not improved by ... religious, and social matters. But some of his poems ... as *La Fonte* ... sweetness, and he had a faculty of ... and poetry which seems to show that with better fortune, ... or, to speak honestly, with more ... severance, he might easily have saved himself from ... miserable destitution which was his lot.

REAU, Jean Victor (1763–1813), the greatest of the French republic after Napoleon and Hoche, born at Morlaix in Brittany in 1763. His father [illegible] in good practice, and instead of allowing [illegible] the army, as he wished, insisted on his [illegible] the university of Rennes. Young Moreau [illegible] for law, but revelled in the freedom [illegible] Instead of taking his degree he con- [illegible] with the students as their hero and leader. In [illegible] he became a person of political importance, the trouble of 1788 formed the law students into [illegible] which he commanded as their provost. In [illegible] became yet more important, and commanded the [illegible] in the daily affrays which took place at Rennes [illegible] the young *noblesse*, who protested against the mode [illegible] on to the tate-général, and the populace. Though hardly weight enough to be chosen a deputy, he [illegible] ence of the committee of correspondence with [illegible] at Paris. He was thus able to follow the [illegible] events in the early days of the Revolution, and [illegible] y impressed with the conviction that no compromise [illegible] court was possible, and a republic the only re- [illegible] These opinions estranged him from his father, [illegible] longed to the party of Breton independence and [illegible] Britanny to France. At last, in 1792, at the [illegible] volunteers he organized a battalion, and was at [illegible] elected its commandant. With it he served under [illegible] nez, and in 1793 the good order of his battalion, [illegible] own martial character and republican principles [illegible] his promotion to general of brigade. Carnot, who [illegible] over the heads of a crowd of generals, promoted [illegible] be general of division in 1794, and gave him com- [illegible] the right wing of the army which, under Pichegru, [illegible] ined to drive the English and Austrians out of Flan- [illegible] separate the Austrians from the French. This wing [illegible] en to cover the occupation of Holland by the main [illegible] under Pichegru. These operations established his [illegible] fame, and in 1795 he was given the command of the [illegible] of the Rhine and the Moselle, with which he crossed [illegible] ine and advanced into Germany. He was at first [illegible] ely successful, and won several victories, but at last [illegible] xembourg before the archduke Charles a retreat which [illegible] reased his fame, as he managed to bring back with [illegible] re than 5000 prisoners. In 1797 he again crossed [illegible] ine, but his operations were checked by the con- [illegible] of the preliminaries of Leoben between Bonaparte [illegible] Austrians. It was at this time he found out the [illegible] s correspondence between his old comrade and [illegible] ador Pichegru and the prince de Condé, which he [illegible] concealed, and naturally has ever since been sus- [illegible] of at least partial complicity. After Fructidor the [illegible] y ceased to employ his services, until the absence of [illegible] ite and the advance of Suwaroff made it necessary [illegible] some great general in Italy. Yet it was only as [illegible] the staff that he served under Scherer and Joubert, [illegible] Brune to Masséna after the latter's death at [illegible] When Bonaparte returned from Egypt he found [illegible] at Paris completely satisfied with the Directory both [illegible] neral and a republican, and obtained his assistance [illegible] *coup d'état* of Brumaire, when Moreau commanded [illegible] e which occupied the Luxembourg. In reward, [illegible] consular government gave him command of the army of the [illegible] with which he fought his last great campaign, that [illegible] enlightened when his success was due rather to the [illegible] l military qualities of his generals and their troops, [illegible] s own tactical genius, than to any inspiration of [illegible] On his return to Paris he married Mdlle. Hulot, [illegible] ortune woman, who gained a complete ascendency [illegible] n, and with the enormous fortune acquired during [illegible] peace he purchased a luxurious hotel in Paris and also Barras's country seat of Grosbois. His wife exercise evil influence over him, and collected around her all who discontented with the aggrandizement of Napoleon. 'Club Moreau' frightened Napoleon, and encouraged royalists, but Moreau, though not unwilling to becom military dictator to restore the republic, would not ha for the restoration of Louis XVIII. All this was known to Napoleon, who seized the conspirators. Mo be treated with real leniency, and permitted to retire to Spain, and then to America. Here the general l in great content for seven years, when his wife, who c not allow him to rest, made him enter into negotiat with Bernadotte, his old comrade, who was now cr prince of Sweden. At his suggestion Moreau entered service of the czar Alexander; and with Bernad he planned the campaign of 1813. Fortunately for tune a patriot he did not live to invade France, was mortally wounded while talking to the czar at battle of Dresden on 27th August 1813, and died o September. His wife received a pension from the and was given the rank of marechal by Louis XVIII

Moreau's military genius stands very high, and from his [illegible] volution, coolness in conducting a retreat he has been called the ge of retreat. His combinations were splendid, and his temperam [illegible] troubled when most closely pressed, but he lacked the sudden [illegible] of striking a victory which distinguished Napoleon in his early [illegible] gns. Moreau was a sincere republican, though his own father [illegible] guillotined in the Terror, and the army of the Rhine was the [illegible] bed of republicanism, as that of Italy was the great support [illegible] military dictator. Moreau had little even of personal [illegible] ition to fill his manner, and would probably not only have s [illegible] Napoleon well but moderated his tendency to absolutism b [illegible] very proper had not the wife ruined any such hope by mixi [illegible] him in intrigues. He was fortunate in the moment of his d [illegible] though he would have been more so had he died in America, [illegible] seem by his final words, "Soyez tranquilles, messieurs; c'est [illegible] ort, not to have regretted being removed from his equ [illegible] petition to a general in arms against this country.

The only authority on Moreau is a pamphlet, the best book being C. Lechimus, *[illegible]* [illegible] Paris, 1814. See also Lebrun, *Campagnes de Moreau*, Paris, 1814; Bertrand de Molleville, *Notices historiques sur la vie politique, militaire et privée du général Moreau*, translated as Philippart, London, 1814; and there are [illegible] in Rocquain, translated into English under the title *[illegible] Directory, Consulate and Empire*. See also *Last Moments* by Paul Svanin, L [illegible] 1814. (H. M.)

MOREL or MORCHELLA. See MUSHROOM.

MORELIA, formerly VALLADOLID, a city of Me capital of the state of Michoacan de Ocampo, is situ 195 miles west by north of Mexico, at a height of 6400 above the sea, in 19° 42′ N. lat. and 101° W. long. [illegible] ite is a rocky hill on the Guayangareo valley, and [illegible] western horizon is bounded by the great Quinceo moun (11,000 feet). Since the middle of the century a conside extension of the city has taken place, especially tow the north; its streets, which run for the most part at angles to each other, had increased from thirty in 187 ninety-nine in 1873. The principal square is the [illegible] de los Martires (formerly de Armas), where Matam was shot by the Spaniards in 1814; its one side is occu by the cathedral (1745), a large building with two to about 200 feet high. The churches of the Carmelites Carmen) and San José are of some note, and of the convents, now for the most part in ruins, several wealthy and extensive. That of the Capuchins is used as a hospital, the old seminary has been turned a state house, and the tobacco factory, one of the ancient buildings in the city, serves as municipal of An important institution, supported by the state, is college of San Nicolas de Hidalgo, originally founde Juan de San Miguel in the 16th century and rebui 1868. The Ocampo theatre dates from 1869–1870. W is brought from a distance of about 3 miles by a aqueduct, constructed in 1788 by D. Antonio de Miguel, but the quality is often deteriorated by the sence of vegetable matter. Morelia lies too far from great natural route to have much commerce in the pr

ate of the country, and its manufactures are limited to e production, on a small scale, of cotton, woollen, and silk oods. A certain delicate sweetmeat called *guayabate* i regular article of commerce to Mexico. In 1750 the city d about 18,000 inhabitants, in 1873 the municipality d 36,940 and the city proper about 30,000, and in 880 the number is stated at 20,100.

In 1541 Mendoza chose the Cerro de Guayangareo (Nueva Valladolid) for the new site of the city of Michoacan, and in 1578 the place received the name Valladolid. Iturbide and Morelos were both born within its precincts; and in 1828 the Government did the latter patriot the honour of renaming the city Morelia. In 1863 it was made the seat of an archbishop. See *Bol. Soc. de geog. de la Rep. M.* Mex., 1873.

MORELLET, ANDRÉ (1727–1819), economist and miscellaneous writer, was born at Lyons on the 7th of March 1727. He was long regarded as almost the last survivor of the philosophe school, and in the character he figures in many memoirs, for instance in Madame de Rémusat's. He was educated by the Jesuits in his native town, then at the seminary in Paris, and finally at the Sorbonne, and he took holy orders, but his dissipation of abbé was the chief thing clerical about him. He early joined the Philosophe party, and was a frequenter of most of them *salons*, being something of a butt especially to his fellow-abbé and rival in political economy, Galiani, but having the credit of a ready and biting pen. Voltaire called him "l'Abbé Morellet." His work was chiefly occasional, and the most notable parts of it were a smart pamphlet in answer to Palissot's scurrilous play *Les Philosophes*, which procured him a short sojourn in the Bastille for an alleged libel on Palissot's patroness, the princesse de Robecq, and a reply to Galiani's *Commerce des Blés* (1770). Later, he made himself useful in quasi-diplomatic communications with English statesmen, and was pensioned, being, moreover, elected a member of the Academy in 1785. The outbreak of the Revolution (soon after which he was engaged in a controversy with Chamfort on the question of the advantages and deserts of the Academy) did not, as it did with many of his friends, drive him from the country or put his life in danger, but it put him in considerable straits of fortune. He maintained a kind of moderate liberal tone, and the return of something like order under the Consulate and the Empire restored him to prosperity and position. A year before his death, at the great age of ninety-two, on the 12th of January 1819 at Paris, he brought out a series of *Mélanges*, composed chiefly of selections from his former publications; and after his death appeared his memoirs, which are of value for the Philosophe period. Morellet, though not a man of extraordinary ability or of specially amiable or estimable character, was in both respects a fair specimen of the man of letters of all work of the time. He was, in fact, a journalist with a special turn for economical subjects.

MORERI, LOUIS. See ENCYCLOPÆDIA, vol. xviii. p. 191.

MORETO, AGUSTIN (1618-1669), Spanish dramatist and playwright, was born at Madrid in 1618. Of his personal and even of his literary history little is known. He studied at Alcalá between 1634 and 1639 and afterwards removed to Toledo, where he entered the household of the cardinal archbishop and took holy orders. Ultimately he withdrew altogether from the world, and died a member of an ascetic religious brotherhood in 1669.

Moreto in his younger years was a prolific writer for the stage, and almost rivalled Calderon in popularity. Three volumes of his plays were printed between 1654 and 1681, and many others besides are attributed in whole or in part to him. He employed all the dramatic forms then in vogue. Of his religious plays, *Los Dichosos Hermanos* (The Most Fortunate Brothers) dramatises the legend of the seven sleepers, may be mentioned as the least bombastic and absurd. Others are *El hostal de Valencia*, turning on the persecutions connected with the introduction of the tobacco plant into Spain, and *María Egipciaca*, a curious representation of the extraordinary legend of St Mary of Egypt. His heroic drama, *El Valiente Justiciero* (The Brave Justiciary), records the exploits of Pedro the Cruel, a king of considerable power. His "comedias de teatro," or "character comedies" (as they are called in vol. xviii. p. 192, include *El Lucero Don Pedro* (The Star Don Pedro) and *El Real sitio y Leales* (Disloyalty Disclaimed), the latter partly borrowed from Lope de Vega's *del Despreciado* and in turn imitated by Moliere (in his *Dépit Amoureux*), by Carlo Goldoni (*Le Trappole per Dilettare*), and by Scribe (*Deux Amis*). The *Cuatro Comedias de los Mejores Ingenios de España* (Madrid, 1676).

MORETTO DA BRESCIA (or The Blackamoor), a term which has not been particularly accounted for, is the name commonly bestowed upon ALESSANDRO BONVICINO (1498–1560), celebrated painter of Brescia, Venetian school. He was born at Rovato in the Brescian territory in 1498, and studied first under Floravante Ferramola of Brescia, afterwards still youthful, with Titian in Venice. His own peculiar method, generally distinguished by excellent colouring, was naturally modelled on that of Titian. He has conceived a great enthusiasm for Raphael (though he does not appear to have ever come to Rome), and his style became partially Raphaelesque. It was, however, a singular combination of diverse elements, and he is best attractive with fine pencilling, a rich yet not lavish use of pearly and decorative effects, and an extraordinary appreciation of light and shade. The human forms are somewhat heavy in Bonvicinese painting, the expression correctly rendered, the flesh tints varied, more so than was common in the Venetian school. The backgrounds are generally landscape, and the drapery well modelled in broad and simple folds with little recurring use of blue. The depth of Bonvicino's talent however was chiefly in proportion to its simplicity and vivacity, and he excelled more in colouring altar-pieces than in subjects of action, and more in oil paintings than in fresco, although one has some of his frescos (especially that in the villa Martinengo at Novagli near Brescia). Among his celebrated works are in the city of Brescia the church of S. Clemente, the Two Virgins Martyrs, the Assumption of the Madonna (the latter many consider his masterpiece), in S. Nazzaro e Celso the Coronation of the Madonna, in S. Maria delle Grazie St Joseph and Mary de Medicis, St Nicholas of Bari. In the Brescian Gallery is a St Justina (sometimes ascribed to Pordenone), in the Städel Institute, Frankfort, the Madonna enthroned between St Arthelais and Sebastian, in the Berlin Museum a colossal Adoration of the Shepherds, and a large picture (one of the master's best) of the Madonna and Child, with infant angels and other figures above in clouds, and believed to be a rich landscape two pictures in the London National Gallery, St Bernardin Angels, and two magnificent portraits. If Moretto is to have been a man of childlike personal piety, proved himself by prayer and fasting for any great act of art, as the biographers of the Venetian painters relate of work extended from 1521 to 1554, and he was then in the prime manhood of the eminent portrait painter Moroni. He died place toward 1560.

MORGAGNI (GIOVANNI BATTISTA (1682–1771), founder of pathological anatomy, was born 25th February 1682 at Forlì, an ancient and important town of Emilia, 30 miles southwards from Bologna. His parents were of respectable circumstances, but not of the nobility, as appears from his letter to Haller that Morgagni's ambitious of gaining admission into the latter rank, and the interest he succeeded from the fact that his father described as a renowned [illegible] at Padua [illegible]. At school he was a favourite pupil of his [illegible] and he was especially noted for his reading [illegible] epigram. At the age of twenty he went to Bol-

[1] A tablet of the house [illegible] the town library [illegible] fourteen [illegible]

philosophy and medicine, and he graduated with
color a doctor in both faculties three years later
He acted as prosector to Valsalva (one of the
guished pupils of Malpighi), who held the office of
demonstrator of anatomy in the Bologna school. He
at Valsalva's more particularly in preparing his cele
work on the *Anatomy and Diseases of the Ear*, which
out in 1704. Many years after (1740), Morgagni
a collected edition of Valsalva's writings, with m
additions to the treatise on the ear, and with a
of the author. When Valsalva was transferred
Morgagni succeeded to his anatomical demon
ship. At this period he enjoyed a high reputa
Bologna. He was made president of the Academia
Inquieti when in his twenty-fourth year, and he
to have originated in imitation of the precedent
Italy by discountenancing abstract speculations and by
the attention towards exact anatomical observa
and examination. He published the substance of his
munication to the Academy in 1706 under the title
De sedibus diagnosticis, the first of a series by which
became known throughout Europe as an
to anatomical research. The book included "Observations
Larynx, the Thyroid Apparatus, and the Pleu
in the Human Body." After a time he gave up his
at Bologna, and occupied himself for the next two
three years at Padua and Venice with anatomical
to be at the latter city), as well as with
try and pharmacy, and with reading in the libraries
then settled in practice in his native town, and soon
ted a large and rapidly increasing practice. There was hardly a
of much difficulty about which he was not consulted
by the older physicians
in praedicendo exitu, et curando febre." Such
in the contemporary eulogy. After less than three
of this career, which he found fatiguing, he sought
portunity of returning to more academical work
dua he had a friend in the elder Guglielmini, pro
of medicine, but later known as a writer on physi
mathematics, whose work he afterwards edited (1719)
a biography. Guglielmini desired to see him settled
teacher at Padua, and the unexpected death of
Imani himself made the prospect feasible. Valsalva
then turned to the vacant chair and Morgagni re
g to the chair of theoretical medicine. He came to
in the spring of 1712, in his thirty-first
ed to taught medicine there with the most brilliant
until his death sixty-five years later (6th December
While he had been three years in Padua an oppor
occurred for his promotion (by the Venetian senate)
chair of anatomy, to which he became the successor
the direct line of scholars including Vesalius,
, Fallopius, Columbus, and Spigelius, and in which
enjoyed a stipend that was increased from time to time
to 1500 scudi until it reached twelve hundred gold
Shortly after coming to Padua he married a lady
noble parentage, who bore him three sons and
daughters. Of the daughters, four died in infancy,
other married as they grew up, of the
one died in her novitiate, one entered the Jesuit order,
resided at Forlì where he married and lived
age of fifty-two, predeceasing his father by five years,
leaving a family to inherit Morgagni enjoyed an
added popularity among all classes. He was of tall
united figure, with blonde hair and blue eyes, and
a frank
tion, his manners were
ed, and he was noted for the elegance of his Latin
He lived in harmony with his colleague, who are
not even to have envied him his unprecedentedly large
, his house and lecture theatre were frequented
"tanquam officina sapientiae" by students of all
attracted from all parts of Europe, he enjoyed the fri
ship and favour of distinguished Venetian senators an
cardinals; successive popes conferred honours upon h
and on two occasions when a hostile army occupied
Emilia his house was ordered to be treated with the s
marked distinction that the great Emathian conqu
bowed to the house of Pindar. Before he had been
in Padua the students of the German nation, of all
faculties there, elected him their patron, and he adv
and assisted them in the purchase of a house to b
German library and club for all time. No person of
learning came to Padua without seeing and conver
with Morgagni and no one ever left him without admi
equally his character and his teaching. One of his
graphers and editors, the celebrated Tissot of Lausa
observes that he had met with several Englishmen
turning from Italy who told with pleasure and grati
"quam humaniter ille exceperat, et quantum ex i
colloquiis, doctis, variis, promptis protecerant." He
elected into the Imperial Caesareo Leopoldina Academ
1708 (originally located at Schweinfurth), and to a hi
grade in 1732, into the Royal Society in 1724, into
Paris Academy of Sciences in 1731, the St Peters
Academy in 1735, and the Berlin Academy in 1
Among his more celebrated pupils were Scarpa (who
in 1842, connecting the school of Morgagni with
modern era), Cotugnius (Cotugno), and Caldani, the au
of the magnificent atlas of anatomical plates publishe
4 vols. at Venice in 1801-1814.

Meanwhile he published on a variety of subjects. In his e
years at Padua he brought out 1717-1719 six series o
le by which his reputation was first m
but for more than twenty years after the last of these he st
medical publications were few and casual (on gall-stones, vari
the conservative care of gout, and several memoranda on medico
points drawn up at the request of the curia). Classical scholar
in these years occupied his pen more than anatomical observat
and the reason of this appears to have been that he spen
some months in the country for the sake of his health, and occ
his leisure with literary studies. His writings in this class in
letter to Cuneus on the manner of Cleopatra's death, commen
on various and sometimes notes on Prosper Alpinus, V
Veratius, Columella and Vitruvius, and antiquarian resea
into the topography of the country round Ravenna and his
birthplace (Forum Livii). His edition of the works of Vals
published in 1740 (in 2 vols. fol.) with plates, occupied mu
his time, being enriched with a life and a commentary, and
many additional observations of his own. It was not until
when he was in his eighteenth year, that he brought out the
work which, once for all, made pathological anatomy a sci
and diverted the course of medicine into new channels of exac
in the *De Sedibus et Causis Morborum per Anato*
He died on 6th December 1771. During the prece
ten years the *De Sedibus*, notwithstanding its bulk, was repr
several times three or four years in its original Latin, and
translated into French (1765), English (1769, 3 vols. 4to),
German (1774). Some account of this remarkable work re
now to be given.

The only special treatise on pathological anatomy previous to
of Morgagni was the work of Theophile Bonet of Neuchatel, *S*
chirurgicae sive Anatomia practica cadaveribus morbo denatis
published (Geneva, 2 vols. folio) in 1679, three years before Morg
was born; it was republished at Geneva (3 vols. folio) in 1700
again at Leyden in 1709. Although the normal anatomy o
body had been comprehensively, and in some parts exhaust
written by Vesalius and Fallopius, it had not occurred to an
to examine and describe systematically the anatomy of dis
organs and parts. Harvey, a century after Vesalius, naivel
marks that there is more to be learned from the dissection o
person who had died of consumption or other chronic malady
from the bodies of ten persons who had been hanged. G
indeed (1651, 1677) shows, in a passage quoted by Bonet in
preface to the *Sepulchretum*, that he was familiar with the
at least, of systematically comparing the state of the organs
series of cadavera, and of noting those conditions which invar
accompanied a given set of symptoms. The work of Bonet
however, the first attempt at a system of morbid anatomy,
although it dwelt mostly upon curiosities and monstrositi

much repute in its day, Hall's ... ook, which may must-still serve for a pathological ... n, in the preface to his own work, criticises the selection and ... the *Sepulchretum*, it was largely a compilation of other ... es, well and ill authenticated, it was poor ... often inaccurate ... eading from ignorance of the normal anatomy and it was ... in what would now be called obscure imputations ... which was introduced as destructive morbid anatomy ... ment as it had been introduced two centuries earlier into ... human anatomy by Vesalius. Morgagni has narrated the ... ances under which the *De Sedibus* took origin. Having ... his edition of Valsalva in 1740, he was ... a holiday in ... try, spending much of his time in the company of a young ... he was ... accurate in many branches of knowledge. The ... tion turned upon the *Sepulchretum* of Bonet, and it was ... t to Morgagni as an dilettante task that he should put ... his own observations. It was ... that others on the ... of diseased organs and parts ... had been written for the ... of the ... South, whose ... now not to be pro... were contrived from time to time, but ... rather muddled ... The ... essay ... on the ... *Sepulchretum*, which was ... to the world ... a quarto ... folio, Venice, 1761. It ... was ... instruction was ... The ... was ... matter of the ... ...

uary 1859, a few weeks before her death, protesting
t being called old. The titles of her books in this
are:—*Fragments* (1829-30), *Dramatic Scenes from Real*
(1833), *The Press* (1835), *Woman and her Master*
), *The Iliad without a Name* (1841), *Passages from*
utobiography (1859). More of her autobiography
any years ago, and letters were edited with a memoir by
ath Dixon in 1862. He respected her prejudice
t disclosing her exact age.

ROMANTIC MARRIAGE. See MARRIAGE.

ROTHLN, RAFFAELLO SANZIO (1758-1833), a distin
d engraver, was born at Naples on 19th June 1758.
ived his earliest instructions from his father, who
engraver, but, in order to be initiated more fully
art he was afterwards placed as a pupil under the
ted Volpato. He assisted this master in engraving
most pictures of Raphael in the Vatican, and the
which represent the miracle of Bolsena are ordered
s name. He married Volpato's daughter, and, being
d to Florence to engrave the masterpieces of the
time gallery, he removed thither with his wife in
His reputation now became so great as to induce
rs of Florence to recommend him to the grand duke
t person to engrave the Last Supper of Leonardo
ci, apart, however, from the disputed fame of
ginal it is, the drawings made for Morghen were
thy of the original, and the print, in consequence,
gh an admirable production, fails to convey a correct
the style and merit of Leonardo. Morghen's fame
ad, soon extended over Europe, and the Institute of
, as a mark of their admiration of his talent, elected
n associate in 1803. In 1812 Napoleon invited
Paris and paid him the most flattering attention-
d at Florence on 8th April 1833.

[illegible] of the artist's work [illegible] published at Flo[illegible] 1819, con[illegible]
[illegible]00 compositions, the name [illegible] artist's
[illegible]. Among the most remarkable, [illegible] dread
[illegible] may be noticed the [illegible]ation [illegible] Raphael a
[illegible] from Murillo; a Head of the Saviour [illegible] Da Vinci; the
Antony from Guido; the Hour [illegible] Espo
[illegible] the Prince of Parma; from Domenichino's Communion
[illegible] XIII. from Crowe's Descent from the Mandorla,
[illegible] Monaldo after Vandyke; portraits of Dante, Petrarch,
Tasso and a number of other engravings. He never
fully maintained the reputation which these exposed to
[illegible] lifetime. Though carefully [illegible] and [illegible]
[illegible]what mechanical and wanting in force and [illegible]

RHOF, DANIEL GEORG (1639-1691), the learned
of a survey of universal literature entitled *Polyhistor*
[illegible] in 1639, studied law at Rostock, and was appointed
or of poetry there in 1660. In 1665 he went to
University of Kiel as professor of eloquence and
the chair he exchanged for that of history in 1673.
at Lübeck in 1691. Of his numerous writings
Polyhistor continues to be of value to the literary
a biographical work displaying much judgment
[illegible] best even books. *Polyhistor*
[illegible] appeared in 1688-1698, the publication of the
[illegible] part of *De Philosophis* and *De Poetis* was
completed by Morhof [illegible]. The last edition is
J. Fabricius [illegible] 1747.

RIAH. In 2 Chron. iii. 1 we read that Solomon
the Temple [illegible] Mount Moriah (הַמֹּרִיָּה
). The name for the hill on which the ancient Zion,
found elsewhere in the Old Testament, and can
have been a current one. But a mountain in the
of Moriah was the place where Abraham was com
d to sacrifice Isaac, Josephus (*Ant.*, i. 13, 2) a sanc-
ne. Μωρίαν ὄρος was the Temple hill, and the same
s extended in the Targums where it is exegetically
on the obscure verse, Gen. xxii. 14 (comp. Jerome,
Quæst. Heb. in Gen. xxii. 2). Probably this tr
already existed in the time of the Chronicler, who
to connect the name etymologically with Jehovah
le station of humility, as is done in Gen. xxii. 14.[1]

Jerome repeatedly call the Temple hill Mount Moriah,
current which the name has with modern writers has
to the erroneous identification of Zion with the western hill
the Tyropœon. In Christian tradition the place of Isaac's
was identified with Calvary or Golgotha. *De Situ Terræ*
mentions a low tower or chapel adjoining the church of th
Sepulchre.

MORIER, JAMES (1780-1849), traveller and auth
born in 1780. Through the influence of his uncle
William Wabdegrave, Baron Radstock, he at an early
entered the diplomatic service, and as secretary t
Elgin followed the grand vizier in the Egyptia
patch. An account of his Eastern experience w
lished in 1812, under the title *A Journey through*
Armenia, and Part of Asia Minor to Constantinople in 1808
1810 to 1810. In which he was the English representative
court of Persia and after his return he published *A*
Journey through Persia to Constantinople between th
1810 *and* 1816. His knowledge of Eastern life an
ners he also turned to account in the composition of
entertaining romances, displaying some skill in the
ation of Oriental scenery and character, and com
powers of wit and humour. The most popular o
were *The Adventures of Hajji Baba of Ispahan*
The Adventures of Hajji Baba of Ispahan in E
1828, *Zohrab the Hostage*, 1832, and *Ayesha the*
Knife, 1834. Morier died at Brighton, 23d March

MORILLON, a name commonly given by tow
the female or immature male of the GOLDEN-EYE
p. 757), the *Clangula glaucion* of modern ornit
under the belief which still very generally obtains
them, as it once did among naturalists, that they fo
distinct species of Duck. The mistake no doubt ori
in, and is partly excused by, the facts that the bird
Morillons were often of opposite sexes, and differed
from the adult male Golden Eye, whose full and he
place is not assumed until the second year. The word
in French in precisely the same terms, but is in that l
applied to the Tufted Duck, *Fuligula cristata*, and is
according to Littré, from *maure*, signifying black.

MORIN, JEAN, or, in Latin, JOANNES MORINUS
1659), the most learned Catholic theologian of his t
one of the founders of Biblical criticism, was born
at Blois of Protestant parents, acquired Latin and
Rochelle, and continued his studies at Leyden. In
in Biblical and patristic lore, he began to waver
Protestantism, and moved to Paris, where he mad
friend in literary circles, particularly Cardinal Du
to whom his conversion to Catholicism is ascrib
1618 he joined the recently formed Oratorian
where he could give himself to quiet study, and
course took priest's orders. In 1625 he visited
in the train of Henrietta Maria, and in 1640 he
Rome, on the invitation of Cardinal Barberini, a
received with special favour by Pope Urban VII
employed him on the commission for forwarding
ject of union with the Eastern Church. He was, h
soon recalled to Paris by Richelieu, and the rest of
was spent among books in incessant literary lab
health, memory, and intellectual vigour remaining
paired even in old age. His pen sometimes broug
into trouble. The *Histoire de la délivrance de*
Chrestienne par l'emp. Constantin, et de la gran
souveraineté temporelle donnée à l'Eglise Romaine
rois de France (1630) gave great offence at Rome

[1] The word Moriah however, can hardly come from רָאָה, "
is perhaps akin to Morel, "provider," "teacher."

ution (1651), directed against faults in the adminis of the Oratory and reflections on the general (Father ong), was strictly suppressed. So, too, his great work ance gave equal offence to the Jesuits and to Port- and even after his death (1659) the polemical ence of his *Exercitationes Biblicæ*, and the exaggera his assertion "sapiunt neoterica. Hæreticos verbe narum non est integra, non apothecæ non lotia, senum, medullam et lodices narium" hence led ants to treat his valuable contribution to the history Hebrew text as a mere utterance of Popish prejudice. us was a voluminous and pedantic writer, and his Pros His principal work on Port- *de disciplina et administ* *causis* and *Opus* *Exercitationes Ecclesiasticæ* and of these would appear to be the ot ordination, etc., to commemorate the visit of Queen Henrietta Maria of Orange, upon the occasion of her *Liturgia Ecclesiæ* and his Hebrew lexicon, *Lexicon Samaritanum*, are also of value. Morin's most famous work is his *Exercitationes Biblicæ de Hebræi Græci et Samaritani Textuum Originis, Integritate, Auctoritate et Editionibus*, published at Paris in 1633, and dedicated to Louis XIII. In this he argues that the Hebrew text of the Old Testament, as we have it, is substantially identical with the original Hebrew text as it left the hands of Ezra and the Great Synagogue, and that the Septuagint version is based upon a Hebrew text which differed considerably from the Hebrew text as we have it. The work is learned and laborious, but its conclusions are not convincing. Morin's other principal works are his *Commentarius Historicus de Disciplina in Administratione Sacramenti Pœnitentiæ* (Paris, 1651), a treatise on the history of penance, and his *Antiquitates Ecclesiæ Orientalis* (Paris, 1682), a work of great learning, but marred by the author's credulity and his uncritical use of his authorities. Morin's *Commentarius de Sacris Ecclesiæ Ordinationibus* was published at Antwerp in 1695, and his *Commentarius de Disciplina Pœnitentiæ* at Brussels in 1703.

MORLAIX, the chief town of an arrondissement of Finistère, France, lies 38 miles west of Brest on the railway from Paris to Brest, and at the confluence of two small streams 7 miles distant from the sea. The port has 13 feet of water at ordinary and 23 feet at spring tides. The entrance of the roadstead is guarded by the Château du Taureau, which stands on a rock in the bay and was built in 1542 to protect the town from the English. Morlaix still contains a considerable number of old wooden houses of the 15th, 16th, and 17th centuries. The most striking piece of

MORLAND, George (1763–1804), animal and painter, was born in London on the 26th of June 176 came of a race of artist. His father, a painter, me engraver, and picture dealer, gave him a careful art t and at an exceptionally early age he produced w wonderful promise. At sixteen he exhibited h the Royal Academy, and even before this his pict found ready purchasers; and some of them ha engraved. But already the taste for dissipation, was stronger in Morland than even his love for a began to manifest itself, and at seventeen he escape the strict discipline of his father's house and a career of reckless prodigality which has hardly a in art biography, for he came round him an *entourage* most fashionable companions, and supporting himself sale of the pictures which he painted. His subjects and scenes f his whole life threw a halo of romance around the o there appeared to be one prospect of amen He went to reside at Kentish Town, came under the ence of better companions, and married the sister of Nattes, and a sister of James Ward the eminent and William Ward the engraver. The style of Morland painted during the period when he was at the h way of life. The folly and frolic, true, M and Peters on seduction, revelries in the He hurdle, were executed at Hampstead exceedingly p But soon the tide of ill luck began to set in. Mor for freedom and began to return to the habits redoubled sobriety, and to paint with untiring ardour and intemperance. The more he did the less he got not wanting, the dealers were ever ready to purch indeed, so eager were they deemed that keen were employed to watch the moment when the p on which he was at work, when it was sold and an unfinished picture. The time of Morland's career from 1790 to 1795 he painted the of a Stable now in the Vernon Gallery, probab several times repeated. So great was his popularity a reduction in prices became necessary, and a time he obtained the highest sum ever paid in November 1791 he was arrested. Obscure th of the law he had been within bounds, an turned to pecuniary difficulties and by drunkenness was released only by the Insolvent Act of 1802, health was ruined. He was speedily stricken with t, but he [illegible] he was [illegible] for [illegible] at [illegible] house in Eyre Street, Cold Bath Field, on the October 1804. His wife survived him only some days, and they were buried in one grave.

[illegible] of Morland are those which [illegible] with [illegible] [illegible] [illegible]

...ood visions in one of which on the night of 21st ...ber 1823 the angel Moroni appeared to him three ...nd told him that the Bible of the Western Continent, ...gether with the New Testament, was buried in a ...ain at Manchester. Further four years later ...ng an ordinary probationer, Smith went, and had ...ven him by an angel of the Lord a stone ...h he was to obtain, cut the third made of three gold ...tes by 7, and to reveal to others by these gold ...The plates were covered with small writing in the ...ed Egyptian language, and were accompanied by a ...upernatural pectoral, consisting of two crystal ...ones fixed in a silver bow and called Urim and Thummim, ...or rims, the use to which stones could be used ...hem will be described later. Smith at once decided to read and write thereby, and the ...ry was soon assisted by Oliver Cowdery, to whom, ...hood's account, he dictated a translation, which, ...ed of a character Martin Harris, who had more ...han was prepared and published in 1830 under ...e of *The Book of Mormon* and accompanied by the ...atements of Oliver Cowdery, David Whitmer, and ...Harris that the angel of God had shown them the ...of which the book was a true history. This is to ...ll three, on a certain day in June in the year ...ceive the plates, but unavailingly, helped Smith ...on the translation, particularly in the absence of ...d plates themselves, which nobody and nowhere ...appeared. The *Book of Mormon* avers that Joseph ...s declared to be God's prophet with all power ...ted to all other prophets before him, and to be ...ne to whom the Lord entrusted the holy ...owers of baptism, and to build such a church as ...ould be pleasing to Him. The contents of the ...ook are of little importance. They are a farrago ...ense, the whole purporting to be the history ...ous tribes of Israel who, after the destruction ...Jerusalem by Titus, had been led to the American ...ent by the prophet Lehi. Lehi's two sons, Laman ...Nephi, with their families, quarrelled, and their ...ants became the Lamanites, the ancestors of the ...n Indians, while the Nephites, who were ...ed to be the ancestors of the white races, became ...ful. Between the Nephites and the Lamanites ...ong and bitter war was maintained for centuries, ...ually, in spite of divine intervention in the person ...ncarnated Christ, the Nephites fell away to the ...ds, and in 384 A.D. were nearly annihilated by ...ir kinsmen in a battle at the hill of Cumorah, ...ar Palmyra, Ontario county, New York. Among the handful that ...ed were Mormon and his son Moroni, the former of ...m collected the sixteen books of record kept by ...ous prophets, into one volume, which on his ...h he committed to his son with the command ...ld and buried in the hill of Cumorah, ...ing that the book would one day be ...ed to the world, chosen prophet. The ...Smith's ...of the book, but in reality it was written in 1812 ...ecently proved by one Solomon Spalding, a retired ...preacher, and fell into the hands of an ...printer named ... Sidney Rigdon was copied by him, ...ently passed to Joseph Smith. Armed with ...d and with ... divine authority, the latter ...an to attract ... On 6th April 1830 the ...ation of the new ... by their neighbours ..., but by them ... Latter Day ...of Jesus Christ, was ... at Fayette, Seneca county, ...rk, and in the same year another revelation was ...d by Smith, proclaiming him "seer, translator, ..., apostle of Jesus Christ, and elder of the church," ...now began to baptize. But, his character, which ...one of the best, being too well known in Fayette, he found it convenient to remove with his followers, thirty in number, to Kirtland, Ohio, which was ...the seat of the New Jerusalem. Here he had a ...revelation, directing the saints to consecrate all their property to God and to start a bank. This being done, Smith appointed president of the bank, the country was flooded with worthless notes, which fact, added to other irregularities, incensed the neighbouring Christians, and on the night of 23rd May 1832 a number of them dragged Smith and Rigdon from their beds, tarred and feathered them. One year later, the ... was further incensed with the three presidents Smith, Rigdon, and Frederick G. Williams, who were styled the "presidency," and entrusted with the keys of the kingdom. About this time the heretofore ... might have led to the dissolution of the church but for the accession of Brigham Young, a Vermont painter and glazier thirty years old, who settled in Kirtland in 1832, and immediately attained to the "Young" indomitable will, ... character, creative ability, brawniness, and ... reliance left, and, when a further step was ... to be toward the consummation of a theocratic ... dictatorship of the "twelve apostles," were sent out to preach the new revelation, the ... Young was ordained one of the "twelve" and ... despatched to preach Mormonism throughout the eastern States. In a large temple ... consecrated in Kirtland, and in the ... year Orson Hyde and Heber C. Kimball were ... missionaries to England, where among the labouring ... in Manchester, Liverpool, Birmingham, Preston, Glasgow, ... and the mining districts of South Wales they achieved ... remarkable success. Early in 1838 the Kirtland ... Temple, and Smith and Rigdon fled to Caldwell county, ... Missouri, where a large body of the saints, after having been driven successively from Jackson and Clay counties, had taken refuge and formed a settlement. Smith's troubles, however, continued to increase. His gross profligacy ... many of his leading supporters and bred much ... dissension, while from the outside the brethren were ... and threatened by the steadily growing hostility ... of the native Missourians. To counteract the effects of ... enemies, a secret society was organized in Smith's ... in October 1838, called the Danites, with the ... purpose of supporting Smith at all hazards, of upholding ... the authority of his revelations and decrees as superior to ... the law of the land, and of helping him to get possession ... first of the State, then of the United States, and ultimately ... of the world. To such a height did the inner dissensions ... and the conflicts with the "gentiles" grow that they assumed ... the proportions of a civil war, and necessitated the calling ... out of the State militia. Defying the legal officers, they ... fortified the town and armed the saints, but finally, ... succumbing to superior numbers, Smith and Rigdon were ... arrested and imprisoned on a charge of treason, murder, ... and felony, and their followers to the number of ... crossed over into Illinois and settled near Commerce in ... Hancock county. Here they were shortly afterwards rejoined by ... Smith, who succeeded in escaping from prison, and, having ... obtained a charter they founded the city of Nauvoo. The ... powers granted them by this charter were so ample as to make ... the city practically independent of the State Government, ... and to give Smith all but unlimited civil power. They ... organized a military body called the Nauvoo legion, of ... which he constituted himself commander with the rank of ... lieutenant-general, while he was also president of the ... church and mayor of the city. On 6th April 1841 the ... foundations of the new temple were laid, and the city ... continued to grow rapidly in prosperity and size. But ... Smith's vices were beginning to bear fruit. Some time ... previously he had prevailed on several women to

him, and in order to pacify his lawful wife and silence objections of the saints he had a revelation on 12th 1843 expressly establishing and approving polygamy. proclamation of the new doctrine created wide prejudice, which found special expression in the press. one *Expositor*, a newspaper published by an old friend Smith, one Dr Foster. Smith at once caused the *Ex* printing-office to be razed and Foster to police on which the latter procured a warrant for the arrest of Smith, brother Hyrum, and fifteen others. Smith resisted militia was called out, the Mormons armed themselves a civil war seemed imminent when the governor of State persuaded Smith to surrender and he and Hyrum accordingly, on 27th June 1844 he and Hyrum were murdered in Carthage jail but that night a mob broke into the prison and beat the two men dead. The thing was the most fortunate there that had ever happened to the Mormon cause. It threw the murderers dent with the halo of martyrdom, and effected a political election of his successor to the interest of the Mormons. the confusion that followed Smith's murder the Mormons profited by procuring the removal from the penitentiary by the connivance of the Governor, upon which his splendid services obtained for him a pardon. subsequent events constantly proved. He subsequently witnessed what appeared to be the culmination of misfortunes. The legislature of Illinois repealed charters of Nauvoo and created out of the territory one that the leaders resolved to concentrate promptly, and preparations were made for a general exodus. ward. Early in 1846 a large number of the Mormons at Council Bluffs, Iowa, and those who had travelled and soon found cause to regret that they too had left Nauvoo, as in the September of the same year city was cannonaded, and the Mormons were driven

Meanwhile pioneers had been despatched to the at Salt Lake valley Utah, and their report proving favourable, a large body of emigrants was marched with military discipline across the wilderness to the valley, where they immediately proceeded to found Great Salt Lake City, where on 24th July 1847 they were joined by their of, Brigham Young. In the May following the main body of the saints set out to rejoin their brethren, and in autumn of that year reached Salt Lake City. Large lots of land were at once put under cultivation, a great city sprang up as by magic, and the untiring industry, energy, and zeal of the emigrants turned a barren wilderness into a fertile and blooming garden. An emigration was organized, missionaries were sent out and converts began to pour in from all quarters of the globe particularly from Great Britain, Sweden and Norway, and less numbers from Germany, Switzerland, and France. Strangely enough, and the fact deserves emphasis, Ireland furnished few if any recruits to the cause of Mormonism.

In March 1849 a convention was held at Salt Lake City, and a State was organized under the name of Deseret, meaning "the land of the honey-bee." A legislature was elected, and a constitution framed which was sent on to Washington. This Congress refused to recognize the new way of compromise for declining to admit the prospective State into the Union. President Fillmore in 1850 organized the country occupied by the Mormons into the territory of Utah, with Brigham Young as governor. District judges were also appointed by the Federal Government; but in 1851, a few months after their appointment, they were forced to leave by the aggressive tactics of the Mormons. Such bold defiance of the Federal Government could not be ignored; Brigham was suspended from the governorship, and Colonel Steptoe of the United States army appointed in his stead. The new governor, backed by a battalion of soldiers, arrived in Utah in August 1851, but no stronger was the opposition which he met with that he dared not assume office, and was forced to content himself with merely wintering in Salt Lake City, after which he withdrew his troops to California. Nor did the other civil officers appointed by the United States Government at the same time show any bolder front. In February 1857 a band of armed Mormons broke into the court-room of the United States district judge, and forced Judge Drummond to adjourn his court *sine die*. He subsequently precipitated the flight of the other civil officers, and with the exception of the United States Indian agent withdrew from Salt Lake City. The outcast Executive Buchanan to appoint a new governor in the person of Alfred Cumming, the superintendent of Indian affairs in the upper Missouri who in 1857 went to Utah, accompanied by Judge Eckels of Indiana, a civil service by a force of 2000 soldiers. Incensed by this action, Brigham Young hastily called the militia to arms in September the United States army reached Utah, and 6th October a band of mounted Mormons destroyed a number of the supply trains, and a few later cut off 800 cows from the army now commanded by Colonel A. S. Johnston, compelled it to encamp for the winter of November to go into winter quarters at Black Fork near Fort Bridger. In the spring of 1858 a party of Mormons under Lot Huntington and led by a Mormon bishop named John D. Lee, captured a train of 150 wagons belonging to Messrs Myers & Co. at Mountain Meadow, near Utah Lake, and murdered every soul. Governor Cumming soon succeeded in persuading the Territory to submit to the authority of the United States, through the mediation of Thomas L. Kane of Pennsylvania, armed with a letter of authority from President Buchanan, the Mormons were induced to submit to the Federal authority, accepted a free offer of pardon made to them by the United States Government at the conclusion of their submission. Matters being thus settled, the Federal troops encamped on the west or shore of Lake Utah, some 40 miles from Salt Lake City, where they remained until withdrawn from the Territory in 1860. On the close of the American Civil War a Federal governor was again appointed, and in 1862 polygamy was declared to be a misdemeanour, and Brigham Young was arrested. This action, however, on the part of the United States Government was merely pro forma, the Mormons continued to practise polygamy and to increase in wealth and numbers, and in 1867, when Brigham Young died leaving a fortune of £2,000,000 (£1,000,000) to his wives and children. He was succeeded as prophet by John Taylor, as High Priest, although, as real leader he fell to George Q. Cannon, who must also be regarded as the ablest Mormon of all. The year 1872 was otherwise remarkable in Mormon history by the final secession, and excommunication of John Le, for the Mountain Valley murders of 1857. Of late years the agitation of Mormonism has largely occupied public attention. In 1872 Mr Lochnbar introduced a bill for the complete suppression of polygamy, and declaring that marriages contracted in accordance with the rites of any religious body should be void. In 1874 the committee of the House of Representatives reported a bill which reduced Utah to the position of a province, placed the control of affairs in the hands of Federal officials, and practically made bigamy, the same year George Q. Cannon was elected a delegate from Utah, and though his election was contested was confirmed by the House of Representatives. This decision, however, was accompanied by the passing of a resolution by a vote of 127 to 51, appointing a committee of investigation into Delegate Cannon's alleged polygamy. It has

…erted, to…wive… Later in the same year the …Judiciary Bill, attacking the very foundation of …m, pa…d the House in spite of the eloquent …ion of Cobden. Other steps in the same direction …ere taken, and bill…, proved, having for their …he separation of polygamy, but all without imme…ediate practical effect. It is, however, a question of …rely polygamy is doomed. The opposition chiefly …ed by its opposition to the practices of Brigham …ung, a Christian preacher, and to a large body …anti-polygamist who claim to be the true Latter-…ay…, represent not an individual opinion but the …ated conviction of a great party, and the days not …g when the Mormons who accept Joseph Smith …s chief prophet must consent to forego polygamy …to secure a corporate body of the United States …there are not wanting hints of upon-closing dis…, of which perhaps the most important is the …of the so-called Church of Jesus Christ of Latter-…ay…, held on 6th April 1863, at Kirtland, Lake …, Ohio. The…ed organization in 1851, seven years …Joseph Smith, when several officers of the …ch and ordained to these received a revelation re…ecting their immediate Brigham Young as …be divinely appointed and legitimate successor …Smith, and a…ounced the proclamation of which the …as polygamy. Young, Utah, God worships, and the right …blood atonement. No…ge of personal interpret…d, however, until 1860, when Joseph Smith, jun., …ed to assert the position of the family, be…identi…th the Reorganization, to prevent Brig…e society have prosecuted their…ionary work through…United States, Great Britain, Canada, Scandinavia, …land, Australia, and the Society Islands, until their …ecruits are said to number over 27,000. Their …arters are at Plano, Illinois, to which place they …d from Lamoni, Iowa, in 1881. The Reorganized …hold that the legitimate succession to Joseph Smith …elder line, that the delegation that Smith intro…polygamy on the strength of divine revelation was …ception of Brigham Young, that the Utah Church …arted grievously from the faith and practices laid …in the *Book of Mormon* and in the secret revelations …eph Smith, and that the Reorganized Church is the …ue and lawful continuation of, and successor to, the …Church, and as such is legally entitled to all that …property and rights. And it was to celebrate the …n of the United States Court of Ohio confirming …-claim, and restoring to them the right to the temple …ated in Kirtland, Ohio, in 1836 and formerly held …ly used owing to litigation, that the Reorganized …ject in that temple on the 6th of April 1883.

…owing to the…rmon body, it may be added that the …tion of Utah is 147,000, of whom 123,000 are …, but as the Saints are scattered over the globe …difficult to arrive at a just estimate of their complete…ical strength. In Idaho, Arizona, Washington …do, Montana, and Wyoming they have of late years …great progress, and their number in the United …outside of Utah cannot fall much under 27,000. …hope they have…ch many adherents and a record …based on recent official returns, would place their …number at 213,000.

At the head of the body is a president, who pos…supreme authority, supported by two counsellors. The…e supposed to be the successors of Peter, James, and John, …titute what is known in the Mormon priesthood as "the First Presidency." The next in…authority, who is chief duty is to help and lay on hand…and to the "twelve apostles," forming a travelling high council…ving a salary of $1000 a year each. Of the…e the president …ike to one, and endowed with authority equal to the other…

…ers. Their duties are important. They ordain all other o…s priests, teachers and deacons, lead all religious me…dminister the rite of baptism and sacrament. Fourth…even presidents of the seventies, each body comprising s…the seventies at present in Utah, each of which has…sident and every seventy one president. The seventies…respond…and to the missionaries and proselytes…ary. Fifth come the high priests, whose chief duty is to o…in the affairs of the church or the decrees of any higher…ers. After these come the priests, who appoint…ers of their own, which amount to 1000 annually…ch has a president, …up of a bishop, seven having a presidency, …and twelve assistants, who are ordained into an order, …which is the normal rank of teachers, deacons, …body, the members of which are…ectors, bishops, …ers, priests, teachers, deacons, and ushers.

The Mormon no longer claims to be a Christian…ers. Moroni, Mahonri Moriancumer, Alma, Amulon, polygamy…ers. The Book of Mormon, according to which the…ople are descended from Shem, the people of Shiz, Ether, of a…ecord of the people of Adam and Seth, who is the deity…ers, Moroni, Mormon, Mahonri Moriancumer, Joseph Smith…ers. Mormon, Alma, Amulon, Nephi, Moroni

572 he returned to France, and had begun to enter
a diplomatic career (his earliest extant "memoire,"
y Coligny before Charles IX, had reference to the
of France to support the Low Countries in their
le for independence) when the St Bartholomew ma
from which he escaped with difficulty, compelled
take refuge across the Channel. There he rendered
le services to William of Orange, and also to the
f Alençon Anjou, as a semi-official political agent
ing to France at the entrance of La Noue toward
d of 1573, he took part with various success in
ous military enterprises, and was made prisoner a
s in 1575 (10th October), but not having been re
d he set off for a "mad ride" on. Shortly afterwards
rried Charlotte Arbalète at Sedan, and at her re
wrote as a bridal present the *Discours de la Vie et
Mort* (1576), which has been often reprinted and
ted. In 1577 Henry of Navarre made from a mom
his council and sent him on a diplomatic mission to
nd, and during this visit, which lasted more than a
e found time among his other pursuits to compose
ance for the pro[illegible] *Vraye Religion Chrestienne*,
Geneva 1578), which at once became popular. From
s till his return to France in 1582 he was chiefly
Low Countries, engaged in public business, and
this interval he wrote and published a considerable
in apologetical theology (*Traicté de l'Eucharistie en
la Chrestienne contre les Athées, Epicuriens, Payens,
etc.*, 1581). With the death of the duke of Anjou
, by which Henry of Navarre was brought within
of the throne of France, the period of Mornay's
st political activity began; his importance in the
not councils was further increased in 1585 by the
of the prince of Condé, to whose influence he practi
ucceeded. In April 1589 he was rewarded for the
liation of the two Henries with the succession hip of
, and he took active part in many of the military
ions that followed the assassination of Henry III.
following August. He was present at the battle
, fought by the exile of Henry IV. at Ivry, and was
the besiegers of Rouen in 1591-92, and of course a
t to the court of Elizabeth. Next in his political
was marked by Henry's abjuration of Protest
in July 1593, which gradually led to Mornay's
awal from the court. In this year it was that he
d the Protestant academy or university of Saumur,
had a distinguished history until its suppression by
XIV. in 1685. In 1598 he published a work on
he had long been engaged, entitled *De l'Institution,
et doctrine du sainct sacrement de l'Eucharistie en
ancienne*. It having reached his ears that Cardinal
ron had alleged that of the fifteen hundred
ions controversial work he could point out two hundred
rein falsified or misunderstood, he challenged him
ut to a public discussion. This was at last arranged
the good offices of the king, and took place at
nebleau on 4th May 1600. Only nine days were
ssigned, but in each of the days, one or more
ed in the circumstances to learn, went [illegible]
ant. Mornay, from whom every indication of the
lar passages to be impugned had been persistently
ld, was forced by supervening illness to withdraw.
nces again did he appear at court, in 1601. He
ued, however, to give his party the benefit of his
l and active support to the end of his long and busy
His last work, entitled *Mystère d'iniquité, ou
histoire de la Papauté*, appeared in 1611. In 1618
chosen a deputy to represent the French Protest
the synod of Dort. Prohibited by Louis XIII.
from personally attending, he nevertheless contri
buted materially to the deliberations of that assembly by
communications. In 1621 he was deprived of his go
hips and his death took place at La Forêt-sur-Sè
11th November 1623.

Two volumes of *Mémoires*, from 1572 to 1652 appeared
four in 1624, and a continuation in two volumes, at Am
in 1652. [illegible] *Mémoires* [illegible]
in five volumes, were published at Paris in 1824-25.
letters remained in MS. were translated into Englis
by Hotoman.

MORNY, CHARLES AUGUSTE LOUIS JOSEPH, DUC DE, b
15th Jan. 1811, was the natural son of Hortense Beauh
queen of Holland, and of the comte de Flahaut, a
dandy of the period, and was thus brother to Na
III. The secret of his birth (23d October 1811) was w
fully kept: he was not acknowledged as son by the co
Morny for a consideration, and was brought up
paternal grandmother, Madame de Souza, a wi
society novel, and a woman of rare wit and high b
At a boy of nineteen he was declared after the re
15th to 30th of July, and was entered at the Ecol
In 1832 he was gazetted aide-de-camp, and
Algeria, where he remained to General Oudinot, he w
sent at Mascara and Constantine received a medal
of the Légion of Honour. In 1837 he returned to
and began his career as dandy and speculator
his capacity he set the fashion for the cut of the coat and
to the young men of Paris, and conceived the no
modern society journal, and in the second year
manufactory of beetroot sugar at Clermont-Ferrand
In 1842 he brought about his election to the departm
the Puy de Dome. In the chamber he voted
with the ministry. The rejection of his mari
ceremonious entertainment, and by legal diffi
failed, and all his property was sold. In de
determined to play a part in politics, and was the
send out at the [illegible] of December 1851. The
of the *coup d'état* was [illegible] to the hea
extreme republican enthusiasm by the great magn
the notion, and all that was needed was a head for
and an attitude above [illegible] to lead moderate
Morny and St Arnaud fulfilled the [illegible]
was on the day of the [illegible] made minister
interior, but he had not to [illegible] the drudgery of a
transaction, and in fact, [illegible] found no scope for h
on the question of the property of the Orleans
The empire established, he was [illegible] able to begin
[illegible] of a man. He looked upon [illegible]

of view, and would not have denied it, but he was shrewd enough to perceive that the emperor relied on the protestant mutineers of Ghent not only in war but in diplomacy, and must strongly urge the emperor to make Paris the capital of religion for the whole civilized world he knew he was not over pleasing himself but doing service to the empire. He was a thoroughly able man of the world, and was witty as well, but the wit does not appear at its brightest in his plays, which were written under the name of Samuel Rowley, of which perhaps the most readable is *When You See Me You Know Me*. He had great influence over the emperor, but could lay no claim to personal regard; he could be cruel also, but equally unscrupulous colleagues, Simon Renard

[illegible] Granvelle, Mary Tudor, [illegible]

[illegible] Count de Feria, the duke of Medina Sidonia, [illegible]

MORO, ANTONIS (c. 1512–1568), otherwise known as Sir Antonio Moor, an eminent portrait painter, was born at Utrecht, according to some, but in 1520 according to Van Mander in his *Het Leven der Schilders*. He studied his art under Jan Schoorel, and after making a professional visit to Italy he commenced to paint portraits in the style of Hans Holbein. His rise to eminence was rapid. In 1552 he was invited to Madrid by the emperor Charles V. to execute a likeness of Prince Philip. Two years afterwards he was in London painting the portrait of Queen Mary. For this picture an annual salary and, as some suppose, the honour of knighthood were conferred upon him. He was also employed to sketch the likenesses of several of the English nobility. On the death of Mary in 1558 Moro returned to Spain, and lived there for two years in great honour with Philip II., executing, in addition to portraits, several copies after Titian. Having compromised himself with the Inquisition, he repaired to the Netherlands, and was received into the service of the duke of Alva. His death took place at Antwerp about 1568. Among his figure pictures Van Mander specifies the Crucifixion of Christ, executed for Antwerp cathedral, as one of the most notable. His portraits are full of individuality and characterized by firm and solid rendering of flesh. Several admirable examples are preserved in Madrid, among the best the portrait of Queen Mary of England, which has been excellently etched by Mr Lucas (1st December 1878). Moro's style, says Stanley in his *Dutch and Flemish Painters*, "so much resembles that of Holbein as to frequently create a doubt to which of them a portrait is to be attributed, but he is not so clear and delicate in his drawing (perhaps from having painted so much in Spain) as that master."

MOROCCO, or Marocco, the term corrupted from the name of the city Marrakush, used in English to designate the Maghrib al Aksa or extreme west of the Arabs, the country at the north-western corner of the African continent, with the Mediterranean on the north and the Atlantic on the west. Its landward limit can only be vaguely defined. The eastern frontier toward Algeria, determined by the treaty of 1845, is a purely conventional line, starting from the mouth of a small stream called the Sikkak and running across country in a general south-east direction. The southern boundary, ever expanding and contracting according to the power and activity of the central authorities, Behm and Wagner (1882) who include Tafilelt, Kenatsa, Figig, Twat, Touat, Tidikelt, the plateau of Tademait, &c., estimate the total area of the sultanate at 309,548 square miles, and this, which is about twice the size of Algeria, or five times that of England and Wales, may be taken as a maximum. The allegiance of many of the tribes within this compass is questionable and intermittent. Morocco is still the portion of Northern Africa about which European information is most defective, and the ordinary maps are composed to a large extent of most unscientific material eked out by probabilities and conjecture. Since the middle of the present century a good deal has been done in the way of exploration, mainly in the lowlands and steppes toward the Atlantic, the country of the great historic cities of Tangier, Fez, Mekinez (Mequinez), and Morocco, but even there what lies but a few miles east or south of some track traversed by Europeans for centuries is a matter of conjecture.

Since the publication of Arlett's survey from Spartel to Cape Bojador (1840–41) and of Vincendon Dumoulin and Kerhallet's surveys from the Strait of Gibraltar to the Algerian frontier (1853–57) the seaward face of Morocco has been known in detail. To the Mediterranean it presents for a distance of about 200 miles a rugged profile of the Rif hills (still unexplored), generally end on lines of cliff broken at intervals by long sweeps of sandy beach, but occasionally open up into fruitful and fertile valleys, with abundant evidence of ancient occupancy and tillage. About 6 miles west of the Algerian frontier lies the mouth of the great river Muluya, and 10 miles further on, opposite Cape del Agua (Ras Sidi Ben Sakkom), a group of dry and barren islands known as the Zaffarines, which form the best roadstead on the Rif coast. Between Point Quiviana and Melilla runs a low and sandy shore in front of a great salt marsh, the Puerto Negro of the Spaniards. Melilla (Mahlaa) is a fortified town held by the Spaniards since 1563, built on a rocky peninsula and connected by lines of rampart with Fort Rosario on the heights behind. Near the village of Azanen is the open shore with the only sand-dunes on all this coast. The fine semicircular bay of Alhucemas is the site of one of the most beautiful valleys in the Rif, well wooded and dotted with handsome villas. A Spanish fortress occupies one of the larger of the Alhucemas islands (Mazemma), which are identified with the Ad Sexsi of the itineraries. Another Spanish fortress crowns the rocky island of San Antonio or Penon de Velez; in the valley off which it lies stood a town known to the Spaniards as Velez de Gomera, to the Arabs as Badis, which continued to be a place of importance in the 16th century. The so-called Bay of Tetuan (Tettawin), the town of which is visible from the sea, is little more than the straight coast between Cape Mazari on the south and Cape Negro or Negrete on the north, but the prominence of the headlands gives it an appearance of depth. From Negro northwards to Ceuta the most notable object on the horizon is the summit of Jebel Músá, which, situated on the Strait of Gibraltar, towers above the [illegible] hills. Ceuta (Sebta), the most important of the Spanish settlements in Morocco, stands on a peninsula, the head, Mt. Acho, standing about a mile out to sea, and the neck being low and narrow. In the eastern end of the strait. Westwards, the first point of interest is again Jebel Musa, the Elephas of Strabo, the Apes Hill of English charts, the truncated summit usually hid in clouds. About 20 miles farther along the coast lies the Bay of Tangiers (Tanja), by far the best harbour in Morocco. West from Tangiers runs the Jebel Kebir (880 feet at its highest), the seaward extremity of which forms the celebrated Cape Spartel, the northern angle of the African continent, known to the ancients as Ampelusia or Cotes Promontorium. The lighthouse, built in 1861 at the cost of the sultan of Morocco, and maintained at the joint expense of England, France, Italy and Spain, is the only one on the western coast.

The Atlantic coast of Morocco is remarkable for its regularity and sameness; not a single gulf or notable estuary occurs throughout its whole length; the

[1] The name is derived from the Arab tribe of the Beni Jaffar settled on the neighbouring mainland at the conquest. Since then the island have belonged to Spain. They are identified with the Tres Insulae of the Roman itineraries.

Statute Miles
0 20 40 60 80 100

ATLANTIC OCEAN

MEDITERRANEAN SEA

Ceuta
Tangier
Tetuan
Larash
Ras el-Kebir
Marja Zarka
Ras al Dura
Mehedia
Sallee
Rabat
Fez
Taza
Melun
Oran
Mascara
Sidi Bel Abbes
Tlemsen
Waida
Selida
Tiaret
Bara
Zaida
Shelif
Shott Shergui
Shott el Hodna
Biskra
Algiers
Blidah
Medeah
Milianah
Tenes
Mostaganem
Arzew
Oran
Mers el Kebir
Nemours
Melilla
Jebel Kebdana
Jebel Kerker
Jebel Tazzeka
Jebel Tidighin
Jebel Ouarsenis
Jebel Dahra
Jebel Amour
Jebel Sahari
Jebel Aures
Jebel Metlili
Jebel Bou Kahil
Jebel Sarsou
Jebel Tessala
Jebel Nador
Jebel Tuggurt
Jebel Sidi Rgheis
Jebel Ksel
Jebel Mzi
Jebel Ksour
Jebel Amour
Jebel Sahari
Jebel Aures
Jebel Metlili
Jebel Bou Kahil
Jebel Sarsou
Jebel Tessala
Jebel Nador
Jebel Tuggurt
Jebel Sidi Rgheis
Jebel Ksel
Jebel Mzi
Jebel Ksour
Shawia
Dukkala
Abda
Haha
Shiadma
Rahamna
Sraghna
Dahara
Saffi or Asfi
Mogador
Agadir
Tarudant
Tedsi
Telohint
Tatta
Figig Oasis
Mzaghra
Erfoud Oasis
Tafilet
Habilat
El Beharat
El Metallet
El Erg
Ghadames
Ghat
Ghadames
Ghat
Ghadames
Ghat
Ghadames
Ghat

v and for the most part feebly marked. South rom Cape Spartel the shore sinks rapidly till it a few feet of the sea-level. In the low cliff which s about 4½ miles from the lighthouse there is a narry, which from remote antiquity has yielded the nills used in the Tangiers district. A stretch of ushy ground along the Tahaddart the estuary of di Kebír (W. Mubarhar) and W. al Kharrub agrees eylax's Gulf of Cotes (Tissot). Three or four miles south lie the ruins of the town of Nebrodh, built by from Andalusia, and 4 or 5 miles more bring us to or Arzilla, the ancient Colonia Julia Constantia Zilis. Since its bombardment by the Portuguese in 1829 been a wretched little place, with a mixed Moorish ewish population of about 1200. For the next 16 between Azila and Larash or El Araish (see) the as a tolerably bold background of hill, Jebel Sarsar forming an important landmark for the latter town, with its Phoenician, Roman, and mediæval remains, rically one of the most interesting places in Mo of reddish cliffs about 300 feet high runs south out 10 miles from the W. Anjera, at whose mouth s built; then the coast sinks till at reache Mula lham, an eminence 220 feet high. Between Mula lham (often wrongly called Old Mamora or Mamore) similar height crowned by the tomb of Sidi Abd Jebli lies the outlet of the Blue Lake (Maja Zerka), 12 miles long. Further south, and separated from a by an unbroken line of rounded hills (230-260 s the much more extensive lagoon of Ras al Duma, in the dry season becomes a zone of marshy acres, the rainy season fills up and discharges into the Eastward it is connected with the Marjat al Ghaila, the W. Medas. On the south side of the outlet of ebú lies Ma'múra, probably founded by 'Abd al n, and originally named Mahdiya, after the Almohade . Twenty miles farther s. the mouth of the Bu k, with its cluster of interesting towns. Salle (Salat) north side, long famous for its pirates and still one most fanatical places in the empire, and on the south New Sallee (Rabat) with its conspicuous tower of , and Shella (Sella of Leo Africanus) with its interruins. Onward for 100 miles to Point Azammur e mouth of the Umm Rabí' river a line of hills skirt ; the shore is for the most part low, and, with the ion of capes at Fedala (a small village) and Dar al or Casa Blanca, it runs in a straight line west-south Casa Blanca, the ancient Anfa, once a flourishing was named by the Portuguese (1468) in reverence for acies. It is now a place of 4000 inhabitants, and thriving export trade in maize, beans, and wool. European colony of about 100 persons. Azammur s, in Berber, "The Olives," viz., of the Shekh Bu o, with 1000 inhabitants, dependent on the shoals es in the river, stands on an eminence about 1½ from the sea on the south side of the Umm Rabí ay of Mazagan (Mazíghan), a few miles to the south, westward with a boldness of sweep unusual on the The town of Mazagan was founded by the Portu in 1506, and held by them till 1769. About 8 to the south and less than a mile inland lie the sive ruins of Tit, a town which proved a thorn in de of the people of Mazagan till they sallied forth and destroyed it. At Cape Blanc (so called from white cliffs) the coast, which bulged out at Cape Mazag again bends east to resume much the same gene direction for 55 miles to Cape Cantin. On the stre the only point of interest is Wahdiya, formerly Al Gha the excellent harbour praised by Edrisi is formed by extensive lagoon, and M. Tissot thinks that by a li dredging the place would again become the safest a ping station on the whole Morocco seaboard. Beyo Cape Cantin (300 feet high) the coast becomes bolder more irregular, especially after the mouth of the Tens passed. About 18 miles farther is Safi (Asfi), by the most picturesque spot on the west coast, with the h wall and square towers of its Portuguese fortifications shown to advantage by the ruggedness of the site. Saf of Mogador (q.v.) and onwards beyond the limit of Moroc the coast, becomes ever more and more macadamizable dangerous in winter, as emphatically known as the I Coast. From Cape Sim or Ogueir Ba Tarawalt), 10 mi south of Mogador, the direction is due south to Cape (Ras Ut'ama) the termination of Jebel Idrá Tamara Ra Mardochee), the last spur of the Atlas proper. Round this headland we reach Agadir (Agadir n Ifrán, the Sa Cruz Major or Santa Cruz de Berberia of the Spaniar formerly known as the Gate of the Sunset. It is a fi town with white battlements, three-quarters of a mile circumference, on a steep eminence 600 feet high. the 16th century it was seized by the Portuguese, Don Manuel caused it to be fortified, but in 15 was captured by Muley Mahdan Ahmed al Hasan merchants were removed to Mogador in 1773. At mouth of the Sus Leo places three little towns called Me (Massa), with a mosque popularly reputed the scene Jonah's recreation to *Cetus ceto nec*. The port of this nam regularly visited by the Genoese traders in the 16th centu who exported lime, gum, wax, gold, and indigo. Immedi at the mouth of the W. Massa 20 miles farther south Ifrán, situated in 29° 23' N. lat., and Sidi Wonzek, the C Non of the Portuguese are the only points calling notice till the better known Cape Nun is reached, which 5 or 6 miles north of the W. Draa. With the Draa Sahara may be said to begin.

On most maps of Morocco is represented extremely mountainous; but, while it is traversed from to west by more than one sharply defined range, the gr part of the surface is really occupied by undulating ter like tracts divided by low hills. The backbone of country is the Great Atlas, Dyrin of the Berbers, its western extremity the range averages from 1000 5000 feet in height, after a slight falling off for a mile it rises till at Aremd an elevation of 10,000 f beyond the pass (about 60 miles from the coast) which b from Morocco to Taroudant the summit seems to be betw 11,000 and 11,500 feet, about 10 miles farther east i a second pass at an altitude of about 7000 feet, beyond that the mountains continue 30 miles at a hei of about 12,000 feet, with a few peaks reaching to 13 or 13,800 feet. Snow lies on some of the summits a

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e absurd story that about the 9th century it was an English ion has its root in the visits of the Normans to the quarter odern town sprang from a fortress built to protect the coast them (Dozy, *Recherches*, 3d ed., ii. 261 *sq.*).

e Portuguese settlers, who had to leave it when Don João decided endering this last stronghold of his country in Morocco, were afterent to Brazil, where they founded Villa Nova de Mazagan.

[illegible] Part I.

[illegible] connected with Santa Cruz de Mar Pequ [illegible] established on the Haza, one where in the [illegible] the Canary Island, and in modern times the object of numer [illegible] graphic exploration. After a [illegible] period was [illegible] the Spanish Government was unable [illegible] costs of

See Valentim Fernandes, *Descripção de [illegible]*, Mo the Arab of Marmol, 3d Chap., pt. [illegible].

Va'Dala, *Descr. de Marrocos*, p. 129; *Hist. des Berbères*, ii. No, Noh, Nou, Naou, Nao, or among the Arabs Wadan was another Cape Nou to the east of Cape Bojador which ca have given rise to the proverb, *Quem passar o cabo de Nou e [illegible] ou não*. See *Bol. da Soc. Geogr.*, p. 416, Madrid, 1880.

Pliny says the natives call the Atlas "Dyrin."

s, but it is probable that none of them retain it
hout the year. Taken as a whole, the Atlas has a
elevation higher than that of any other range of
en th in Europe or in the African and Asiatic
- bordering on the Mediterranean. From the
ls to the north it has a very fine appearance, rising,
ems, in steep and almost abrupt ascent, though the
tance from foot to summit is a slope of 15 miles
e the panorama prefixed to Hooker and Ball's
)

- the culminating point of the range is quite unknown, the
peak has never been ascertained. The English embassy
1 30 advanced up the northern slope only a little beyond
ant (5,031 feet), and Davidson in 1850 merely reached the
el then turned westwards. From Tasermant eastwards the
altogether unexplored for 200 miles till we come to the
flows by Aïn-el-Hadjar at Mount Ta'ya, Caillé (1827),
ibid. 563). The English expedition of 1871 (Hooker and
) beside visiting Tasermant, went up the Dra'a valley to
of 4,000 feet, up the Ait Mgun valley to the Tagherot pass
, and up the Amzaz valley to the summit of Jebel Tezeh
feet. In the Tagherot pass Mr Maw was the only one of
y who reached the watershed, but from Jebel Tezeh a good
s obtained southward across the great valley of the Sa to
Atlas, which appeared to be from 9000 to 10,000 feet high.
Du Leon crossed the range by the ordinary route from
to Tarudant. "But he says, "it reached comparatively
flat land, composed of Cretaceous and Tertiary rocks, then
plateau with ranges of red, probably Triassic sandstone;
ally come the barren and steep peaks of clay slate with
Silurian deposit. The pass where the descent towards
n Tarudant begins, and is 5000 feet above the sea. The
ain to Tarudant is very steep, debouching suddenly and at once dangerously
he plateau of the Anti-Atlas to the Atlas proper at its
end nothing certain is known.

he principal rivers of Morocco take their rise in the
mountains, and the headwaters of the Muluya, the
he Umm Rabi', the Dra'a, and the Ziz are all to
ed in that part of the range which lies between
and 32° 30' N. lat., and between 3° 30' and 5° W.
In almost every instance the summer current is
atively feeble, but the wide beds and often high
anks are sufficient of themselves to show the changes
ed by the rains of winter and the thaws of spring.
luya (Mulucha and Malva of Pliny, &c.) is mainly
wn as the river which the French have long wished
e the western boundary of Algeria. Its course is
ntirely unexplored. About 34° 20' N. lat. Captain
found it some 200 yards wide but quite shallow.
5 miles east of its source where it is crossed by the
Ziz it is already a powerful stream with a deep
, in the granite rock, and shortly afterwards it is
by the W. Sgimmel, a still larger affluent (Rohlfs).
lesser streams which flow into the Mediterranean it
h to mention the W. Martil or Martin (otherwise
Subu, W. Ras, W. Mgeksa), which falls into the
Tetuan, and is identified with the Tamuda of
nd Thabuda of Ptolemy. On the Atlantic seaboard
the Sebu the rivers are a number of comparatively small
, the chief of which is the very winding W. Anlkos
ses, with several tributaries. If Renou's statement
Sebu (the *Sebou navigabilis et navigabilis* of Pliny)
course not much inferior to that of the Seine be
ot of an exaggeration, it may at least be compared
Thames in length and width, though not in steadiness
gth of current. At Mehra'at al Kseir, about 70
om its mouth, it is about 10 feet deep in the month
and more than 160 feet wide, and, though its
re 21 feet high, extensive inundations occur from
time. The tide ascends as far as Al Kantara 15
bove Ma'mura, and steam barges with a small draught
r could make their way to the ford just mentioned,
ssibly even as far as Fez (Trotter). Affluents of the
re W. Mikkes and W. Al Redem (90 miles long).

The swift and muddy current of W. Beht usuall
itself in a swamp before it reaches the main stream
impetuous Umm Rabi', with a rocky bed and
rapids, is perhaps as large as the Sebú; but as th
no important cities in the country through which i
its course is not so well known. W. al-Abiad, W. al
and W. Tessaut seem to be the principal affluents.
last is separated by about 10 miles only from the
of the Tensift, the river which flows to the north
city of Morocco; and, by the W. Nefis, the Asif
(Asif is Berber for "river"), the W. Ushi, and other
tributaries, receives the waters of about 180 miles
Atlas range. The valley between the Atlas and th
Atlas is traversed by the W. Sus, whose ever flowing
is sufficient to turn the whole district into a garden
Massa or W. al Ghas (Wholgras of Davidson, Oue
Ras of Delaporter), though its headwaters drain only
two of the lesser valleys at the south west end of th
Atlas, is "about 50 yards from bank to bank at the
with a depth at high water and in the proper cha
something over a fathom." Farther south is the
of W. al Akal, long known to European geographers
name of W. Nun, and finally the famous W. D
reached, which in length of course exceeds all the r
Morocco, but, except in spring when the snows are
in the highlands, remains throughout all its lower
a dry sandy channel, hardly noticed by the traveller
surrounding desert. In the upper valleys, on the co
innumerable streams from the south side of the mas
of the Atlas, the W. Dades from the east, and th
Marghen, W. al Melah, or Warzazet from the wes
through populous and fertile valleys, and uniting t
the Dra'a cut their way southward through a gorge
Jebel Sogher, which, as the name implies, is a lowe
running parallel to the Atlas proper. For the ne
miles the noble stream holds south-south-east, dra
every step by the irrigation canals which turn thi
into a green oasis, till at last its dwindling current
westward to the sebkha (salt marsh) of Debaya.
few weeks once a year the thaw floods fill this shall
extensive basin and rush onward to the Atlantic;
summer it dries up, and, like the bed of the river fo
distance below, is covered with flourishing crops.
the south of the Atlas still farther east descend a n
of other streams, the W. Ziz (with its tributaries
Todgha and W. Gheris), the W. Ghir, the W. Kenat
which, after watering the oases of Medghara, T
(Sijilmasa), Kenatsa, &c., lose themselves in the sa
the Sahara.[1] Besides the lakes and lagoons of th
district already mentioned, there are several others, s
the Daya Sidi Ali Mohammed, which Rohlfs passe
the summit of the Atlas, but they do not form a fea
the country. The eastern frontier runs across th
Western Shatt, and south from that point lies the ex
Sebkha Tighri.

According to Du Leon, in his geological map of West Africa
the strip of country in the vicinity of Ceuta and Tetuan
Lias, modern Tertiary and Eocene rocks cover all the res
great northern promontory for some distance south of Waz
extend in an irregular belt from the neighbourhood of Fe
west to the province of Abda; between these two areas the
district of Cretaceous formations which extends to the Atlan
skirts the whole African coast from Larash as far south as Cap
700 miles south of the Dra'a; nearly all the rest of the
western slope of the country is occupied by alluvium. T
ward portion of the Atlas shows a belt of Cretaceous rocks, a
Jurassic belt, and one still broader of Red Sandstone, por
and porphyrite tuffs forming the backbone of the ridge.
Tarudant eastward runs a strip of clay slates, possibly of
iferous origin, and from Anti-Atlas in the west and Figi

[1] See Castries on the "Oued Draâ" in *Bull. de la Soc. de*
1880.

zoian rocks stretch for hundreds of miles into the Sahara
n around the city of Morocco has a sheet-like covering of
s crust rising over hill and valley and following all the
ons of the ground, the result probably of the intense heat
n rapidly drawing up water charged with soluble carbonate
from the calcareous strata, and depositing it layer by layer on
ce till an accumulation several feet thick has been produced
This crust is extensively burned for lime, and it forms a
strong roof for the numerous underground cellars which
ors excavate in the soft strata beneath. An enormous
of boulders occurs in the lateral valleys and above the
ent of the Atlas, and the opinion that these are the pro
remote glacial action, supported by the existence of true
s on the upper part of the slopes. All along the west coast
e undulations of an elevation of 50 feet or the slopes of
caches, of 100 or 150 at the south of Cape Spartel, 50 or
0 or 70 feet high, but a number of other lines seem to
at present a process of abrasion rather than of
numerical or positive evidence exists in Morocco that
ount Atlas, Haidon or the Iron Mountain, the highest
orld of Mogador, did ever rise to the altitude. Vol
an, but whether they formerly reached the snow-line
On the road to Rabat, Revoil found and sketched
by the Beni Sedh. Antimony is locally said to be found
the south of the Atlas. Rohlfs found at one place
and its beautiful and enduring timber has been identified
cedar with which the Cordova cathedral mosque was
with the citron wood of the ancient Romans. The ancient
Silphium confined to Morocco, extending only about 150 miles along the coast, from the river
almost to the river Sus, and about 60 miles inland,
found nowhere else in the world. A crushed tumbler
preceding contorted thorns, can be seen at a distance
Date-palms have been observed from 30° to 31° N., and
2 or 26 feet. The fruit, were it ripened better, and
on cave-dwelling and speckled cattle, camels, asses
and horned cattle but not for horses, for the sake of the
per crops, and enabled by the natives to extract the oil
kernel. The chestnut, stone-pine, and fan-palm
to the European palate than any of those used in the
southern Morocco. The prickly pear is one of the
of the Lindley from the coast up to the slopes of the
The cork tree commences in the line of vegetation
succeeded by thuya, holm oak, and cedar, the latter
to have extended for some 40 miles between the
and the sea. Though not a widespread tree in Morocco
large of southern Europe, the palmetto is very
abundant. Cistus, lemon, lime, orange and
in the warmer, and the fruit are consumed in
Lower forms, as grapes, Medicago, Scorpiurus,
peas and beans. Lupins, Lathyrus and Vicia
Vegetables and fruits are cultivated, the dew
and, once every six to eight days, to apply the natural
Morocco has also specialized. Both the imperial
to be the protection of a comparatively
pure quality, before being sold, is boiled, the latter
be smoked or not. Besides the cereals
excellent crops of vegetables, potatoes, peas, chick
and many kinds of fruit, especially
favour in certain districts.

Horticulture is more developed in Morocco
to more than it was before the Moorish conquest
Arab horticulturists are not specialists
that not more than a dozen varieties of grapes
vated at all, and the cultivated persons are chiefly
Inside Fez the quiet courts of the wealthy
a place of the most prominent features of the Moorish
cistern, which is the source of the
to be none of the wells dug at the time
Under ground channels, or *khettara*, are
of the city, which bring water from the
The well-known *norias* or water-wheels
Besides the Arab, which has its counterpart
Egypt and Turkey, there is the Moorish
The Arab is a simple contrivance
is, the latter is a complicated machine
and were first
The *noria* is not kept in motion
part of the Atlas, but is worked by the
the north of the Empire and near the
which is also employed. The
the Spanish peninsula. Modern
the neighbourhood
Mexican Agave, which has
Barbary, is cultivated
Prickly pear, Indian fig, and
Yucca, and the
Date-palm, between Mo
Mogador, grows
Laurus
Among the
Every
Morocco that the wood-boring
the trees of landscape is greatly diminished. The
of mistletoe is one of the plagues of the country in the
to Europeans, and even to the Moor, who, not recognizing
mischief, considers the parasite one of the
creation.

The camel is the great beast of burden in Morocco, though
and mules are also employed. The horse is a hardy
breed, usually a sturdy little animal, but from
ancient reputation of the Barbary breed. Roughly broken
young, his mouth
by quite the
The

…ls. In form and size the mules are much superior, and …ually fetch two or three times the price. The horned … not unlike Alderneys, and the sheep, for the improve… which nothing is done, have spiral horns not unfrequently …nded to the head, and long fine wool. Domestic fowls are … numbers, they are of the Spanish type, small and …

… kind) Fishery off the coast at Casa Blanca and Tangiers … sent from Spain, Portugal and other parts of Europe. … all, a mullet should not be found south as Mogador … that no fish … congers and mullet are common alone… … allied the … ugh scaled a … and cravish … warm in the ro… … no proper method of catching the … fish, and a kind of shad known as t… … ve at time of practical importan… … Barbel … lmon, a species of h… … ept rivers of the coast, and v… … en from 5 to 15 pounds in weigh… They a… nd from the … ce spring. B… … mall fish swa… n the streams, but I… …

… population of Morocco only the vaguest estimate is pos… … Chiar and Wagner give 6,410,000 probably too high a … Ethnographically it consists of three main elements … of Shelluh Arabs, and Jews with a large admixture of Negro … and a sprinkling of Negro individuals. A distinction is … drawn between the country Arab and the city "Moor" … … but the difference between t… … of … the "Moor" has probably also a… … ve … ps element-as of method of … … ult of the same. The Berber … … n … upon of th… country as may be proved by … word-p… d by … rd writers and they still f… … the most numerous … the most industrious and civilized … the people. With the Arabs still by preference a dweller … the Berber for the most part … of tow… … On the whole, the Arab … rant … owl finds … Berbers in the hilly districts … … corrupted, even in the tow… Hau Kh… Arabic … to his ears, with the comple… reached … extreme degradation. Of … ry little … , but everything co… to p… the … ar pronunciation … nt with the better … ten… tive of the Ber… … e Jews are the great comme… the community … usually said to number … 150,000 to 200,000 but … Pleasance's *Mélle*, … to suppose that … not exceed 64,800. Having … rom Spain, they … more, themselves a corrupt Spanish …

… one time Morocco was much more populous country is … from the description of Leo Africanus, who even in his … number of ruined or decaying towns … very great … Tangiers, Larash, Salle, and the other pl… on the coast … less than, there are only a few … in the country … these … Fez, Mekne… or Mequinez, W… … e in the basin of the Sebú. On the Z… … ne rivers, north … to the foot of Mulay Idris of Zerhún. … hich not … than … … d … p. 150). Jackson did manage to pay … … According … Captain Trotter, who got within three … of apparently 1500 to 2000 inhabitants, … ge buildings. Wazan Rohlfs. Wazan is … ame the seat of a chief, whose influence … lowed it from that of the sultans. It was … village by Muley 'Abd Allah al Sherif … one of the clerical and best-kept places … a considerable trading centre on the … … …

MOROCCO

na were autonomous under a number of indigenous or foreign
. The chief of these principalities were that of the Idrisites
(*supra*, p. 581), the kingdom of Tahart, and that of Nakúr
first years of the 10th century the Fatimite caliphs, at the
f the powerful Berber tribe of Ketáma, overthrew the Aghlá
thus putting an end for ever to Arab rule in North Africa,
pidly extended their empire to the Atlantic. When the Fati
stablished themselves in Egypt, the Zanáta dynasty reigned as
assals in the west, and maintained themselves with varying
s till the rise of the great empire of the Almohades (*q.v.*),
elded in turn to the Almoravides (*q.v.*). The latter dynasty
tinguished by the princes of the Beni Merin, whose chief,
b. 'Abd al-Hakk, captured Morocco in 1269 A.D. The subs
t history of Morocco and Fez under the Merinids and their
ors presents little interest, being a tale of internecine war,
ed successions, fratricides, general bloodshed, and barbarism
s empty of all indications of an advance in civilization. As
s the relations of the country to Europe in particular, four periods
distinguished – (1) a period lasting down to the close of the
entury, when the Moorish potentates were still the most pow
representatives of aggressive Mohammedanism; (2) a period
which the Portuguese and Spaniards, having expelled their
rs, made vigorous reprisals and obtained possession of many
on the coast of Morocco; (3) a period in which the expansion,
rtenod by the disastrous defeat in the Battle of the Three
(1579), allowed the Moors to recover much of the ground
ad lost, and to become, by their piracies and detention of mari
al law, an object if not of terror yet of apprehension and
on; and (4) a period in which the prestige of the after
f greatness has gradually died out.

following are the more noteworthy events in the Moorish
since the beginning of the 15th century.

. Ceuta captured by the Portuguese. 1436. Disastrous expedition
Tangiers by Don Duarte; capture of Don Fernando, who
exile in 1439 (it was proposed to ransom him by cession of
but the pope objected). 1459. Capture of Arzila and Seem
Capture of Tangiers. 1510-1540. Rise of the dynasty of the
. 1577. Edmond Hogan sent by Queen Elizabeth of England
ey 'Abd al-Melek (see Report in Hakluyt). 1578. Defeat of
Sebastian (see Leared, *Visit to Court of Morocco*, appendix). I
Founding of the Company of Barbary Merchants (Earls of War
Leicester, &c.) in London; Elizabeth's second ambassador
Roberts well received. 1610. The Moors from Spain settle
at Rabát, &c., and prove troublesome. 1619. Muley Zedan
to King Charles I. requesting him to attack Sallee by sea
this time Ali Sherif of Yanbo, near Medina, is recognized as
f Táfilelt, and gradually of the rest of the empire except the
Morocco; with him commences the dynasty of the Alaouis
death his sons, Mohammed and Arshid, dispute the succes
1662. Tangiers (Portuguese since 1471) becomes an English
ion as part of the dowry of Catherine of Braganza. 1664-1672.
of Arshid, a warlike, active, and cruel prince, who was the
take the title of sultan. 1672-1727. Reign of Ismail, who
ity and ferocity completely outdid his brother Arshid, and
ted his throne by an enormous army of slaves from the

1678. Great plague; ambassadors sent to Louis XIV
the hand of Mademoiselle Blois, the king's natural daughter
The sultan sends two lions to the King of England. 1684.
oudesley Shovel defends British interests on the coast; with
of the English from Tangiers. 1687. Capture of Larash from
aniards. 1691. Siege of Ceuta. 1727. Thomas Betton who
on a slave in Morocco, left £13,000, the half of his fortune,
s ransom of British captives in that country. 1727-1730.
ed succession. 1757-1789. Reign of Mohammed. 1775.
s. 1780. Great famine; Agadir opened to the Dutch. 1791-
Reign of Soliman, abolition of Christian slavery in Morocco,
ssion of piracy. 1822-1859. Reign of Abd er Rahman.
with Spain on account of the decapitation of Consul Dar
wounding of a Moor. 1844. Defeat of forces sent to
l-Kader in Algiers; bombardment of Tangiers and Mogador
prince de Joinville, rout of the Moorish forces in the battle
; and peace of Tangiers. 1845. Naval demonstration at
rs and ratification of treaty; surrender to Spain of disputed
y at Ceuta. 1853. Establishment of a cordon of
military posts along the Algerian frontier. 1856. Anglo-
rcial treaty by which no duty shall exceed 10 per cent. of
ue of the wares. 1859-1873. Reign of Mohammed; Spanish
n. 1860. Decisive battle between General O'Donnell and
ors near Tetuan (March). By the treaty of Tetuan Morocco
pay 20,000,000 piastres to Spain, to surrender territory at
Cruz de Mar Pequena for a commercial establishment, and to
the Spanish missionaries to have a house at Fez like that
they had at Tangiers. Money not being obtainable to pay
demnity, the Spaniards obtained control of the customs for
of years. 1864. Decree permitting Europeans to trade in
rt of the empire. 1873. Accession of Hasan. 1880. English
y for improvement of commercial relations; conference at

Madrid to define the rights of European representatives in
to the protection afforded by them to subjects of the sultan
ber of *protégés* limited to three. 1882. Expedition to sub
Hoscin of Hah. 1883. Protest of the English Government
the slave trade in Morocco.

Lists of works in regard to Morocco will be found in Renou, *Bi*
de l'emp. de Maroc, Paris, 8vo, former part of *Exploration scientifique*
en Algérie, de la Soc. géogr. de Madrid, 1875, 187-; and in *Bibliotheca*
Madrid, 1884. Besides Renou's *Bibliographie*, a masterly critical and
geographical material. The following may be mentioned: Ibn Khal
de Barbarie (tr. by Baron de Slane), Leo Africanus, *Descript. Africæ*
Torres, *Origen y sucesion de los Xarifes y de Marruecos*, Ar., 1585;
Descripção de Africa, 1600; Faria y Sousa, *Africa Portuguesa*, Lisbon, 16
son, *Account of the Barbary*, 16.; Chamberlain's Coll., xvi.; Chenier,
de Maroc, i. 7; Jackson, *Account of the Empire of Morocco*, 1809;
Journal and Letters, 1820; Drummond Hay, *Western Barbary*, 1844; Jo
Notes on Morocco and Diary of a Visit, 1859; De Amicis, *Morocco*,
Ris, Mrs. J. Murray, *Scenes and Sorrows of Morocco*, 1859; Ro
Travels in Morocco, 1860; Matteo, *Due Imperatori in Marocco*, 1
Cecchi), Rohlfs, *Mein erster Aufenthalt in Marokko*, Bremen, 1873; Erl
Vercourt to Fez; Hubbard, Leared, *Morocco of the Moors*, 1876;
Voyage en Abyssinie, 1876; De Amicis, *Morocco*, Milan, 1876; a very
French which has been deservedly translated into English from
Archives du Maroc, Exploration du Maroc, Documents historiques*, 1
Hugo, *Empire de Maroc*, Santiago, 1878; Hooker and Ball,
Atlas Mountains, 1878; Cordell, *Travels in Morocco*, 1878; Payne
Journal, 1879; Llana y Rodriguez, *Historia de Marruecos*, 1880;
Watson, *Western Barbary*, 1880; Trotter, *Memorials of the Coast of Mor*
Cowan and Johnston, *Moors at Home*, 1881.

Morocco, or Marocco (Marrakush), one of the
capitals of the sultanate (Fez and Mekne being the
two), lies in a spacious plain about 15 miles fr
northern underfalls of the Atlas, and 90 miles eas
east of Safi, at a height variously estimated at
feet (Hooker and Ball), 1110 (Beaumier), and
(Leared). Ranking during the early centuries of it
once as one of the greatest and most flourishing c
Islam, Morocco has long been in a state of grievous
and were it not for the exceptional beauty of its
the luxuriant groves and gardens by which it is
passed and interspersed, and the magnificent outlook
it enjoys towards the mountains, it would be altog
very miserable place. The wall, 25 or 30 feet hi
relieved by square towers at intervals of 360 fee
dilapidated that foot passengers, and in places even
men, can find their way in and out through the br
Open spaces of great extent are numerous enough
the wells, but for the most part they are desola
mounds of rubble and patched ruins. With the ex
of the tower of the Kutubia, the Moorish mosque and ancient m
which was brought in pieces from Spain, there is n
asserted, to be a stone building in the city, an
brick – though the local manufacture of excellent
are sparingly employed. *Tabiya*, or pounded clay
almost universal material, and the houses are conse
seldom carried more than two stories in height. The
of the sultan covers an extensive area, and has it
and gardens enclosed by walls similar to those of t
proper, but is architecturally quite unimportant.
whole of Morocco the tower of the Kutubia alone is a
memorial of the constructive genius of the early Moor
it and the similar tower of Hasan at Rabat are after t
of the Giralda at Seville, and, if tradition may be
all three were designed by the same architect Jabir
mosque to which the tower belongs is a large brick
was erected by 'Abd al-Mumen; the interior is
with marble pillars, and the whole of the crypt is o
by a vast cistern excavated by Mansúr. Other mo
some note are those of Ben Yusuf, Al Mansur, and Al
the Glaoui chief, Bel Abbas, in the extreme north
city possesses property to the value of £200,00
serves as a great almshouse and asylum. As in mo
town throughout Morocco, there is a special Jews'
walled off from the rest. The general population is o
mixed and turbulent kind, crimes of violence are
common, and there are countless varieties of the
sional thief. Almost the only manufacture ext
prosecuted is that of Morocco leather, mainly
yellow, about 1500 men being employed as tann
shoemakers. The city was founded in 1062 by Y

n. Before it was more than a hundred years old it
o have had 700,000 inhabitants, but at present the
mber probably does not exceed 50,000 or 60,000.

Mr Ford, Lamb's detailed description in *Bol. de la*
ec., Feb., 1865, and by Leared, *Estacionado* of Lan
fluent point of Morocco reproduced with some additions
ect and notices may be found in Cadiz. (H. A. W.)

ON or MORON DE LA FRONTERA, a town of Spain,
rovince of Seville about 32 miles to the south
that city, occupies an irregular site upon broken
ities at a distance of a mile and a half from the
nk of the Guadiana. It is connected by rail with
on the Cadiz and Seville line. On the highest
t to the eastward are the ruins of the ancient
of considerable importance during the Moorish
and afterwards used as a palace by the counts of
In 1810 it was fortified by the French, but
n by them in the following year. The chief public
of Moron is the large parish church, which dates
16th century, but presents no noteworthy features.
e district between Moron and the Serrania de
is freely occupied by olive plantations and the
oil and other agricultural produce forms the chief
of the town. Moron used to labour throughout
r as a stalk-fed cattle. Morony, from which the white
ter is largely used in the Peninsular, is derived. The
on of the town was 14,579 in 1878.

ONI, Girolamo (c. 1520–1579), an eminent
painter of the Venetian school, was born at Albino
ween Bergamo and Lecco, and became a pupil of Bonvicino
Moretto. Lanzi records of his works very
s praises regarding him have reached us. Titian,
hom also Moroni while still very young, is said
studied (but this appears hardly probable), had
ate a high opinion of his powers, he used that
made his portrait "with a pencil dipped in actual fire."
the magnates of Bergamo came to the great Venetian
their likenesses he advised them to go to their
ntryman. In truthful and accurate portraiture
ranks near Titian himself. His pictures do not
ttain to a high ideal character; but
e full of straightforward life and individuality,
mmo unforced choice of attitude, and excellent
and arrangement of drapery. His colouring
y to a violet tint in the flesh, and the drawing
me of the hands are not first rate. As leading
of his portraits may be mentioned in the Uffizi
Florence, the Nobleman pointing to a Flame, in
"Et quel volo mi fai andar?"; in the National
Lendon, the portraits of a Tailor, a member of
roli family, Canon Ludovico de Terzi, and others,
Dulwich Gallery, his own portrait; and in Stafford
e seated half-length of the learned Ercole Tasso,
s termed "Titian's Schoolmaster," not as indicating
y real connection between the latter and Titian,
the consummate excellence of the work. Besides
ait Moroni painted, from youth to his latest
s ordinary round of sacred compositions; but in
fail to follow his master Il Moretto, and his draperies
artake more of the Lombard or Milanese style
the Venetian, has at times some of the dryness of
trecento. One of the best is the Coronation of the
in S. Maria Maggiore della Croce, Bergamo, also in the
al of Verona, St Peter and Paul, and in the Brera
n, the Assumption of the Virgin. Moroni was
upon a Last Judgement in the church of Corlago
died on 5th February 1578.

OSINI, the name of a noble Venetian family.
g to the best authorities, Cappellari and Barbaro would seem to have been two families of that
name, distinguishing themselves by the variation of their
shield. The one came from Mantua at the time of Attila's
invasion, and bore or, a less azure. The other came from
Illyria in the 7th century; they bore or, a bend azure.
However that may be, nothing authentic is known of the
Morosini till we find them settled as one family in Venice
during the 8th century. The Morosini belong to the Case
Vecchie, or twenty four families of Venetian nobility who
were descended from the tribunes of the confederate islands
before Venice became united in one centre at Rialto. The
10th century was a period of danger for the family. They
became involved in a blood feud with another noble house,
the Celsi, who were Ghibelline in politics, and relied
upon the emperor Otto for support. The Morosini, however, proved the stronger, thanks to their popularity; and
the year 931 saw them victorious through the deposition
of the doge Memo, who had favoured their enemies. The
Morosini engaged in commerce with the East, and in
the 11th century two brothers of the family, Alban and
Marco, founded a house at Aleppo with branches in
Damascus, Beyrut, and elsewhere in Syria. The wealth
and importance of the family may be gathered from the
fact that in 1379 no less than fifty nine Morosini subscribed
towards the fund for carrying on the war of Chioggia. The
house of Morosini gave four doges to Venice, and numbered
among its honours two royal marriages, two cardinals,
twenty four procurators of St. Mark, besides numerous
generals of the republic. The Morosini continued to
flourish till the opening of the last century, when the
family began to decline; it is now represented by one surviving member.

Among the more distinguished members of the house
must be mentioned. Giovanni, who in 982 founded the
monastic establishment on S. Giorgio Maggiore after the
order of St Benedict; Domenico, doge 1148-1156, in
the third year of his reign Pola and Istria, which had
rebelled, were reconquered; Marino, doge 1249-1252,
during whose reign the Inquisition, in a modified form and
under the surveillance of Venetian officers, was introduced
into Venice for the first time. In this same century (1290)
Fiamma ma Morosini, the sister of Albertino il Grande,
married Stephen, prince of Hungary. Their son Andrew
succeeded to the throne, and was directed in his government by his uncle Albertino, on whom he conferred the
dukedom of Slavonia and the county of Morlacchia. A
cousin of Tommasina, Costanza, married Ladislaus, king of
Servia. In 1382 Michele Morosini was elected doge.
He had acquired a large fortune and a reputation for
fortune-telling by buying Venetian property while the Genoese
were still in Chioggia; and much was expected of him in
the restoration of his country's finance when that war
came to an end. But he died the year of his election.
Andrea Moro-sini the historian was born in 1558. He
studied at Padua, and on coming of age embarked on
public life. He passed through the various offices of
state, till in 1618 he was a candidate for the dogeship,
but failed to secure it, and died the same year. On the
death of the official historian Paolo Paruta, in 1598,
Andrea was commissioned by the Council of Ten to continue his work, and received authority to consult the state
papers down to 1594. He wrote his history in Latin. It
covers from 1521 to 1615, and was first published in
Venice, 1623.

Andrea's other works, of which only the first has been edited, are:
(1) *L'imprese et espeditioni di Terra Santa e l'acquisto fatto dell'*
Imperio di Costantinopoli dalla Serenissima Republica di Venetia,
Venice, 1627; (2) *De rebus quæ Veneta Respublica ad Istrim oras gessit*
adversus Othonem Federici Imperatoris filium, in the Corner-Dandolo
collection of MSS.; (3) *De forma reipublicæ Venetæ*, in the National
Library, Paris; (4) *Raccolta delle Leggi del Cons. N.*, in the
Archivio Generale at the Frari, Venice; (5) *De rebus gestis ac nece*

ancisci Carmanola, in the Correr-Dudolo collection. The life of ndrea has been written by Luigi Lollin, bishop of Belluno (1623), Niccolo Crasso (1624), and by Antonio Pilazzoli (1629).

The most distinguished member of the house of Morosini as Francesco, the captain general of the republic against he Turks and conqueror of the Morea. He was born in 618. In 1666 he was in command during an unfortunate ampaign in Candia. In 1687 he conquered Patras, and opened the Morea to the Venetian arms. In the following year he was elected doge. After his return to Venice he republic suffered severely in Candia, and though now n old man Francesco took the field again in 1693, but ied the next year at Nauplia, seventy-two years of age. A ore detailed account of his exploits will be found in the rticle VENICE.

Authorities.—Barbaro, *Genealogie delle Famiglie Patrizie Venete*, S., class. vii. cod. dcccxxvii., in the Marcian Library; appellari, *Campidoglio Veneto*, MS., Civic Museum, cod. cxvi. in the ame library; Romanin, *Storia documentata di Venezia*; the ho *Nobiltà Veneta*; Cicogna, *Iscrizioni Veneziane*.

MORPETH, a municipal and parliamentary borough of Northumberland, England, is situated in a fine valley on he Wansbeck, and on the North Eastern Railway, 30 miles outh of Berwick and 16 north of Newcastle. The Wansbeck, which is crossed by a stone and two wooden bridges, inds round the town on the west, south and east, and small rivulet, the Cottingham, bounds it on the north. Morpeth is irregularly built, but possesses a number of good shops. The parish church of the Blessed Virgin, a plain building of the 14th century, restructed on Kirk Hill, short distance from the town. Among the other public buildings are the Edward VI. grammar school, reopened in 1857 after a Chancery suit lasting 150 years; the hall, erected in 1870 to supersede a building of Vanbrugh; and the county hall and former gaol, baronial style, built in 1814. Nothing remains of castle except the gate-way. Morpeth had at one time the largest cattle markets in England. The industries of the town include tanning, brewing, malting, iron and brass founding, and the manufacture of flannels, agricultural implements, and brick and tiles. The population of the municipal borough (251 acres) in 1871 was 7517, in 1881 it was 7556. The population of the parliamentary borough (17,075 acres) in the same years was 30,[illegible] 33,159.

Morpeth (*Morthwaite*, &c., the path over the moor) had [illegible] before the Norman Conquest, when it was [illegible] With[illegible] Merley. From the De Merleys it [illegible] and came to the Howards, earls of Carlisle. [illegible] Conquest it obtained the privilege of [illegible] and were granted to Edward VI. by [illegible]. Municipal Act of 1835 the government was placed in [illegible] boroughs, but there is a local board of health [illegible] corporation have exercised over an area slightly larger [illegible] of the municipal borough. From 1868 the borough [illegible] members to parliament, but the 7252 county electors [illegible] returned another to the new House of Commons.

MORPHEUS (a personification, apparently [illegible] by Ovid (*Metam.*, xi. 633), of the power that [illegible] shapes before the eyes of a dreamer. The name [illegible] (*morphé*) expresses the American Ovid translates it [illegible] (*moulder of images*). Morpheus is naturally [illegible] the son of Sleep (Somnus).

MORPHIA. See OPIUM.

MORPHOLOGY

THE term Morphology (*morphé, forma*), introduced by Goethe to denote the study of the unity of type in organic form (for which the Linnean term METAMORPHOSIS (*q.v.*) had formerly been employed), now usually covers the entire science of organic form, and will be employed in this more comprehensive sense in the present article.

§ 1. *Historical Outline.*—If we disregard such vague likenesses as those expressed in the popular classification of plants by size into herbs, shrubs, and trees, or of terrestrial animals by habit into beasts and creeping things, the history of morphology commences with Aristotle. Founder of comparative anatomy and taxonomy, he established eight great divisions (to which are appended certain minor groups) *Viviparous Quadrupeds*, *Birds*, *Oviparous Quadrupeds and Apodes*, *Fishes*, *Mollusks*, *Malacostraca*, *Entoma*, and *Ostracodermata*, distinguishing the first four groups as *Enaima* ("with blood") from the remaining four as *Anaima* ("blood less"). In these two divisions we recognize the Vertebrata and Invertebrata of Lamarck, while the eight groups are identical with the Mammals, Birds, Reptiles, Fishes, the Cephalopods, Crustaceans, other Articulates, and Testaceans of recent zoology. Far, too, from committing the mistake often attributed to him of reckoning Bats as Birds, or Cetaceans as Fishes, he discriminated the true affinities of both, and erected the latter into a special γένος beside the Viviparous Quadrupeds, far more on account of their absence of limbs than of their aquatic habit. Not only is his method inductive, and, as in modern systems, his groups natural, *i.e.*, founded on the aggregate of known characters, but he foreshadows such generalizations as those of the correlation of organs, and of the progress of development from a general to a special form, long afterwards established by Cuvier and Von Baer respectively. In the correspondence he suggests between the scales of Fishes and the feathers of Birds that hinted at between the furs of Fishes and the hairs of Quadrupeds, the idea of homology too rarely accepted from the compilation of his disciple Nicolaus of Damascus, who regarded Aristotle as imperfectly developed brute, almost to have anticipated the idea of the metamorphosis of plants. In short, we find a knowledge of facts and a comparative freedom from the errors by physiological evidence of which his successors, as Theophrastus and Pliny generally more classified habit, show little trace and which the modern has slowly regained. Little indeed can be recorded in the 13th century, when the reappearance of Aristotle gave a new impulse to the study of organic nature; the works of this period that of Albertus Magnus the most important, but they are all no more than revivals of Aristotle, marking the reappearance of method and the reawakening of interest in and sympathy with nature. Meanwhile leech and apothecary, alchemist and witch, were accumulating considerable knowledge of plants, which, after the invention of printing, were collected and extended in the descriptive and well illustrated folios of Gesner and his successors, Fuchsius and others, as well as by the establishment of botanic gardens and chairs of botany in the academies, while, as Sachs remarks, the large additions to the naive empiricism of the German fathers of botany came their Italian contemporary Caesalpinus, as the thinker of the vegetable world. Many systematic efforts, the Germans vaguely according natural affinities in mere similarities of habit, the Italians with no inconsiderable success striving towards more intellectual basis of classification. Monographs on groups of plants and animals frequently appeared, those of Belon on Birds and Rondelet on Fishes being among the earliest. In the former of these (1555) we find a comparison

ns of Bird and Man in the same posture and as
as possible bone for bone, an idea which, despite
temporaneous renaissance of human anatomy ini
y Vesalius, disappeared for centuries, unappreciated
the surgeon Ambroise Paré. Palissy, like Leonardo
and, discerned the true nature of fossils; and such
ot morphological insight continued to appear from
time during the 17th century. Thus, Joachim
cognized "the distinction between root and stem,
rence between leaves and tobacconist branches, the
on from the ordinary leaves to the *folia florea*," and
anticipated the generalizations of modern embryo
his researches on development and his theory of
sis.

neyclopaedic period of which Gesner is the highest
ntative was continued by Aldrovandi, Jonston,
rs in the 17th century, but, aided powerfully by
roman movement, then profoundly influencing all
e minds, it developed rapidly into one of genuinely
ne aim. At this stage of progress by far the most
nt part was taken by John Ray, whose classificatory
both among plants and animals were crowned with
ne success. He first definitely expelled the fabulous
s and prodigies of which the encyclopaedists had
dly handed on the tradition from mediaeval times,
o his predecessor Morison, classifying in a truly
spirit by anatomical characters, he succeeded,
arly among plants in attaining many natural
tor which his very terms sometimes survive, *e.g.*,
edons and Monocotyledons, Umbelliferae and Le
The true precursor of Linnaeus, he introduced
of *species* in natural history, afterwards to become
and reformed the practice of definition and termino-
Of the many works which followed up Ray's
ne and monographic labours, though often, like
f Tournefort and Rivinus, Reaumur and Klein of
portance, none can be even named until we come
of his great successor Linnaeus, whose extraordinary
logical method and unparalleled lucidity of thought
ression enabled him to reform and reorganize the
abours of his predecessors into a compact and
"systema naturae." The very genius of order,
olished modern taxonomy (see BIOLOGY), not only
ntroduction of the binomial nomenclature. At the
ion of descriptive terminology and method, but
subordination of the species henceforth clearly
under the successive higher categories of genus,
nd class, so finally reconciling the analytic and
ic tendencies of his predecessors. Although the
ation of plants by the number of their essential
which vastly advanced not only the cultivation of
but the knowledge of the flora of the globe, and
h he is popularly remembered) is highly artificial,
be remembered that this artificiality is after all
ion of degree, and that he not only distinctly
ed its provisional character but collected and ex
these fragments of the natural system with which
soon afterwards commenced to build. His classi-
of animals, too, was largely natural, and, though
whole he not accurately lent his authority to main-
hat disastrous philosophic and scientific aberration
d from the alchemists through the later encyclopaedist
er's school the notion of three kingdoms of nature
lea that at one time divorced the fundamental unity
als and vegetables and united them in opposition to
living world as *Organisms*. At the same time he
l far more a scholastic naturalist than a modern in-
or, and his works represent little more than the full
ion of the ancient era, and in the hands of fanatical
s served often to retard the commencement of the
modern one. So, too, his excessive systematic and descri
precision, united as it was with comparative inatte
to other than superficial characters, established a tend
even yet not extinct, to rest contented with mere nu
and nomenclature instead of aiming at complete mo
logical knowledge.

While the artificial system was at the zenith of its
and usefulness, Bernard de Jussieu was arranging
garden on the lines afforded by the fragmentary na
system of Linnaeus. His ideas were elaborated by
nephew and successor Antoine de Jussieu, who for
first time published diagnoses of the natural order
giving the system its modern character. Its subseq
elaboration and definite establishment are due main
the labours of Pyrame de Candolle and Robert Br
The former concentrated his own long life and that o
son upon a new "systema naturae," the colossal *Prodr*
systematis naturalis (20 vols., 1818-1873), in which 8
species were described and arranged. Meanwhile the
trative genius of Brown enabled him to unravel such s
tural complexities as those of Conifers and Cycads, Or
and Proteaceae, thus demonstrating the possibility of
taining the systematic position of even the most h
modified floral types. Both Candolle and Brown were
no mere systematists, but genuine morphologists of
modern school. The former, as we shall afterwards
established the theory of floral symmetry on groun
pure comparative anatomy, and distinguished with gr
success than hitherto between fundamental unity of s
tural type and mere superficial similarity of physiolo
adaptation. The latter (Humboldt's "facile pri
botanicorum"), using the same ideas with even keen
sight, made many memorable anatomical researches,
as those on the structure of the ovule and the seed
indeed by his demonstration of the affinities of the
nosperms almost anticipated the discoveries of Hofme
who stands pre-eminent among his modern successo
account of his elucidation of the secret of phanerog
reproduction.

The labours of Bernard and Antoine de Jussieu init
to a vast parallel advance in zoology, the joint m
in the classification of mammals with which Cuvie
Geoffroy St Hilaire almost commenced their career r
ing its dominant impulse from the "genera" of An
Cuvier's works correspond in zoology to those o
whole period from the Jussieus to Brown, and epito
the results of that line of advance. Although in
respects preceded by Haller and Hunter, who comp
though mainly with physiological aim, the same pa
different organisms, and much more distinctly by
Vesalius, the only real comparative anatomist of the 18t
tury, he truly opens the era of detailed anatomical res
united with exact comparison and clear generaliz
The *Règne Animal* (1817) and the theory of types (
brate, mollusc, articulate, and radiate) are the resu
this union of analysis and synthesis (although he hi
exasperated by the aberrations of the Naturphilose
was accustomed to proclaim the importance of de
empirie*m* alone), and mark the reconstitution of taxo
on a new basis, henceforth to be no longer a matt
superficial description and nomenclature but a com
expression of structural resemblances and differences.
even than Linnaeus he is the founder of a great s
whose names and labours are imperishable. In Ger
Bojanus, Meckel, Von Siebold, and the illustrious Joh
Müller, with his many living pupils, have carried o
work; in France, too, a succession of brilliant anato
such as De Quatrefages, Milne-Edwards, and La
Duthiers, are his intellectual heirs; and in England h
been admirably represented by Owen.

The histological movement inaugurated by Bichat will be subsequently discussed; the rise of embryology, however, may be briefly noted, especially since it supplied the most obvious deficiency of the Cuvierian school. Here the principal figure is Von Baer, who established independently the four types of Cuvier on developmental grounds, so for the first time applying embryology as the touchstone of anatomical classifications, besides establishing his famous law of differentiation from a general toward a special form.

It is now necessary to return to Linnaeus, whose more speculative writings contain, though encumbered by fantastic hypotheses, the idea of floral metamorphosis ("Principium florum et foliorum idem est," &c.) About the same time, and quite independently, C. F. Wolff, the embryologist, stated the same theory with greater clearness, for the first time distinctly reducing the plant to an axis bearing appendages—the vegetative leaves which become metamorphosed into bud scales or floral parts through diminution of vegetative force. Thirty years later the same view was again independently developed by Goethe in his now well-known pamphlet (*Versuch die Metamorphose der Pflanzen zu erklären*, Gotha, 1790). In this brilliant essay the doctrine of the fundamental unity of floral and foliar parts is clearly enunciated, and supported by arguments from anatomy, development, and teratology. All the organs of a plant are thus modifications of one fundamental organ the leaf and all plants are in like manner to be viewed as modifications of a common type the *Urpflanze*. The controversy as to the merits and importance of this essay, and of Goethe's morphological work in general, can scarcely be entered upon here. That Goethe discerned and proclaimed, and that more clearly than any of his predecessors or contemporaries, the fundamental idea of all morphology the unity which underlies the numerous varieties of organic form and that he systematically applied this idea to the interpretation of the most important, most complex, and most varied animal and vegetable structures, is unquestionable. The difficulties arise when we seek to estimate the importance of his works in the chain of progress, and when we inquire whether, as some historians hold, his "Urpflanze" was a mere ideal archetype, bringing forth as its fruit the innumerable metaphysical abstractions of the Naturphilosophie, and leading his countrymen, to their fall, into all the extravagances of that system; or whether, as Haeckel maintains, it represented a concrete ancestral form, so anticipating the view of modern evolutionists. That to him Schelling was largely indebted for the foundation upon which he erected his philosophic edifice, as also that Goethe largely shared the same ideas, is unquestionable; but it must be remembered that he lived and made progress for forty years after the publication of this essay, that he was familiar with the whole scientific movement, and warmly sympathized with the evolutionary views of Lamarck and Geoffroy St-Hilaire; it is not therefore to be wondered at that his writings should furnish evidence in favour of each and every interpretation of them. His other morphological labours must not be forgotten. Independently of Vicq d'Azyr, he discovered the human premaxillary bone; independently of Oken, he proposed the vertebral theory of the skull; and before Savigny, he discerned that the jaws of insects were the limbs of the head. In 1813 A. P. de Candolle published his *Théorie Élémentaire de la Botanique*, which he developed into the classic *Organographie Végétale* (1827). Although at first unacquainted with Goethe's essay, and not clearly discerning the homology of leaves and floral parts, he established his theory of symmetry, reducing all flowers to "symmetrical" groupings of appendages on an axis and accounting for their various forms by cohesion and adhesion, by arrested or excessive development. The next great advance was the investigation by Schimper and Braun of *phyllotaxis*, or the ascending spiral arrangement of foliar and floral organs, thus further demonstrating their essential unity.

The term *morphology* was first introduced by Goethe in 1817, in a subsequent essay (*Zur Naturwissenschaft überhaupt, besonders zur Morphologie*). It did not come into use in botany until its popularization by Auguste St Hilaire in his admirable *Morphologie Végétale* (1840), and in zoology until later, although De Blainville, who also first employed the term *type*, had treated the different forms of animals under "morphologie." Though the naturphilosophie of Schelling and its countless modifications by his followers, its mystic theories of "polarization" and the like, its apparatus of assumption and abstract hypothesis and metaphor, cannot here be discussed, its undoubted services must not be forgotten, since it more than anything else stimulated innumerable reflective minds to the serious study of natural science, but, by its incessant proclamation of the unity of nature and the free use of Platonic archetypal types, gave a most powerful impulse to the study of comparative anatomy, and nobly vindicated the claims of philosophic synthesis over those of merely analytic empiricism. Among its many adherents, some are of more distinctly theological type, others metaphysical, others mystical and poetic, others, again more especially scientific, but the most typical and picturesque figure is Lorenz Oken, who epitomizes alike the best and the worst features of the school, and an age whose innumerable pseudo morphological dreams therein occasionally occurred suggestions of the greatest fruitfulness, notably, for instance, the modern statement of the vertebral theory of the skull.

Although Lamarck shared in this movement, his great work (the *Philosophie Zoologique*, 1809), being physiological rather than morphological, scarcely claims discussion here. By far the most distinguished anatomical adherent of the transcendental school is Geoffroy St Hilaire, who, comparatively free from the extravagance of Oken, united a depth of morphological insight scarcely inferior to that of Goethe with greater knowledge of facts, a much wider influence and reputation in the scientific world, and, although affected to some extent by the poetic and metaphysical spirit of the age, necessarily a more and had enormously greater influence on the progress of science than either. He started from the same studies of anatomical detail as Cuvier, but profoundly influenced by the idea of unity of plan and by the evolutionary doctrines of Lamarck, he rapidly diverged into new lines, and reached that idea of serial homology of which we so frequently noted the independent origin. His great work, the *Philosophie Anatomique* (1818–1822), contains the principal doctrines. These are (1) the theory of the conditions, identical in spirit with that of Cuvier; (2) the theory of analogues, according to which the parts, differing only in form and in degree of development, should occur in all animals; (3) the "principe des connexions," by which similar parts occur everywhere in the same relative positions; and (4) the "principe du balancement des organes," upon which he founded the study of teratology, and according to which the high development of one organ is allied to diminution of another. The adventurous morphological theory is here obvious; unfortunately, however, the principle pursuit often deceptive homologies, and wandered into the transcendentalism of the Naturphilosophie, and seems utterly to have failed to appreciate the type theory of Cuvier or the discoveries of Von Baer. He earnestly defended Buffon's and Bonnet's earlier ideas of unity of plan in nature; and the controversy reached its climax in 1830, when he maintained the unity of structure in Cephalopods and Vertebrates against Cuvier before the Academy of Sciences. On the point at issue he was of course utterly defeated, the type theo-

forward fully accepted and the Naturphilosophie
d its deathblow, while a "second empiric period"
t anatomical and embryological research seemed
r to replace it. Such was the popular view; only
like the aged Goethe, whose last literary effort was
tely critique of the controversy, discerned that the
wer interpretation was the deeper and essential
at a veritable "scientific revolution" was in pro
and that the supremacy of homological and synthetic
scriptive and analytic studies was thenceforward
The irreconcilable feud between the two leaders
nvolved a reconciliation for their followers, theories
ological anatomy had thenceforward to be strictly
d to anatomical and embryological verification,
anatomy and embryology acquired a homological
This union of the solid matter and rigorous method
ner with the generalizing spirit and philosophic
Geoffroy is well illustrated in the works of Owen;
heir, the so-called Cuvierian school is in reality
onward also Geoffroyan.

further evolution of the idea of homology is sketched
of the knowledge of all the structural aspects of
and animals alike make an historical survey impera
to the appearance of the *Origin of Species* (1859);
, no further *quasi a priori* advance was possible, since,
his has been pointed out, morphology necessarily
s, under the Lamarckian dogma of the constancy of
, the same two irreconcilable lines
ught which were represented by Geoffroy and
ly German botanists respectively, on one side the
t strictly conservative classification, and on the other
ously felt existence of a natural relationship. Strict
cation of forms supposed constant could in fact carry
relationship. The type theory, the theory of unity
nic composition, and the like, are regarded indeed
explanations. They may be regarded as either ex
g a creative plan, or taken as purely Platonic
ch typal ideas. Both are tenable on theological
taphysical grounds respectively, but the fact must
disguised that of the unity of type explanation
least degree scientific, viz., in terms of the phe
of the natural world, does or can exist. The need
ation was effected by Darwin. The "transformation" of
, the types of Cuvier, and the like, at once became
ubjects as schematic representations of ancestral organ
which, in various and varying environments, have
one differentiation into the vast multitude of extant
ms. • All the enigmas of structure become resolved
-entative and "aberrant," "progressive" and
ded, "synthetic" and "isolated," "persistent
anophetic" types no longer baffle comprehension
nity to type represented by differentiated or ra
v of unity in one organism is no longer contradicted
n entire disappearance in its near allies, while
ated and morphological become related simply as
ct and generalized, all through this escape from the
n dogma of the unity of species. The phenomena
vidual development receive interpretation in terms
stral history; and embryology thus becomes divided
togeny and phylogeny, the latter, too, coming into
e relation with palæontology, while classification
henceforth the reconstruction of the genealogical
All these results were clearly developed in the most
ant work of the new period, Haeckel's *Generelle
phologie* (1866), while the valuable contemporaneous
ples of Biology of Herbert Spencer also gave special
on to the relation of morphology to physiology.[1]

§ 2. *Results.*—Though the preceding is but a
outline of the rise and progress of the science, no
sponding sketch of its results can be here attempted
description of the refined applications of the doc
ctional metamorphosis, an inquiry into the morpho
the Cryptogams, or an account of such beautiful
logies as those presented by the Arthropods or the
derms is alike impracticable; least of all can we e
the splendid simplification of the supremely comple
lem of vertebrate structure by the elaboration of
theory of the skull, and by such luminous discove
those of the segmental organs, or of the origin and
ly, etc., of the spinal and cranial nerves. For these
logical conception, the reader must study such art
those on AMPHIBIA, BIRDS, HYDROZOA, MOLLUSCA
and such works as those of Huxley, Gegenbaur
Haeckel, Balfour and Parker, Dyer, Lechler, or Asa
and (provided with the needful bibliographical equ
afforded by the various "*Jahresberichte*" and the
English publications) must indeed also plunge in
current literature of the science. And there too m
sought the innumerable attempts at taxonomic sy
which such organological processes constantly org
(see ANIMAL KINGDOM, Biology, vol. iii. p. 690;
VEGETABLE KINGDOM). Embryological generali
such as Haeckel's "gastræa theory," Lankester's riva
nula theory, or the foremost "coelome theory" o
wig, have been recently thoroughly criticized in B
Embryology. The present article will be confine
brief discussion of a few main problems, commencin
the cell theory and the problem of organic indivi
—these being selected partly because of their specu
trativeness and intrinsic importance, partly becau
have somewhat less recently been summarized.

§ 3. *Histology of Tissues.*—Although the application
simple microscope to the minute structure of plants and
had been in progress since the end of the 17th century, th
modern histology really dates from the *Anatomie Générale*
of Bichat, which analyses the organism into a series o
tissues with definite structural characters. This new
together with the improvement of optical appliances, led
to "fibres" and "globules," "lamin
described, and even "cells" by Mirbel
and in 1835 Johann Müller pointed out the existence
homologous tissues of plants in the vertebrate notochord. T
lar and nucleated structure of epidermis and other tissues
demonstrated, while Robert Brown discovered the nucleu
vegetable cell. In 1838 Schleiden referred all vegetable ti
the cellular type, and traced back the plant embryo to
nucleated cell, while in 1839 Schwann boldly extended t
ception of plant structure and development to the anima
and so fully constituted the "cell theory."

Schwann's cells were essentially nucleated vesicles wi
contents which originated in an intracellular substance;
view was soon abandoned. Dujardin had discovered that th
of Foraminifera were composed of a viscous granular co
ode, and Von Mohl described independently in simila
the contents of the vegetable cell as *protoplasm*. This wa
ted by Max Schultze as Dujardin's sarcode, the newer n
viving; and this living matter, and not the membrane, be
to be the essential constituent of the cell, since which his
definition of the cell as a unit mass of nucleated protopl
been generally accepted. Prevost and Dumas had not
segmentation of the ovum into masses as early as 1824, a
were naturally identified as cells immediately after the pu
of Schwann's work. In 1846 Kölliker showed that all tiss
from these segmentation masses, and that the multiplic
animal and vegetable cells takes place by a continuation
same process, that of transverse division already observe
Protozoa.

These points gained, the attention of histologists was wi
for a considerable time from the scrutiny of the minute s
of the cell itself to be concentrated on the modes of origin
unit masses, and their subsequent differentiation and agg
into tissues and organs. The minute structure and histog

[1] For bibliography see Carus, *Geschichte der Zoologie*; Sachs, *Geschichte d. Botanik*; Cuvier, *Hist. d. Sci.*; Is. G. St-Hilaire, *Hist. Gén.*; Masters in *Med.-Chir. Rev.*, 1858, &c.; also articles LINNÆUS, OKEN, &c.

as well as of at least the higher animals, have been studied
much and ever-increasing accuracy of detail. (See ANA-
HISTOLOGY, EMBRYOLOGY.) Both vegetable and animal
have been simply classified both according to their adult
and according to the embryonic layers from which they
rively arise. This scrutiny of plant and animal structure
d above the special generalizations of the botanist and the
st has afforded much result to general histology. The
vement of technical methods has of late years largely aided
ogress of discovery. A return from the study of the cell-
ate to that of the cell has commenced, and the question of
ucture may be said to be again paramount in histology. The
s of transverse division has of late been much elucidated,
although its complex details cannot here be entered upon,
ult has been to establish a minute and thorough correspond
cases so widely dissimilar as pollen-grain from a flower-bud,
derm of a tadpole, or the cells of a tumour—a result which
ly enhances the morphological completeness of the cell.
Minor modes of cell multiplication also are not without
morphological interest. Gemmation, familiar in the yeast
ocytes in other low and simple organisms, and most probably
tified with the formation of polar vesicles in ova, is a modifi
n of transverse division. Schleiden had supposed all new
originate within pre-existing cells, and the process known
cell-formation, may readily be observed in various plant
imal tissues. The protoplasm-groups at first found within cells,
w cells being in fact formed much as Schwann had imagined
upposed; but these modes have repeatedly been chosen
om segmentation of the original nucleus, and thus this pro-
o seems a mere modification of the general one of transver-

ing. Conjugation, too, that coalescence of two contiguous cells
may be observed in many Algæ, Fungi, and Protozoa, and
sidered as the undifferentiated form of that fertilization which
in higher animals and plants, the two apparently similar
having become respectively differentiated into ovum and
atozoon, or into egg-cell and antherozoid. An indefinite
r of amœboid cells sometimes flow together more rarely
—a phenomenon regarded by some as multiple conjugation,
haps more probably as an almost mechanical coalescence of
sted cells, from which conjugation proper and finally fertili-
may indeed have originated. The amœboid cells of higher
ls similarly unite when drawn, and this formation of *plas-*
, as these are termed, seems to be a deep-seated property of
nœboid cell. Similarly, too, the process of reproductive conju-
occurs in many of the lowest plants and animals, notably
occus and Amœba, where the protoplasm passes from a rest-
d encysted to a naked and mobile stage, has many analogies
ly among the Protista but even in the tissues of higher
ls, while the phases which the lowest organisms more or less
t—the encysted, the ciliated, the amœboid, and the flagellate—
may be regarded as the fundamental forms of a "life-cycle,"
epresented indeed only in such extremely low organisms as
nyxa and Myxomycetes, yet nowhere completely suppressed
ery highest plants and animals may thus be considered as
gates of more or less differentiated and variously arranged
ed, amœboid, and ciliated cells, while their development
bsequent changes, their variations normal and pathological,
ity exhibit phases more or less distinct of the ancestral life-

examination of the precise modes of cell division, particularly
hands of botanists (see BOTANY, and SUMMARY OF SACHS'S
Lehrbuch der Botanik, 1874, are also constantly
ing the most interesting light upon the structure of the adult
sm. Thus then, in our own dynasty in those of Richard Owen,
nn, the labours of the histologist, when inspired by higher
han that of the mere multiplication of descriptive detail, not
e one morphological importance, and result in the demonstra-
f a unity of organic structure deeper even than any which was
Linnæus or Cuvier, Goethe or Geoffroy.

Individuality.—Probably no subject in the whole range of
y has been more extensively discussed than that of the nature
ganic individuality. The history of the controversy is
st, since besides leading up to solid results it serves, perhaps
than any other case, to illustrate the slow emergence of the
l sciences from the influence of scholastic thought. Starting
he obvious unity and indivisibleness of Man and other higher
ls, and adopting some definition such as that of Mirbel
tionally unmetaphysical, however), "Tout être organisé,
et dans ses parties distinct et séparé des autres êtres qui
dit," it was attempted times without number to discover the
conception elsewhere in nature, or rather to impose it upon
er beings, plants and animals alike. The results of different
ers were of course utterly discrepant. It seemed easy and
l to identify a tree or herb corresponding to the individual
l, yet difficulties at once arose. Many apparently distinct
may arise from a common root, or a single plant may be
posed into branches, twigs, shoots, buds, or even leaves, all

often capable of separate existence. These, again, are de-
able into tissues and cells, the cells into nucleus, &c., and ult
into protoplasmic molecules, these finally into atoms, the
thus passing outside organic nature altogether and meeting
dispute as to the ultimate divisibility of matter. In s
Haeckel remarks, scarcely any part of the plant can be
which has not been taken by some one for the individua
necessary, therefore, briefly to notice some of the princip
on the subject, and these may conveniently be taken in chr
order.

While Cuvier practically agreed with Mirbel in attem
regard separate plants as individuals, the widest interpret
the individual is that of Gallesio (1816), who proposed to
a an individual the entire product of a single seed, alike
the developed monocarpic plant extended continuously
Banyan, or multiplied asexually by natural or artificial me
the Weeping-willow or the Canadian Pondweed, of each of
on this view there is only a single individual in Britain,
dicotyledon.

At once the oldest and most frequently maintained view
which regards the bud or shoot consisting of a single a
appendages as the plant individual, of which the tree repr
colony like a branched hydroid Polyp. This conception
attributed to Aristotle, but apparently without foundation,
distinctly in the writings of Hippocrates and Theophrastus
later times. The bud-crown on the tree-like plant in the g
Theophrastus of Lamarck—"Semina totidem herbæ, totidem
and in the view of C. F. Wolff and Humboldt concerning
Erasmus Darwin appealed to by an appeal to the facts of
and development. The most influential advocate of the bud
during the first half of the present century was, however, H
Thomas, who, although starting much in accord with the
unique definiteness," supported by the theory of extensive
largely incorrect observation on the structure and growth
him the tree is a colony of *gemmæ*, or buds, each with its
and root. Following out the
central wood of Alex. Braun
pointed out the illegitimate
ith inductive morphology
ver, all preceding theories
ividual are the plant,
Lysimachia than an *individual*
ceed by a partial cutting
the morphological ma
cult, because, unlike the
ntial character of the
ie to accept the bud or
ternal
ecially led Goethe, Ok
ucleus, while Johannes
Link stopped short at the cell, adopted the same view on various
logical grounds. Candolle elaborated a theory inter
tween tissues and that of Du Petit Thouars, according
the plant or bud-type of individual, each consisting of a
its adjacent internode or stem, which were regarded as the
and this was supported by Edward Forbes and other, w
naturally conveyed a view like that of the leaf as a mere outg
pan out of the term segment was proposed by Hochstetter
Though many attempts at identifying various grades,
the tissue-cells to bundles of the coexistent individuals
pre-eminent, those connected with the cell theory are
important. Schwann declared an account of the cell and
the plant as a cell-community, in which the separate elem
like the bees of a swarm, a view virtually concurred
entific reputes by Schleiden, Virchow, and other founde
cell theory. Yet, although the structure and function of t
co-ordinate, and evidently subordinate, it is impossible t
the fact that, even in the very lowest organisms, these are
not fused and did not at first enter into later aggregates, and form
bricks of a building, and hence the later theories
or attempts to find the individual in the nucleu
proto
ing
the theory of the plastid-individuality. The conce
modern Botany is well traced by Frech upwards t
e
and the older De Candolle to its
on in Alp
Candolle and Schleiden, both of whom take the cell, the s
the multicellular plant as forming three successive and subo
categories. Nägeli too recognizes not only the necessity of e
ing such a series (cell, organ, bud, body-axis, multi-axi
but the distinction between morphological and physiolo
dividualities afterwards commented on by Haeckel.

Passing over the difficulties which arise even among the
(see FORAMINIFERA), we find that a similar controver
chronicled in Haeckel's *Kalkschwämme*) has raged over
dividuality of Sponges. While the older observers were c
regard each sponge mass as an individual, a view in which La

r monographers, substantially concurred, the application of oscope led to the view suggested by James Clark, and still supported by Saville Kent, that the Sponge is a city of l or infusorian individuals. Carter looked upon the separate ons alone as the true individuals, while Schmidt, defining vidual by the possession of a single exhalent aperture, div s Sponges into solitary and social. Later, however, he *a compounda*.

e higher animals the problem, though perhaps really ev ntly less prominent. As Haeckel points out, the earth ns and even the comparatively late essay of Johann ke an almost purely psychological rather than a biological view, and the morphological aspect of the inquiry only ward when the study of much lower forms, such as Ceelen se Physophoridæ or Siphonophores (see Hydrozoa), d the difficulties with which botanists had so long been

With the rapid progress of embryology, too, arose new s; and in 1842 Steenstrup introduced the conception of an tion of generations" as a mode of organo-distinct individuals, thods, for him fundamentally similar, the sexual from nu- d females and the asexual from unimpregnated "nurses," dopted by Edward Forbes and many other naturalists, but ticized by Carpenter and Huxley. In Leuckart's remark y on polymorphism (1851) the Siphonophora were analysed ne, and their varied organs shown to be morphologically, at, while the alternate generations of Steenstrup were to a case of polymorphism in development. Leuckart arly distinguished individuals of different orders, as well n morphological and physiological individuals.

Huxley proposed the view which he still substantially s (see Biology). Starting from such an undoubted homo hat of the egg-producing process of Hydra with a free- g Medusoid, he points out that the title of individual, if o the latter, must logically be due to the former also, and s confusion between organism and individual by defining the al animal, as Galton had done the plant, as the entire of an impregnate fovum, the swarm of Aphides or bee which in this way must belong to a single individual being *Annals*.

ns's *System of Animal Morphol* 1858 another theory ounded, but the problem then seems to have fallen into until 1865, when it formed the subject of a prolonged and ssion in the *Principles of Biology*. Adopting the cell as an aggregate of the lower order, itself formed of physi- nits as the morphological unit, Spencer points out that y either exist independently, or gradually e gate of the second order, like the lower Alg of which nduality may be more or less pronounced. The union of ondary aggregates or compound units into individual of a r order is then traced through such intermediate forms as nited by the higher seaweeds or the Liverworts from that which the axes and appendages of Monocotyledons and don are ingeniously derived. The shoot of a flowering thus an aggregate of the third order, it branches into an of the fourth or higher order, and finally as a tree s a degree of composition too complex to be any longer Proceeding to animals, the same method is applied lozoa are aggregates of the first order. The e, like plant ttractions, of which Radiolaria, Foraminifera, and are taken as examples, to such definite compound whole , and such secondary aggregates multiply by gemmation ir most aggregate of the third order, which may exhibit es of integration up to that of the Siphonophora, where ndividualities of the Polyps are almost lost in that of the e form. The whole series of articulated animals are next ed as aggregates of the third order h as the Annelid are the less developed forms, the ol- bretels into segmented and individualized Molluscs to the ites of the ge appe morphological the *Generelle* of Haeckel[1] here pure morphology is distinguished ubsequent the first purely structural, *tectology*, which the organism considered as a genus individuals of different the second experimental, etiology, *promorphology*. To , detailed in the *Generelle* of organic individuality, a large of the work is devoted. Drawing on the theory of absolute dity and metaphysical fragment, and starting from the Schleiden, De Candolle and Nägeli of several successive es of relative individual he shows how more clearly than ne the physiological individual or *œcie*, characterized by ence and independence of function from the morphological ual or *cenobium*, characterized similarly by definiteness of of the latter he establishes seven categories, as follows

Plastide (cytod, metacyte, or elementary organisms).

Anter (cell-tissue or cell fusion-mass) or homoplastic or- ans (tissues), or heteroplastic organ. Organ-system, organ- (apparatus).

3. *Antimeres* (opposite or symmetrical or homotypic part rays of radiate animals, "halves of bilaterally symm animals).
4. *Metameres* (successive or homodynamous parts), *e.g.* segments of Phanerogams, segments or zooïtes of A or Vertebrates.
5. *Persona*, shoots or buds of plants, polyps of Coelen &c., "individuals" in the narrowest sense among the
6. *Cœnœcia* (stocks or colonies), *e.g.*, trees, chains of Salpæ stocks, &c.

In his subsequent monograph on calcareous Sponges, an final paper he somewhat modifies these categories by subst one category of extreme comprehensiveness, that of the *ido* place of the three separate orders of organs, antimeres, an meres. The idorgan (of course clearly distinguished fr physiological organism or biorganes) finally defined as a morph unit consisting of two or more plastids, which does not pos positive character of the person or stock. These are distin into *homoplasts* or *homœomera* and *alloplasts* or *allœomer* former meeting, as subdivisions, plastid-aggregates and fusions, the latter idiomeres, antimeres, and metameres. The definition of the tetrantimere, as denoting at once each ray of a radiate, or the right and left halves of a bilateral metrical animal, is corrected by terming each ray a *paramere* symmetrical halve the antimeres. Thus an ordinary Medu four parameres and eight antimeres; a Starfish five and ten. T ception of the persona is largely modified, not only by with the comparison of the animal with the vegetable shoot and b ting the antimere and metamere as necessary constituents, taking the central embryonic form of all the Metazoa the g l and its assumed ancestral representative, the gast the simplest and oldest form of per- sona. The different morphological stages to which it may attain are classified into three series. (1) Monaxonial[2] inarticulate persons, *i.e.*, un axial and unsegmented without ant meres or metameres, as in Sponges, e lowest Hydroids, (2) Stauraxonial inarticulate persons with antimeres, but without metameres, *e.g.*, Coral, Mollusc, Turbellarian, Trematode, Hy drozoon, (3) Stauraxonial articulate per sons with antimeres and metameres, *e.g.*, Annelids, Arthropods, Vertebrates. The colonies of Protozoa are merely idor gans. True cœnœcia, composed of united persons, occur only among Sponges, Hydroids, Siphonophores, Corals, Bry ozoa, Tunicates, and Echinoderms, of which the apparent parameres are regarded as highly centrali sorts of a radially budded worm colony; and these can be c according to the morphological rank of their constituent p They usually arise by gemmation from a single persona, yet in and Corals occasionally by fusion of several originally per ons or cœnœcia. The theory of successive subordinate individuality being thus not only derived from historical of previous theories but brought into conformity with th facts of development and descent, various groups of or being referred to their several categories, the renaming of tectology, that of the relation of the morphological to the logical individuality, is briefly discussed. Of the latter, th genera are proposed—(1) the "actual bion or complete phys individual," this being the completely developed organic for has reached the highest grade of morphological individualit to it as a representative of, *e.g.*, its species; (2) the "virtu or potential physiological individual," including any incom developed form of the former from vum upwards; the "partial bion or apparent physiological individual," su ments of the actual or virtual bion as may possess tempora pendence without reproducing the species, this latter having, however, inferior importance.[3]

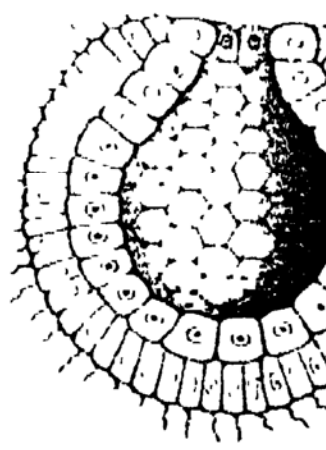


FIG. 1.—Gastrula in op tion, showing primitiv and digestive cavity pore and arch enteron outer and inner layers, and endoderm. (After

Haeckel's theory, moved in its earlier form, has been ado ray Lankester and other morphologists, also in its later form b who, however, rejects the category of idorgan on the groun general morphological principle that every natural bod carries on any chemical changes with its environment differentiated into more or less concentric layers, but the especially as far as animals are concerned, is again recei cussed in a large work by Perrier. Starting from the cell or he terms a permanent colony a *microde*, and these may isolated like Syzygia or Rotifers, or may multiply by gemm

[1] For explanation of these terms see s.v. Promorphology, p. 814.

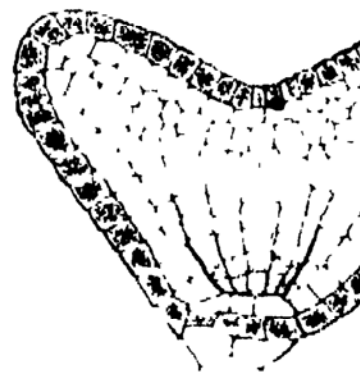
[2] For criticism of this theory on the ground of its making physiol pend on morphological individuality, see Fisch, *Untersuchung und Verschiedenen Ansichten über das pflanzliche Individuum*, p. 11.

higher aggregates which he terms *zoöds*. Such zoöds may be
lar, radiate, or linear aggregates, of which the two to
especially are termed *demes*. The organ Haeckel's idiorgan
luded, since tissues and organs result from division of labour
e anatomical elements of the meride, and so have only a
dary individuality, "carefully to be distinguished from the
duality of those parts whose direct grouping has formed the
sm, and which live still, or have lived, isolated from one
er." Perrier further points out that undifferentiated colonies
ssile, as Sponges and Corals, while a free state of existence is
ated with the concentration and integration of the colony into
ividual of a higher order.

far the various theories of the subject, detailed criticism is
sible, but some synthesis and reconciliation must be attempted
ng from the cell as the morphological unit, we find these
g homogeneous aggregates in some Protozoa and in the early
opment of the ovum. But integration into a whole, not
y aggregation into a mass, is essential to the idea of individu-
the earliest secondary unit, therefore, is the gastrula or
e. This stage is permanently represented by an unbranched
a or Sponge or by a Planarian. These secondary units may,
ver, form aggregates either irregular as in most Sponges, ir-
tely branched as in the Hydroids and Actinozoa, or linear as in
Planarians as Catenula. Such aggregations, colonies, or demes,
ing aggregated, do not fully reach individuality of the third
This is attained, however, for the branched series by such
as Siphonophore among Hydrozoa, or Rose
g Actinozoa; for linear aggregates again by the higher Worms,
till more fully by Arthropods and Vertebrates. Aggregates
et higher order may occur, though rarely. A longitudinally
ng Nais or laterally branched Syllis are obviously aggregates
se tertiary units, which, on Haeckel's view, become integrated
e Echinoderm, which would thus reach a complete individ
y of the fourth order. A chain of Salpæ or a colony of Pyro-
exhibits an approximation to the same rank, which is more
y obtained by a radiate group of Botryllus around their central
, while the entire colony of such an Ascidian would represent
dividual of the fifth order in its incipient and unintegrated
—these and the preceding intermediate forms being, of course,
y intelligible, and indeed as Spencer has shown, inevitable
e theory of evolution.

exclusion of tissues and organs from rank in this series is
seen to necessarily follow. Ectoderm and endoderm cannot
alone; they and the organs into which they differentiate
merely, as Jäger expresses it, from that concentric lamination,
th Perrier, from that polymorphism of the members of the
y, which is associated with organic and social existence. The
of the antimere is omitted, as being essentially a promorpho
l conception for a Medusoid or a Star-fish, though of widely
et order of individuality, are equally so divisible; that of
netamere a convenient to denote the secondary units of a
tertiary individual; the term persona, however, seems unfit
to survive, not only on account of its inseparable psycholo-
l connotations, but because it has been somewhat vaguely
d alike to aggregates of the second and third order, and the
colony, corm, or deme may indifferently be applied to those
gates of primary, secondary, tertiary, or quaternary order which
ot, however, integrated into a whole, and do not reach the
dividuality of the next higher order. The term zoöd is also
ionable as involving the idea of individualized organs, a view
al while the medusoid gonophores (à la Hydra) on were looked
evolved of its homologue in Hydra, whereas the latter is
a degenerate form of the former. Passing to the vegetable
, here as before the cell is the unit of the first order, while
gate representing almost every stage in the insensible evolu
f a secondary unit are far more abundant than among animal
lete unity of the second order can hardly be allowed to the
us, which Spencer proposes to compound and integrate into
ry aggregates—the higher plants, as in animal the embryo
l method is preferable, both as avoiding gratuitous hypothe
s leading to direct results. Such a unit is clearly presented
e embryo of higher plants in which the cell aggregate is at
differentiated into parts and integrated into a whole. Such
bryo possesses axis and appendages, as where fully dev
2). The latter, however, being as organs more [illegible] exp
of the concentric layers into which the plant embryo, like the
l, is differentiated, and so neither stages of evolution nor
le of separate existence, are not entitled to individual rank
mbryo, the bud, shoot, or uniaxial plant, all that belong to
econd order of individuality, like the Hydroid they resemble
the lower Coelenterates, too, aggregates of such axes are
ed by branching out from their low degree of integration
colonies can hardly be termed individuals of the third, much
ot higher order, at least without somewhat abandoning that
of treatment of plants and animals without which philosophi
iology disappears. Individuality of the second order is most
reached by the flower,—the most highly differentiated and
integrated form of axes and appendages. Such a simple
as a raceme or umbel approximates to unity of the thi
to which a composite flower head must
be admitted to have attained, while a
compound inflorescence is on the way
to a yet higher stage.

If, as seems probable, a nomencla-
ture be indispensable for clear ex
pression, it may be simply arranged
in conformity with this view. Start-
ing from the unit of the first order,
the plastid or *monad*, and termi
any undifferentiated aggregate a *deme*,
we have a *monad-deme* integrating
... - ondary unit or *dyad*, thi
rising through *dyad-demes* into a
triad, this forming *triad demes*, and
these when differentiated becoming
tetrads, the Botryllus colony with which the evolution of co
individuality terminates being a *tetrad deme*. The separat
form, whether monad, dyad, triad, or tetrad, requires also s
tinguishing name for which *person* will probably ultimately
most appropriate, since such usage is most in harmony with
table physiological and psychological connotations, while th
logical individual of Gallesio and Huxley, common also to all
gories, may be designated with Haeckel the *cœnobium* or
cycle, the complete series of forms ne represent the
being the *species cycle* (though th with the for
in cases where the sexes are separate, or polymorphism
For such a peculiar case as *Diplozoon paradoxum*, wh
separate forms of the same species coalesce, and still more
heterogeneous individuality as that of a Lichen, where a
unit arises from the union of two altogether distinct forms
and Alga, yet additional categories and terms are require



Embryo of D
(after Sachs), showing
axis and appendages,
the three concentric
layers.

§ 5. *Promorphology*. Just as the physiologist constant
to interpret the phenomena of function in terms of me
physical, and chemical laws, so the morphologist is ten
inquire whether organic as well as mineral forms are n
reducible to simple mathematical law. And just as the c
grapher constructs an ideally perfect mathematical form
imperfect or fragmentary crystal, so the morphologist has fr
attempted to reduce the complex-curved surface of organi
to definite mathematical expressions.[1] Canon Moseley (*Phil*
1838) succeeded in showing by a combination of measure
mathematical analysis, that the curved surface of any tu
or discoid shell might be considered as generated by the re
about the axis of the shell, of a curve, which continually v
dimensions according to the law of the logarithmic spir
Goodsir this logarithmic spiral, now carved on his tomb
a fundamental expression of organic curvature and the d
new epoch in natural science that of the mathematical m
tion of organic form—and his own elaborate measurement
body, its organs, and even its component cells seemed t
now the trianole, and again the tetrahedron, as the fund
form. But such supposed results, exhibiting more of the
philosophic than of sober mathematic, could only serve
courage further inquiry and interest in that direction.
find that even the best treatises on botany and zoology
the subject, satisfied with merely contrasting the ample geo
round-forms of crystals with the highly curved and he
complicated lines and surfaces of the organism.

But there are other considerations which lead up to a
metical conception of organic form, those namely of symm
regularity. These however, are usually but little de
botanists since Schleiden contenting themselves with t
organisms into three groups, first, absolute or regular,
regular and radiate, third, symmetrical bilaterally or zyg
the first being capable of vision into two halves only in
plane, the second in two or more planes, the first in mo
Braun (later), and more fully Bronn, introduced the fund
improvement of defining the mathematical form, they so
by the surfaces, but by axes, and their poles; and Hae
developed the subject with an elaborateness of detail and
[illegible] as unfortunately to have impeded its s
a sketch of which the main results may, with slig
tions chiefly due to Jäger (*Lehrb. d. Zool.*, 1878), be fo
lined.

A. *ATAXONIA*, forms destitute of axes, and cons
wholly irregular in form, *e.g.*, Amœba and many Sponges.

B. *TAXONIA*, forms with definite axes.

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1 See Haeckel, *Gen. Morph.*, i., [illegible] ; Sachs, *Lehrbuch d. Bot.*, Pasch, *Allgemeine [illegible]* ; Rose Perrier, *Les Colonies Animales*, 1881, as from these and other referen obtained.

2 The sciences of organic and mineral forms would thus (as Hae out) become theoretically [illegible] for a more complete [illegible] graphy of organic form, so mineralogy, as the study of [illegible] of pseudomorphism or of mineral development, become [illegible]

…MAXONIA – all its
(*a*) Sphere – where an indefinite number of equal axes can
…le drawn through the middle point, *e.g.*, Sphere-cosmi.
(*b*) Polyhedra, with a definite number of like axe-
…s or an indefinite number occurring in nature for example, many
…ane-faced solids, potential crystals, &c.,
…ot to be distinguishable by the
…and to identity of their fac-
…TAXONIA, where all the parts
…ed round a main axis, and of
…h through
…axes with not more than one
…axis. Here are distinguished
… with similar poles – spheroid
…al and cylinder. Perpendicular
… those with dissimilar poles,
…rchina

Heteraxonia, where, besides the
…definite number of equal
…re placed at right angles, and
…ometric ground-form becomes
…et. Here, as one may be distin-
… those with polar similar *A*
…nometric forms), the double pyramid-tetrad, *t*, and *h* the exarch
…mid, *Stauraxonia holaxonia* (or
…to the tetrametric forms), the

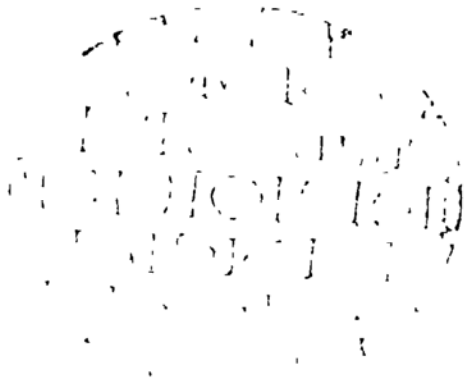

Fig. 5. – Echinocyathus Digitale (Tetrac-
…axonia, or tetrad-pyramidal Lucernarian
…pod-bearing, with the common
…ntal Type of Hom-
…axonia.

…vermiculi, and where we distin-
…al, monaxonial, polar from an
…ntial equatorial pole. The bases
… may be either rectilinear or rec-
…tilegons, and thus a new division
… into *Homocrossa* and *Heterocrossa* naturally arises.
…mpler groups, the Homocrossa
…e either auricular or rectangular
…d sides, and Rectangula among the
…nata we have examples of rod,
…st, angle and double pyramid.
… Homostauria with all
…of sides such as Medusæ, the
…nd interradial planes have com-
…, but in the case with a
…ber of sides like most Echi-
… each of the former is a rect-
…al and half-amphithect figure
…group of *regular* double pyra-
… twelve-sided polhedrum of
…ting. It may be taken as an
…, having the ground-form of
…gonal system, the hexagonal dodecahedron. Of the equal
…d angle-pyramid (Heteropoda, Alcyonium,
…, Auricularia may be taken as ex-
…of the eight-sided, rectangled and
…d pyramids, while those with an
…ber of sides may be illustrated
…ma or Primula with five sides,
…flower of Lily or Rush with three

…hly-developed and most complicated
…he Heterostauria the basal poly-
…o longer regular but amphithect
…ross double-ebody and a
…ha-an even number of sides, and
…divided into symmetrical halves
…of two planes intersecting at right
… one, or three

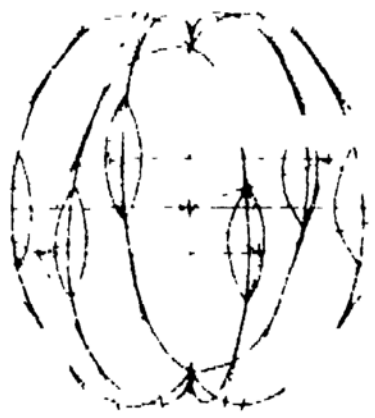

Fig. 6. – Stauraxonia holaxonia (Discoid Hydromedusa, Aurelia aurita).

Fig. 8. – Stauraxonia heteraxonia (Heteropodous Gasteropod, Carinaria mediterranea).

…ded into four concurrent polygons. The lower of
… may be termed lateral, the border the equatorial or dorso-
…, and the two axes, along with the numerous always-definite
…dominant axis of pro- Ctenophorae, &c., furnish examples
…sided or perfect pyramid; some Madreporæ, Corals of six
…Trochus, some Medusæ, and Crinoids of four-sided amphi-
…ramid.

…ese forms the poles of the dorso-ventral and lateral axes are
… and, as in the preceding Monaxonia and Stauraxonia, the
…f the body is definite. The dorsal, and therefore termed
…*onia*, while the Protaxonia, which are defined by their central
…re, however, other forms,
…se the most complicated of all in which the poles of at least the
…ntral axis are unlike, and in which the body is thus defined
…h reference to a line but to a median plane, and these have
…gly received the name of *Cathemopoda*. Their ground-form
…lygon with an even number of sides, which can only be
… into two symmetrical halves by the one median plane. It
…obtained by halving an amphithect pyramid of double the
… of sides, and is consequently termed a half-amphithect
…l (fig. 7). The whole amphithect pyramid may be most con-

…ly obtained by
…ation of the ground-form as a
…mirror. Of half-amphithect pyramids there are again two fo
…termed by Hæckel *Impapleura* and *Enapleura*, the former
…cluding the "bilaterally symmetrical" or irregularly radiate
…of previous authors, such as Spatangus, Viola, Echis, while
…Zygopleura include forms bilaterally symmetrical in the str
…case, in which not more than two radial planes, and these at

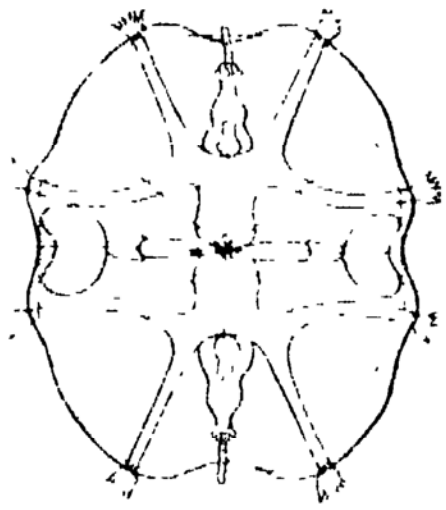

Fig. 6.

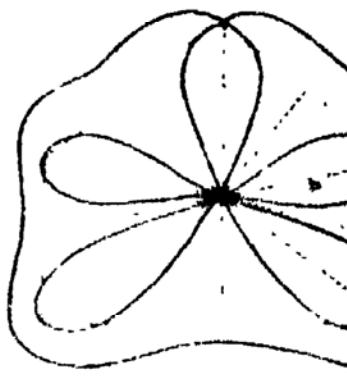

Fig. 7.

…Zygopleura (Dactylocyclus Graptolitoides), ground-form an eight-sided double amphi-
…pyramid.
…Spatangus, covered by one side of half-amphithect pyramid.

…angles to each other are present. The heteroclinic ground-
…eight-sided double pyramid. Hæckel again divides these, accor
…to the number of antimeres, into *Tetrapoeria* and *Diplopoeria*.

Promorphology has thus shown that the reigning dogma
…fundamental difference of organic and mineral forms is fal
…that a crystallography of organic forms is possible. The fo
…the cell or the cell-aggregate differing from the crystal mere
…in more or less reversible state of aggregation, its inherited p
…erties, and its greater adaptability to the environment.
…ssification into *bilateral* and *radiate* forms which usually
…duty for more precise promorphological conceptions must be
…done; as hopeless discontinuous or essentially different forms, or at
…must be greatly restricted. The term radial to regular and
…pyramid, the term bilateral to the Centropoeda if not ind
…ciplined forms. Similarly, the topographical and relative
…anterior and posterior, upper and under, horizontal and ve
…must be superseded by the terms above applied to the axe
…their poles, oral and aboral, dorsal and ventral, right and le

6. *Nature of Morphological Change.* – The main forms of o
…structure having been ascertained and classified and their stage of ind
…ality being ascertained, the question next arises, by what mo
…logical changes have they arisen, and into what categories ev
…mode of differentiation be grouped? They at first sight
…innumerable, yet in reality are few. Goethe somewhat v
…generalized them for the flower as ascending and descending
…morphosis, expansion and contraction of organs, &c., but th
…attempt at careful enumeration seems to be that of Auguste
…Bravais, who recognized defect of development, adherences, e
…of production or "dedoublements," metamorphosis and di
…ment of organs. Subsequent authors have variously treate
…subject: thus Asa Gray enumerates as modifications of the fl
…coalescence, adnation, irregularity, abortion, non-alternat
…antiposition, multiplication, cohesion, unusual development
…axis, and other morphological modifications connected with
…ction. These are obviously too numerous, as may best be
…by a single comparison with the view of an animal morphe
…Thus Huxley, in discussing the arrangement of the Verte
…recognizes only three processes of *modification*, not only
…ancestral evolution of the Equidæ, but in the individual de
…ment of animals generally, these are "(1) excess of develo
…of one part in relation to others, (2) partial or complete su
…sion of certain parts, (3) coalescence of parts originally dis
…It is probable that this "threefold law of evolution" may i
…all observed cases of change, even in the flower; thus Chori
…Peloria may be regarded as peculiar forms of excess, while di
…ment is probably in all cases only apparent, and really
…adhesion or coalescence (see BIOLOGY, vol. iii. p. 681 *sq.*).[1]

§ 7. *Nature of Morphological Correspondence – Catege
Homology.* To indicate all the steps by which the idea o
…phological has been distinguished from that of physic
…resemblance would be to examine the whole history of morph
…it must suffice to discuss the terminology of the subject whi
…as ever, served not only as an index but as an engine of pr
…For these two distinct forms of resemblance the terms *ho*
…and *analogy* gradually became specialized, and were finally
…lished and clearly defined by Owen in 1843, – "the former
…same organ in different animals under every variety of for
…function (*e.g.*, fore-limbs of *Dasyurus talpinus* and wings of Bir
…second as a part or organ in one animal which has the same fu

[1] Compare A. de St Hilaire, *Morphologie*; Gray, *Manual*, p. 172
Huxley, *Proc. Zool. Society*, p. 619, Lond., 1880.

…part or organ in a different animal (*e.g.*, parachute of …wing of Bird)." He further distinguishes three kinds …gy: (1) *special*, being "that above defined, namely, the …den…ce of a part or organ determined by its relative position …nexions with a part or organ in a different animal, the …ation of which homology indicates that such animals are …ed on a common type," *e.g.*, ba…dial process of human … with bi…ero…cipital of bird; (2) *general*, that "higher …n which a part or …ne of part…s stud…d to the fundamental …l type, involving a knowledge of the type on which the …question is constituted," *e.g.*, the … human bone and …of the lu…bar vertebræ; (3) *serial* homology, "repe… …or repetitive relation in the segment…ation of the same skeleton" …nated when general and special homologies have been …ed, thus usually the bi…ero…cipital and bra…phenoid …motype." These terms were hereafter accepted by …ts; but the criterion of analogy and homology became …sis and other embryological developmental as well as …ive, reference to the ideal archetype becoming less …t frequent. Passing over the discussion of Agassiz and …of which the latter is entirely and partly incorporated …ed, we find the last prominent phrase coined under general …, interesting categories of homologies parallel's corre… to those of individuality, *a homotaxy* of antimeres …tinct from that of Owen's *homodynamy* of metameres, …*nomy* of part arising on the vertebrate …s, homotypy …homology in terms of identity of embryonic origin. In …last point we have fully noted upon by Ray Lan…ho decomposed into two others, proposed to supersede …homology, to *homogeny* hence the correspondence of …de…ent and *homoplasy*, denoting any superinduced …dence of position and function in part…embryonically …Thus the fore-limb of a mammal is *homogenous* with …t bird, but the right not left ventricle of the heart is only *homoplastic*, the chamber…s undergoing similar …gence of both groups from a more central type are to be …to similarity of physiological needs. Mivart next pro… retain homology as a term to vary…homogeny, and …y to two species under it and erect the nerves into …tail, disregarding all but twenty-two but little fifteen …correspondences. Of part…s multifunctional only, *e.g.*, …ard and Lobster's 20 part…s unite both in function and …position, wing of Bat and Bird…s part of common …fore-limb of Horse and Rhinoceros…s part of morpho… …n origin whatever be their present remote relations, *e.g.*, …s of Panther and Perch, "separated by similar embryonic …whatever be their present general relations, *e.g.*, legs of …; 6, 7, 8, 9, 10 lateral, ventrally serially intercos… …ly, and radially homologous parts of abundant …nucleus, *e.g.*, points of attachment, 12 and 13 secondary …ary subordinate to 11 homologous, 11 and 12 special …ral homologies in Owen's sense. In his *Kritik der exakten …* proposed to term *homoiatia* the truly phylogenetic …y in opposition to *homoiomeria*, to which he…s hereby …ng; and finally Von Ihering has published a repetition of …r's views.

…s discussion, as in that of individuality, it is evident that …ealing with numerous logical processes, but by concen… …g, no doubt, to the complex web of inter-relations presented …e, yet remaining in need of discrimination. Thus we …t aside analogies of functional activity, the resemblances …al shape or geometrical ground-form which correspond to …, Hydrozoa and Bryozoa, Echinoderms and Ctenophores, …re, are nevertheless, as our historic survey showed, the …s to attract attention, and the archetypes or homomorphs …as Haeckel has shown, comes entirely within the province …morphology as do homoplasy or homogeny, with that of …gnological collocome the cryptotypes. Here, too, …considered "radial," "vertical," "lateral" homodynamy …py of antimeres, and all questions of symmetry, for which …s nomenclature of *homaxonial, homopolar*, &c., is devised …le. Entering the field of tectology or morphology in the …sense, we may next consider whether two organisms …e of the same category of individuality are *homogenous*, …der this or that homology, for instance, would come under …ivision, the correspondence between the units or parts of …a linear dyad, deme or triad. From a third point of view, …he embryologist, we trace the development of each multi… organism (1) from the embryonic layers and systems into …e secondary unit (gastrula or plant embryo) differentiates, …a unit-deme or unit of the inferior order or orders of …ality. The parts and units thus recognized by ontogenetic …, respectively or successively *homodermic*, *homosystemic*, *…nodemic*, may then conveniently be termed (undifferently …considerations of priority) either "specially homologous," …genous," "homophylic," or "homogenetic," in the language …genetic theory. These three great classes of morphological …correspondence—promorphological, tectological and embryologi… …may or may not coincide. But the completest homolog… …in which all forms of resemblance unite and from which the …differentiate, is that expressed in the cell theory, or rather in the …ovum theory which underlies it, and which Agassiz therefore …naively regarded as "the greatest discovery in the natural sciences …of modern times."[1]

Its Results to Taxonomy. The advance and modification …clusions which follow each morphological advance have been …pointed out above, and taxonomy thus never quite reaches a level …with morphological knowledge. That it require… much reform… …present is obvious. Although the dogma of the constancy of species …is no longer maintained, it is still suggestive, and perhaps a majority …of groups have still to be monographed in the generalizing spirit …with which Huxley treated the Colcareous Sponges, or Carpenter, Parker and Rupert Jones the Foraminifera. The union of the …Protozoa and Protophyta into the Protista, a consummation which …research is continually confirming, involves a final abandonment of …the medieval fragment of three kingdoms of nature, and a revival of …the Oken-Lamarck conception of Common Physiological properties are now …completely compelled, hence for the time, the constant attempt …to separate Animals and Vegetables by physiological characters …(i.e., which would be present or absent in the whole Animal …exactly morphological characters must be applied to the connective …of the theoretical, the premises of evolution, and the …are, however, not accurate to the stages of evolution …in beauty or intelligence, but is determined mostly by position …in the … reference to another, to the degree of morphological …differentiation by which … appreciate or condemn which the …exhibit. That the supreme position of Man in the Creation must …be abandoned, since the Primates are simply one of the five groups …(*i.e.*, Insecta or Arthropoda, Mollusca, Vertebrata, Annulata and the Mammalia themselves …on the whole certainly less specialized than the land or perhaps even …inferior to Insecta Reptilia. The morphological importance of the …so-called Lower Vertebrates, such as Amphioxus, Ascidians, Tunicata, Cyclostomes, Ganoids, Dipnoi, Amphibia, Ichthyopsida, …with appendages, and a notochord, have been compared not with …the central cavities or nervous system, but more especially with that …homomorphic or better homotypic with them as vertebrates …is reducible to …tes and upward … too small to be seen and in the Hydromedusæ, which have only the mesoderm and endoderm, are invaginated into the space …or cavity of the blastula, which … thus be called the archenteron …the blastopore or primitive mouth. Tubularia, …although a Coelenterate, has a true anus (Hincks).

Its Relation to Morphology and Physiology. Although the purely morphological investigation of the last decade has rightly claimed the exemption of its advancement, not from yet all be…penetrated, apart from physiological considerations, but labour would be unsupported and results unexplained if not made …subservient to … Long before Goethe, the plant, the …head and chapter seemed to an apparently permanent …fundamental comparison that of cell but another adaptation …from the relative size of successive adaptation till …exposure of the most specialized adaptive characters, at …settled to be of various degrees of constancy, and often …of no importance. The morphological aspect of an organism …merely the … and has that of readily observable …ones, truly enough when viewed as it does, but …, there is the reason to … the structural unity of …

[1] For bibliography see Lankester, *Art. Mollusca, Encyclop. Brit.*, and Haeckel, *Jena Zeitschr.*, 1868.

primeval flower from a somewhat fern like Cryptogam, of which foliage leaves, the envelopes of the spore bearing leaves, the ro and macro potangio-phore- had become permanently differ- ated in a centhner order, of which the microspores, doubtless ough the intervention of a spore eating insect, had come to ger ate upon the microsporangium instead of upon the ground, and hich the variation (evidently advantageous, nice making fertil- tion at once more certain and more economical) was added to per- nate at first to the contemporaneous evolution of those floral colours l, is now current even among the Thallophytes. And thus the mor ogist, though excluding teleological and functional considera- s from his anatomical researches, has yet a physiological ideal, and is sooner or later upon a new series of inquiries those of the ndependence of structure and function Milne Edwards's law of hysiological division of labour, Dohrn' principle of functional ange, the speculations of Claude Bernard, Spencer, and Haeckel, xperimental inquiries such as those of Semper where organ-ms subjected to special modifications of their environment and like are all contributions to this newest and evolutionary artment of morphology. Such ideas are even applied to the ld of cellular morphology. Thus Spencer points out the relation of the shapes of cells to their environments; James ingeni explains the occurrence of cell division by the rapid increa bulk over surface which the growth of a solid involves, and corresponding increase of difficulty of nutrition; and the w has attempted to explain the forms of free and united cel specializations of a protomyxoid cycle in which variations of tional activity are accompanied by the assumption of correspon forms, the whole series of changes depending upon the prope of protoplasm under the variations in the supply of energy the environment. Rauber, Hy, and others have even attempt explain embryological phenomena in terms of the simplest cel mechanics, but as yet such speculations are somewhat crude.

(J. M.) *Organization and Subdivisions of Morphology.*—The pos of morphology in the classification of the sciences and the p mode of subdividing it cannot be discussed within these li although the latter is peculiarly the subject of much disagree The position above assumed that of including under morpho the whole general aspects of the organic world, is that of Hae Spencer, Huxley, and most recent animal morphologists, bot frequently, however, still use the term under its earlier and limited significance. (P. G.)

MORRIS, Robert (1734–1806), American statesman, born at Liverpool, England, on 20th January 1734 [illegible] the age of thirteen he accompanied his father to America, and after serving in a countinghouse at Philadelphia became in 1754 partner in the business. From 1776 1778 he was delegate to the Continental Congress, and was one of those who signed the Declaration of Inde- pendence. During the war he served on the committee of ways and means, and freely placed his immense wealth at the disposal of his country his personal credit being at one time pledged to the amount of £1,400,000. He also 1780 established the Bank of North America, and until 84 acted as superintendent of finance. In 1786 he be- came a member of the Pennsylvania legislature, and he was one of the convention which framed the Federal constitu- tion in 1787. From 1786 to 1795 he was United States senator. On account of the depression consequent on the financial speculations Morris passed the later years of his life in a debtor prison. He died at Philadelphia, 8th May 1806. Robert Morris had as his assistant superin- tendent of finance Gouverneur Morris (1752–1816), with whom he was associated also in several mercantile enterprises. Gouverneur Morris, who rose to some eminence as a states- man and orator, was more fortunate in his speculations than his colleague, and latterly became celebrated for the munificence of his hospitality. He was the author of a series of essays on currency and finance, which are included in the *Life, Correspondence, and Writings of Gouverneur Morris*, 3 vols., edited by Jared Sparks, 1832.

MORRIS-DANCE, or Morrice-dance, a performance which for a time associated with certain festive seasons in England but now wholly discontinued. The origin of the name is doubtful, and whether the dance was indigenous [illegible] was introduced by John of Gaunt from Spain or was borrowed from the French or Flemings, must be left to conjecture. That, as the name would seem to indicate, it was a development of the morisco dance of Spain is certainly not however, invalidated by the fact that the morisco was for one person only, for, though latterly the morris-dance was represented by seven characters, modernity in this respect was not always observed, and the element of the dance may have been borrowed from the morisco. There are few references to it earlier than the reign of Henry VII, but it would appear that in the reign of Henry VIII. it was an almost essential part of the principal village festivities. Although allusions to it in poems are very frequent in the 16th and 17th centuries nothing more than fragmentary descriptions have been handed down to us, so that an accurate knowledge of its characteristic features at even any particular period is impossible. In earlier times it was usually danced by five men and a boy dressed in a girl's [illegible] musicians; and, at least sometimes, one of the dan more gaily and richly dressed than the other, acted "foremarch of the morris." The garment of the dan were ornamented with bells tuned to different notes so sound in harmony. Robin Hood, Friar Tuck, and L John were characters extraneous to the original da and were introduced when it came to be associated the May games. At Betley, in Staffordshire, there painted window of the time of Henry VIII., or ea portraying the morris, the characters including Maid Marian, Friar Tuck, the hobby horse, the piper, the tabo the fool, and five other persons apparently represen various ranks or callings. The hobby horse, which, lat at least, was one of the principal characters of the d consisted of a wooden figure attached to the person o actor, who was covered with trappings reaching to ground, so as to conceal his feet. The morris-dance dedicated alone with the May games and other fe tiv by the Puritans, and, although revived at the Re tora the pageant gradually degenerated in character and dec in importance. Maid Marian latterly was personate a clown who was called Malkin. Though the dance is wholly discontinued, it is probable that some of the ori elements of it still survive in a country dance which, the same name, is still popular in the north of Engla

See Douce, "Dissertation on the Ancient Morris-Dance," *Illustrations of Shakspeare*, i. 139; Strutt, *Sports and Pastimes of the People of England*; and Brand, *Popular Antiquities* (1849).

MORRISON, Robert (1782–1834), the first Protestant missionary to China, was born of Scottish parents at Morpeth, Northumberland, on 5th January 1782. After receiving an elementary education in Newcastle, he was apprenticed to a last-maker, but his spare hours were devoted to studies connected with theology, and in 1803 he was received into the Independent academy at Hoxton. In the following year he offered his services to the London Missionary Society, by which, after he had attended for a session college of Gosport, and studied Chinese under a native teacher, he was sent to Canton in 1807. He was appointed translator to the East India Company's fa

[1] See, Biology, vol. iii. p. 681 *sq.*; Spencer, *Principles of* Haeckel, *Gen. Morph.*; C. Bernard, *Phenomènes d. l. vie com* [illegible] *et mort etc.*; Semper, *Animal Life* (1880); Jones, *Med. Journal* 1883; Geddes, *Zool. Anzeig.*, 1883; Rauber, *Jahrb.*, xi., Haeckel, *Kalkschwämme*, i. p. 481, &c.

[2] See Haeckel *Gen. Morph.*, i. Introduction; also Comte, *Pos.*, iii. (1851–1854); Spencer, *Prin. of Biol.*, i.; Gegenbaur, *Anat.*; Asa Gray, *Manual*, and the article Biology, also G *Jena Zeitschr.*, 1883.

[3] See Sir Walter Scott's *Fair Maid of Perth*, note on a dre served by the glover incorporation of Perth.

n 1808, and, in addition to his official duties con- with this post, laboured with intense application *Chinese Grammar* and a translation of the New ent, both of which were published in 1814. In e published *A View of China for Philological Pur-* nd his translation of the entire Bible was completed following year. His next enterprise was the estab- nt of an Anglo-Chinese at Malacca for "the eal cultivation of Chinese and European literatu was opened in 1820. In 1821 his *Chinese Dictionary* blished by the East India Company at an expense ,000. Leaving China at the close of 1823 he spent rs in England, where he advocated Chinese mis- lar large and enthusiastic audiences, and was elected a of the Royal Society. Returning to China in 1826 him-elf to promote education and to prepare a commentary on the Bible and other Christian re. He died at Canton on 1st August 1834. His s, compiled by his widow, were published in 1839 , 8vo, London).

RISTOWN, a city of the United States, county Morris county, New Jersey, lies on the Whippany 31 miles from New York by the Morris and Es- of the Delaware, Lackawanna and Western Rail It was twice the headquarters of the American uring the War of Independence, and Washington- ce, owned by the Washington Association, is sited State's a half mile to the east. On Whippanong m, 3 miles distant, stands the State mansion known called Morristown, Avhom, a vast granite building st long, erected in 1874–1875 and capable of ac- mmodating 1000 patients. The population in 1880 18.

RSE, SAMUEL FINLEY BREESE (1791–1872), artist ventor, was born at the foot of Breed's Hill, Charles lassachusetts, on 27th April 1791. His father was v. Jedediah Morse, D.D., the author of *Morse* *aphy*. At the age of fourteen Samuel Morse entered ollege; under the instruction of Professor Day and n he received the first impulse towards those che- tudies with which his name is mainly identified. l Morse, whose tastes during his early years lean- ore strongly towards art than towards science, be- e pupil of Washington Allston, then the greatest of an artists, and accompanied his master to England he remained four years. His success at this period nsiderable, but on his return to America in 1815 ed to obtain commissions for historical painting, working on portraits for two years at Charleston, removed first to Washington and afterwards to , finally settling in New York. In 1826 he had ndations of the National Academy of Design, and ected its first president, an office which he held for 8 to 1845. The year 1827 marks the revival of Morse in electricity. It was at that time that he learned rofessor J. F. Dana of Columbian College the ele- y facts of electromagnetism. As yet, however, he voted to his art, and in 1829 he again went to to study the old masters.

year of his return, 1832, may be said to mark the of his artistic, and to open that of his scientific life rd the packet-ship "Sully," which sailed in 1st October 1832, while discussing one day with ow passengers the properties of the electromagnet, led to remark: "If the presence of electricity can e visible in any part of the circuit, I see no reason telligence may not be transmitted by electricity." not a novel proposition, but the process of formu- t started in his mind a train of new and momentous The current of electricity, he knew, would pass instantaneously any distance along a wire, and if interrupted a spark would appear. It now o to him that the spark might represent a part of either a letter or a number; the absence of the another part, and the duration of its absence, or spark itself, a third, so that an alphabet might be formed, and words indicated. In a few days completed rough draft of the necessary apparatus he displayed to his fellow passengers.[1] During the years that followed Morse was engaged in a painful s to perfect his invention and secure for it a proper pr tion to the public. The refusal of the Government mission him to paint one of the great historical pict the rotunda of the Capitol seemed to destroy all artistic ambition. In poverty he pursued his new purpose, making his own models, moulds, and castings mechanically the common necessaries of life and encom embarrassment and delay of the most disheartening It was not until 1836 that he completed any app that would work, his crowning idea having been mented by his discovery in 1835 of the "relay," by of which the electric current might be reinforced on where it became weak through distance from its Finally, on 2d September 1837 the instrument exhibited to a few friends at his room in the uni building, New York, where a circuit of 1700 feet of wire had been set up, with which the factory to ma awaken the practical interest of the Messrs Vail, ir iron-workers in New Jersey, who thenceforth becam connected with Morse in his undertakings. Morse's p for a patent was dated 28th September 1837, an soon followed by a petition to Congress for an priation to defray the expense of subjecting the tel to actual experiment over a length sufficient to e its feasibility, and determine its value. The com on commerce to whom the petition was referred, re favourably. Congress however, adjourned without the appropriation, and meanwhile Morse failed to to take out patents there. The trip was not a In Prussia his application was rejected, on the ground that his invention had been already pub and while he obtained a patent in France, it was quently appropriated by the French Government compensation to himself. His connection with proved fatal, and after a year's absence he return New York. On 23d February 1838 Congress pa long-delayed appropriation, $30,000, to enable Morse to construct a telegraph from Baltimore to Washingto on the 24th of May 1844 it was used for the firs Morse's patents were already secured to him and h ciates, and companies were soon formed for the erec of telegraph lines all over the United States. In th 1847 Morse was compelled to defend his invention courts, and successfully maintained his claim to be the original inventor of the electromagnetic recordin graph. The interest and Morse's life was spent now with the growth of his creation, and in gathering the h which an appreciative public bestowed upon hi was unable to receive from the various foreign G of which he was the distinguished citizen, while in 1858 the entative of Austria, Belgium, France, the Nethe Piedmont, Russia, the Holy See, Sweden, Tus Turkey appropriated the sum of 100,000 francs in ition of the use of his instrument in those countri the preparations for laying the first Atlantic cable an active part, though the attempt of 1857, in wh personally engaged, was not successful. He died 2

[1] Five years later the captain of the ship identified ma Morse's completed instrument with that which Morse had on board the "Sully" in 1832.

t New York, where his statue in bronze now stands Central Park. His instrument and alphabet are sed on 90 per cent. of the telegraph wires of the (S. L. P.)

RSHANSK, a district town of Russia, situated in vernment of Tambeff, 98 miles (187 miles by rail) north of the capital of the province on the Tsna tributary of the Oka, and on the railway between and Orenburg. The village Morshansk was founded the middle of the 17th century, and received al institutions in 1779; but a hundred years ago it ready a wealthy town, owing to its location in a rule district. Since it was brought into railway nication with Ruzhak (on the railway between and Ryazan) it has acquired still more importance, become the chief centre for trade in wheat raised vernment of Tambeff, Penza, Saratoff, and in the districts of the government of Ryazan. Merchant cow, Yaroslav, Vladimir, St Petersburg, and the port come to Morshansk to make large purchases n, flour, horses, cattle, tallow and pot. h. This as ther to the Shatsk landing-place on the right

TALITY TABLES. See Insurance, vol. xiii. p

RTGAGE. The general object of mortgage is to money debt by making it a charge on land, or other debt be not paid by a time agreed upon between the the creditor may sell the property and pay himself the proceeds. In English law the mortgage is a nce of the land or chattel to the creditor, on condition only to re-convey it to the mortgagor should he the time fixed upon for repayment to which the property incident duly to convey it is pect. An absolute conveyance, however, is necessential to the purpose of mortgage.

history of mortgage in Roman law presents three well marked stages. In the first, the property was conveyed absolutely to the creditor, who merely ant (*obligavit*) to reconvey it when the debt should . All the interest, however, in the property passed the debtor to the creditor, and, should the latter to reconvey, there was no remedy to the original except a personal action. In the second stage *pignus*) the property did not pass to the creditor, ly received possession of the thing pledged, together right of sale, &c., in the event of payment not ng at the time appointed. Lastly, without parting the possession even of the pledge the debtor ld a lien or charge (*hypotheca*) over it in favour creditor, who acquired thereby a right on failure ment to follow the thing by real action against the or, who could be sought for, and to repay himself he proceeds of the sale.

mortgage of English law is the result of two different ideas. Its origin and form belong to the common he restriction by which it is made to serve the of a security only, and nothing more, belong to the of equity. In the eye of the common law the gee was the owner of the estate conveyed in the ge; in equity the mortgagor remains the real owner, e mortgagee is merely an encumbrancer. A, the of land in freehold, conveys to B and his heirs, with so that on repayment of money lent by B to A, on a future day, with interest until payment, B or his will reconvey the estate to A and his heirs, and that default be made in payment, A and his heirs may without interruption from B and his heirs." The common mortgage of land, and at law, after failure payment, the land belonged absolutely to the mortgagee while in the meantime, before payment, the legal estate was considered to be vested in him, subject only to be defeated by payment at the proper time. The Court of Chancery first interfered in the reign of James I. to allow a redemption after forfeiture, and a case in the reign of Charles I. decides that payment after forfeiture had the same effect as payment before. The right of the mortgagor to redeem his estate after it has been forfeited according to the terms of the deed, is called his equity of redemption. No agreement between the parties was allowed to oust the jurisdiction of the court, or to deprive the debtor of his equity of redemption. And this equity of redemption was at first regarded as a mere right of the debtor, but was established in course of time as an estate in land which descended to the heirs of the mortgagor. On the other hand, the interest of the mortgagee as part of his personal estate, and passed to his executor and not to his heir. In spite of the terms of the mortgage, the owner of the land was still the owner, and the mortgagee is a creditor only for the money he advanced and the interest thereon. It is quite from whether a given deed is a conveyance by way of mortgage, and the courts, in deciding, will look at the circumstances of the case, and will treat it as a mortgage when it was the real intention of the parties that it should operate as a security only. Thus, if the price was grossly inadequate, if the purchaser was not let into immediate possession, if he accounted for the rents to the grantor, retaining an amount equivalent to interest, if the expenses of the deed were borne by the grantor, there would be reason to believe that the conveyance was only meant to be by way of security. And "once a mortgage, always a mortgage," but subsequent agreements can change its character.

A mortgagee may, however, on default of payment, file a bill of foreclosure requiring the mortgagor to pay the amount of the debt with interest and costs by an appointed day, or else be for ever debarred and foreclosed of his equity of redemption. The effect of failure to pay by the time appointed is not to make the mortgagee absolute owner of the property, but the court in any foreclosure suit may, at the request of either party, order a sale instead of a foreclosure. A power of sale is now implied as one of the incidents of the mortgage, unless forbidden or varied by express stipulation. The mortgagee is entitled to retain out of the proceeds of the sale the amount of his principal, interest and costs, the surplus belonging to the mortgagor. The mortgagor cannot require the creditor to receive payment before the time appointed in the deed; and, on desiring payment at the appointed time, he must give the creditor six months' notice of his intention to pay off the mortgage, so that the creditor may have time "to look out for fresh security for his money."

When the same land is successively mortgaged to different persons, their rights take priority according to their dates in logical order. But the operation of equitable doctrines in the formation of the law of mortgage leads to an important modification of this rule. Of the successive mortgagees, the first only takes the legal estate, and therefore according to the maxim of the Court of Chancery, which will turn the scale when there is an equality of equitable rights between two contracting parties. Thus, if the third mortgagee had no notice at the time of making his advance of the existence of the second mortgagee, the equities of the two claimants are supposed to be equal, and if nothing else intervened priority of time would decide the case

ghts. But if the third mortgagee gets an assign- the first mortgage, he can *tack* his third mortgage first, and so postpone the second mortgagee. And rst mortgagee himself makes an additional advance e date of the second mortgage, but without notice is whole debt will take precedence of the second gee. A similar result of equitable rules is seen in nsolidation of securities. Two separate estates, ged at different times and for different sums of by the same mortgagee to the same mortgagee, are d as consolidated, so that the whole of the land s security for the whole of the money, and the annot redeem either mortgage without redeeming ner. So that, as Mr Justice Williams remarks, no can safely lend money on a second mortgage, for, tion to the risk of a third person creating *tacking*, there anger that, if the mortgagor should have mortgaged r estate for more than it is worth, the holder of the st security may buy up the first mortgage, consolidate with his own, and exclude the second mortgagee *Equitable* mortgages are created simply by the of title-deeds as security for money advanced etment of the Statute of Frauds that no action shall ught on any contract or sale of lands, or any interest s in or concerning them, unless the agreement be ng and signed by the party to be charged, has been s incompatible with the free creation of equitable es, but it is enacted by Lord Westbury's Act that the Act never meant to affect equitable mortgages. The deed ures the evidence of title which is required in on at law and, if the mortgagor sues in equity the ould require the execution of a legal mortgage by repayment oney borrowed on the deposit. Any subsequent ortgagee, having notice of the deposit, will be post to the equitable mortgagee; and with the legal gee has not imposed a duty to call for the deed there out pense to him such a mortgagee would have ed if he had made inquiries.

o mortgages of personal property. Personal *ty.* In the United States the courts differ as to nt to which equitable principles are to be remedially ad- n the side of the common law rule that the mortgagee *Law of Real Property* pretty well-defined limits to the power to hold to create a kind of equitable mortgage with common law mortgagee. In the second, the mortgagor's right to redeem cannot ules of equity prohibit. In the third, the mortgagee all, but is bound only to foreclose, the sale of the p

s a means of paying the debt. In the New England sachusetts, Maine, Connecticut, New Hampshire, Rhode Is t, Indiana, Missouri, North Carolina, Mississippi, Minneso second, Iowa, Illinois, Pennsylvania, Kentucky, Ohio sas, and Texas, mortgages, California, Georgia and Wi which may be said to Ohio so

(CATION, a term used in surgery (*mortificare* death. Any cause which interferes with the blood of a portion of the body will, if sufficiently pro or sufficiently severe, give rise to mortification. In ases the death may be preceded by inflammation. er, as in old people with diseased vessels. The part e in consequence simply of its advanced t any previous inflammation. The part is said to ; the process termed gangrene, the dead part is a slough. A severe injury may end in mortifica Extreme heat as in severe burns, or extreme cold frost bite, may give rise to the condition. Those f the body farthest from the centre of the circula e most liable to mortification. Frost bite, for ex may attack the toes or fingers as well as those which are most exposed to the cold more particu e point of the nose or the ears. The part affected becomes pale, bloodless, cold, and insensible. The gr point to attend to is to restore the circulation gradual using gentle friction. the person is brought be fire, or if any hot applications are used, then a rapid action may issue in a severe inflammation, which may followed by mortification. Chilblain is a mild form frost bite occurring in young people with sluggish circu tions, very often caused by sitting down before a fire with cold feet; any one suffering from cold feet hands should take plenty of exercise, and if after a retu from a sharp walk the feet remain cold the heat should restored by rubbing with a rough towel.

MORTMAIN, STATUTE OF. The object and effect the enactments are treated in the articles CHARITY M CORPORATION (*q.v.*). The following is a list of the Mo main Acts:

9 Henry III. c. 36 Magna Charta. 7 Edward I. st. 2. c 18 Edward I. c. 3. 13 Edward I. c. 32. 13 Edward I. c. 41. 15 ward I. st. 3. 27 Edward I. st. 2. 31 Edward I. st. Edward III. st. 3. c. 3. 15 Richard II. c. 5. 4 Henry VIII. c 5. 23 Henry VIII. c. 10. 1 and 2 Philip and Mary, c. 8. 13 Elizabeth, c. 1. 21 Geo. I. c. 49. and 11 Geo. II. c 36. 23 Geo. II. c. 7 and 9 William III. c. 37. 9 Geo. c 36. 43 Geo. III. c. 108. 3 Geo. IV. c. 92. and 2 and 3 William IV. c. 115.

MORTON, JAMES DOUGLAS, 4TH EARL OF (*c.*1530–158 regent of Scotland, second son of Sir George Douglas Pittendreich, was born at Dalkeith in 1530. Having married Elizabeth, daughter of the third earl of Mort he threatened her succession to the title and e of the latter in 1553. After the return of Queen Mary had been elected provost of Edinburgh and in 1563 became Lord High Chancellor. Though sympathising w Protestantism, he took no part in the conspiracy of Protest tatione in 1565, but he headed the armed force of 150 m who took possession of Holyrood Palace to get the as sination of Rizzio secured. It is believed that the lead conspirators had determined to murder or imprison Mary's consort to the Scottish throne. The que before completing with the request, escaped to Dunb castle on her return to Edinburgh with an escort of 2 men. Morton joined the other Protestant lords in Englan her return with Darnley, Morton returned, and w good terms at the Berwick, Carlisle, where queen, on the death of Lord Darnley retired. He conference at Cuckney H part in obtaining the com of the queen at Lochl to an abdication. The reg he was to cooperate Lord High Chancellor, and to succeed Bothwell's Lord High Admiral. On the death of the of May he became regent (October 1572). Through to take measures to overthrow the crown power, by the comm of Argyll, widow of the earl of Moray, Morton awake the latter's murderers of Ruthven and Athole, who per the young King James VI. to resume the governme Morton deemed prudent to retire and for a time ret to Lochleven, but shortly afterwards, with the assist of his nephew, the earl of Mar, he obtained possession Stirling Castle, where the king was residing, and thro a troop raised by his influence. Suddenly, howe Stewart, earl of Arran, of hav taken part in the murder of Darnley, the father of King, and been tried by a jury of sixteen peers, mo whom were his enemies, was condemned to death and headed on 2d June 15[illegible].

MORVEAU. See GUYTON DE MORVEAU.

MOSAIC (late Greek ψηφωτός, from ψῆφος, a s stone; also *pavimentum*, *i.e.* pebbled, delicate work, hence Latin *opus musivum*) is the fitting together of m generally small, pieces of marble, opaque glass, colo clays, or other substances so as to form a pattern,

may be of various degrees of elaboration, from the st, almost monochromatic, geometrical pattern to st elaborate picture, with figure subjects represented ns of countless gradations.

earliest existing specimens of mosaic belong to less important branches of the art namely, the entation on a small scale of jewellery, ivory thrones, her furniture, or more rarely of some elaborate archi- l ornament. Most of this earliest sort of mosaic ol- in execution what are called *cloisonné* enamels. Louvre and in the British Museum are preserved ery beautiful ivory carvings in low relief, some from ch and others from Egypt, in which figures of deities, nts formed of the lotus and papyrus plants, and artouches are enriched by small pieces of glass or azuli and other gem-like stones, which are let into made in the ivory. Each minute piece is separated he next by a thin wall or *cloison* of ivory, about as cardboard, which thus forms a white outline, and the brilliance of the coloured stones. The favourite in this sort of work for decorating the larger sur- ppears to have been suggested by the feathers on a wings. See Ivory, vol. xiii. pl. vii. fig. 3.

ent excavations at Tell el Yahudiya in Lower Egypt brought to light some mosaics on a larger scale, but d in the same way. These are caps of columns, walls nd other objects, either of white lime stone or earthen- ware, on which designs, chiefly consisting of the papyrus med by brilliantly coloured bits of glass or enamelled ware, let into a coating on the tile or column. orm of mosaic was employed by the Greeks, the heum at Athens, both in the middle of the 5th v. B.C., had the base of one of its white marble s ornamented with a plait like design, in which of coloured glass were inserted to emphasize the ne of the pattern.

ther, quite different sort of mosaic was known to ypians of the Ptolemaic and Roman period. This entirely of glass, and is extremely minute. The known specimens in the British Museum, it is a ll let about three-eighths of an inch square, apparently el of a ring, on which is represented the sacred every feather on the bird's wing being produced a great number of colours and tints, each minute di- and so inlaid [illegible] strong magnifying glass it ld look enough like detail.

way in which this wonderful little mosaic was pro- is extremely interesting. Number of long thick ed coloured glass were arranged in such a way that d all round so as to form the The whole bundle of thick rods of glass when looked ways presented the figure of the hawk with a oad contour, somewhat larger than it afterwards be The bundle was then heated till the rods melted ther, and the whole thick rod, softened by fire, was drawn out to a greatly diminished thickness. In rods the original positions of the thick rods of coloured pattern, though not altered. A slice of the as then cut off, and the face polished, the design reduced in size, of course, but equally visible at ides of the slice, and like the micro-cosmic minute the mosaic was protected with a tortoiseshell de- ornament; many slices, each showing the same e, could be cut from the same rod.

more important use of mosaic has been on a large either for pavement or for wall and vaulted ceil- Mosaic for these purposes has by many writers, both t and modern, been divided on various systems into s, perhaps the simplest classification is the following:-

I. *For Pavements*: (*a*) *Tesselated*, in which the is formed of small cubes, generally of marble, more of glass or clay; (*b*) *Sectile*, formed of larger pi marble, shaped and cut so as to fit accurately on another. II. *For Walls and Vaults*: *Tectile or v lated*; pieces of opaque glass, in small cubes, arran as to form complicated pictures.

This classification is not altogether satisfactory than one method often being employed in the same e.g., in the "Opus Alexandrinum" of mediaeval which is often partly tesselated and partly sectile.

Until Roman times we know but little of these k mosaic. There is some evidence (in Pliny and writers) to show that elaborate mosaic pavement *emplecton* or *Asarotos oecus*, were made by the Greeks 4th century B.C., or even earlier; but most of t merous fine specimens of tesselated work still exis Greece, such as those at Sparta and Athens, must ferred to the time of the Roman occupation. Th examples of Hellenic mosaic are some pavement covered during the recent excavations at Olymp fig. 1 and *Mittheilungen aus Olympia*, 1877, p. 2).

Among the Romans the use of mosaic, both of and opaque glass, was very extensive. Accord Pliny (*N.H.*, xxxvi. 2 6), they derived this art fr Greeks, but not until the time of the Third Punic W B.C., while glass mosaics for walls, "vitrea pa were a recent invention in his time. Many of the been found at Pompeii, most commonly they are decorate niches for fountains or statuette. Judgin the description given by Vitruvius (vii. 1), and an ex tion of numerous specimens of Roman tesselated m

Fig. 1.—Greek Pavement from the Temple of Zeus at Olympi

the process of manufacture was the following. Th was first carefully rammed down to a firm and even s on this was laid a thick bed of stones, dry rubbish, an called "rudus," from 6 to 9 inches deep, and abo another layer, 4 to 6 inches thick, called "nucleus," part of lime to three of pounded brick, mixed with on this, while still soft, the pattern could be sketch with a wooden or metal point, and the tesserae or sm of marble stuck into it, with their smoothest sides most. Lime, pounded white marble, and water wo mixed to the consistency of cream, forming a ver setting cement, called "marmoratum." This cemen liquid, was poured over the marble surface, and well into all the interstices between the tesserae. Wh

concrete and cement were both set, the surface of the pavement was rubbed down and polished. This kind of mosaic was largely used for floors of hypocausts; the concrete bed was then supported on large tiles resting on numbers of short pillars.

If used for upper floors very strong joists were required, and both Pliny (xxxvi. 25) and Vitruvius (vii. 1) recommend a *double* layer of boards, one crossing the other, on which the concrete and cement bedding was to be laid.

The usual Roman pavement was made of pieces of marble, averaging from a half to a quarter of an inch square, but rather irregular in shape. A few other, but quite exceptional, kinds of mosaic pavements have been found, such as that at the Isola Farnese, 9 miles from Rome, made of tile like slabs of green glass, and a fine Oecetile pavement on the Palatine Hill, made of various shaped pieces of glass, in black, white and deep yellow. In some cases (*e.g.* in the "House of the Faun" at Pompeii) glass tesserae in small quantities have been mixed with the marble ones, for the sake of greater brilliance of colour. Pompeii is specially rich in its mosaics both on floor and walls, almost every house having at least its vestibule paved in this way.

In addition to the flowing patterns and geometrical designs, pictures like the [illegible] of great elaborateness frequently occur. Of these the most important is the large one now unfortunately lost, the scene of the battle of Issus, found in the "House of the Faun." It is of special value as being the direct copy of a picture of high [illegible] existing. It was a well-designed though somewhat crowded composition, representing the moment of Alexander's charge against the cavalry of Darius. The expression of the face and the characteristic dress of the Greeks and Persians are represented with great skill even in the [illegible] of the case in this out-of-work, as the one to the smaller it is only about one tenth of an inch square, to be preserved for the floor, where greatest refinement of detail was required. The wall decoration mosaic, though generally the [illegible] inlaid wood work, was affixed to walls.

The most skilfully-executed of the existing specimens of the pictorial kind is that known as the Pliny Dove, found in Hadrian's villa at Tivoli, and now in the Capitoline Museum. It was probably the one so highly praised by Pliny (xxxvi. 25) in the words of Sosus, for, although he describes the Pergamum, as it was a common practice with the Romans to remove the mosaics from one place to another, and this very composition may well have been brought to Tivoli to adorn the emperor's villa. It is [illegible] in a very realistic way: the hair on the gold bowl, the plumage of the doves, and especially the reflections on the water of the drinking dove, are represented with wonderful skill. It is in fact, far too pictorial, and, like the late mosaic in St Peter's, Rome, is more remarkable for its technical skill than for any

This excessive realism, produced with great difficulty and cost, is not uncommon fault of the more elaborate Roman mosaics, and was the inevitable result of the luxury and ostentation of imperial Rome, which made art the bond-slave of the wealthy rather than the free and natural expression of a whole people as it was among the earlier Greeks.

Another interesting mosaic from the wall of a house at Pompeii, of extreme delicate work, is a richer classical scene in a cool shady grove where the choregus is instructing the actors in their parts, remarkable from its being signed as the work of Dioscorides of Samos. Other figure-subjects are not uncommon, such as various representations of the victory of Theseus over the Minotaur, a story of Achilles in Scyros, many hunting scenes and the like.

Throughout England, Germany, France, Spain, Asia Minor, and Northern Africa in no way have traces of Roman occupation been left so clearly and in such conspicuous a form as by the numerous large and generally well preserved mosaic pavements which have at various times been discovered in all these countries. In many cases, long after all traces of the walls of the buildings have disappeared, owing to their being dug up and removed for building purposes, the mosaics still remain to testify of the artistic power and mechanical skill of the Roman colonists.

Few countries are richer than England in these remains: the great pavements of York, Woodchester, Cirencester, and many other places are as elaborate in design and as skilfully executed as any that now exist even in [illegible] itself. In whatever country these mosaics are their style and method of treatment are always much the same; the materials only of which the tesserae are composed vary according to the stone or marble supplied by the country. In England, for instance, limestone often takes the place of the white marble so common in Italian and North African mosaics; while, instead of marble, a fine sort of burnt clay or red sand-stone is occasionally used; other make-shifts had to be resorted to, as many of the Anglo-Roman mosaics are made entirely without marble. It is perhaps partly owing to the wealth of Northern Africa in marble of many colours and of varying shades that the finest of all Roman mosaics have been found in Algeria and Tunis, especially

Part of Pavement Head-piece to the Battle of Issus, fo

from Carthage, one of which have been brought to the British Museum. See *Archæologia*, vol. xxxviii. p. [illegible].

The range of colour in the marbles to [illegible] and [illegible] and [illegible] are three or four different shades of red and a number of yellow and green, the last colour not being almost peculiar to the part of Africa, and of the most pleasant and harmonious in almost all situations. Deep black brown, and blush-grey are abundant. The white marble which forms the ground nearly all the decorations is often not pure white, but stained with grey, giving great softness and beauty of texture to the surface, and doing away with too much sense of force. The Roman practice, common in their mosaics, of not letting the tesserae quite fit together, but allowing the cement joints to show, was also of great value in giving effect to the beauty of texture of the surface, a point quite forgotten by later mosaic workers who thought that the closer the tesserae were fitted together the better the mosaic would be. This remark does not apply to such mosaic, in which sufficient variety can be given by the markings and colour in each piece of marble. To return to the mosaics of Carthage, they are no less excellent in design than in the richness and beauty of their material. Large

ed by grand sweeping curves of acanthus and other
, drawn with wonderful boldness and freedom of
and varied with great wealth of invention. With
e use of very small tesserae, much richness of effect
n be obtained by gradations of tints, suggesting light and
without a painful attempt to represent actual relief.
ders of the marble sanctuary and elsewhere by the
s are so quiet and harmonious that it would have
been impossible to produce with them a hurried
y design, and when used with the skill and knowl-
ledge of the mosaic workers at Ravenna the
is a real masterpiece of decorative design. In
and in the Roman colonies of Europe the kind of
e to be laid was largely governed, with but
alteration in style or method of treatment, till the
ntury. In Syria and Asia Minor the art survived
enturies later.

ope the best existing examples are those which
he vestibule of the church of S. Prassede, and
e have been executed in the 9th century, under
to the work of the Eastern Empire. Before we
the Roman method, which, carried into Italy,
into that provincial form which is represented by the most
ne pictorial mosaics. These are the mosaics which
s an application of the principles of painting
ion of a fixed standard of colour, to the same purpose as the
he latter process was known to the ancients
were
n the other hand, by the
Other
both
of the
Further
till the 6th century. At Ravenna
e Roman
are preserved
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is
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alteration
ntury. In
the
Rome
near
Seville,
Hadrian's
time. No
pretty
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of about the

Wood Mosaic.—The
ral classes: (1) those used to decorate walls and
, made of glass cubes; (2) the floor pavements, made
ble, partly in large shaped pieces, and partly in small
s, (3) glass in small pieces, either rectangular or
ular, used to enrich marble pulpits, columns, and
architectural features, (4) wood mosaic.

The wall mosaics were, in their present, purely Byzan
and appear to date from the beginning of the 5th
y. The ware made of coloured glass, rendered opaque
addition of oxide of tin. The melted glass was cast
ts, especially about half an inch thick, and then
into small cubes. Every possible colour and grada-
of tint was produced by the mediæval glass makers
e of gold (which were very largely used) and of
were made thus: the metal leaf was spread over
the glass slab, the colour of which did not matter
was hidden by the gold or silver, over the metal
slab a film of coloured glass was fused, so as to
the metal leaf from injury or tarnish, and then
ab was broken up into cubes, the *gemmæ vitreæ* of
time writers.

e method of putting together the mosaic was much
me as that employed by the Romans in their tes-
pavements. A thick coat of cement was applied to
all or vault, the outline indicated with a metal point,
he cubes stuck one by one into the cement while it
was yet soft, the main difference being that no rub
down and polishing were required, the faces of the
ts, even showing the natural surface of the fracture, w
was not quite level, and by the slight inequality of su
reat additional lustre and brilliance of effect were g
to the whole picture.

Owing to the intense conservatism of Byzantine ar
o subjects, scarcely any progression can be traced in this cla
ration. Some of the 5th century mosaics at Ravenna
many ways as fine as those of the 12th, and it was
till the end of the 13th century that any important ch
ce took place, when Cimabue, and more especi
his pupil Jacopo da Turita and Taddeo Gaddi, ap
their increased knowledge of the human form and o
harmonies of colour to the production of the most
tiful of all mosaics, such as those in the apse of S. M
Maggiore at Rome. It must not, however, be supposed
during all this time from the 5th to the 14th cent
one steady level of excellence was kept up. The mo
of the 9th century are poor in drawing and ge
treatment, as are both of the earlier and later times, w
in both of these the artist was absolutely restricted du
the 10th and 11th centuries. Extreme splendour of c
and a soft-like brilliance combined with the most st
grand style of form are the main characteristics of this s
decoration. Its most frequent application is to the
domes, arches and roof of the early basilica.

A great deal of symbolism entered into the treatment of the
subjects, which were generally treated in a hieratic manner. In
the apse or over the triumphal arch of the entrance Christ was repres
in glory, to whom the twelve apostles, in the form of sheep
personification, Christ, the Good Shepherd, sometimes de
as a beautiful youth, stood among a circle of sheep, the tree
of the mountains being represented by palm trees, or a
complete picture, as in the tomb of Galla Placid
Ravenna, in the apse of the church, with much of the old Roman
and classic feeling and composition. Frequently the Virgin Ma
the principal figure of the church, occupies the central space
pied by a series of other and smaller subjects.

The Doom, or Last Judgment, a favourite subject for
mosaic worker, the Triumphal Arch being one of the gr
decorative spaces of the Apse, executed in the 13th century,
several instances, and have the scene of Christ's baptism,
Jordan, sometimes represented in a very classical ma
a figure with flowing hair holding an urn from wh
pours forth the waters. S. Vitale at Ravenna has the sanctu
the Presentation of Justinian and his empress
Theodora, attended by a numerous suite of courtiers
which are certainly of the 6th century, and
with dignity, though the fact that he
is represented with a circular nimbus appe
that he was not then alive. Scenes from both Ol
New Testament, or the lives of the saints, are also represen
generally on the walls of the body
in oval shaped pictures, arranged in one or more
over the nave colonnade or arcade.

In most of the best period of the treatment of the f
and draperies is broad and simple, a just amount of
being expressed by delicate gradations of tints. In mo
of the 9th century the drawing is very awkward, an
folds of the robes are rudely expressed in outline, wi
suggestion of light and shade.

A further application of this work was to the decor
of broad band over the columns of the nave, as
Maria Maggiore in Rome, 5th century, and in the
churches of S. Apollinare at Ravenna, 6th century,
one case almost the whole interior of the churc
encrusted in the magnificent way, as at Monreale Cathe
the Capella Palatina of Palermo, and S. Mark's at Ve
the magnificence of which no words can describe;
quite unrivalled by that of any other buildings in
world. See MONREALE.

In these churches the mosaics cover soffits and a
entirely, and give the effect of a mass of solid gold
colour producing the utmost conceivable splendou

decoration.[1] In many cases vaulted ceilings were covered with these mosaics, as the tomb of Galla Placidia, 450 A.D., and the two baptisteries at Ravenna, 5th and 6th centuries. For exteriors, the large use of mosaic was usually confined to the west façade, as at S. Miniato, Florence, S. Maria Maggiore, Rome, and S. Mark's, Venice. In almost all cases the figures are represented on a gold ground, and gold is freely used in the dresses and ornaments, rich jewels and embroidery being represented in gold, silver, sparkling reds, blues, and other colours, so as to give the utmost splendour of effect to the figures and their drapery.

The revival of the art of painting in Italy and the

FIG. 3. Mosaic of Theodora and attendants, from S. Vitale, Ravenna; over life-size.

introduction of fresco work in the 14th century gave the deathblow to the true art of wall mosaics. Though at first the simple and archaic style of Cimabue and his

[1] Unfortunately the world-wide fame of S. Mark's and the other great churches of Italy has subjected these extraordinary works to the fatal process of "restoration," and wherever any signs of decay in the cement backing (the tesserae themselves are quite indestructible) has given the least excuse the "restorers" have destroyed whole masses of ancient work, and supplied its place with worthless modern copies. The mosaics of the S. Mark's baptistery, and of the apse at S. Miniato, at Pisa, and many other places have in this way been wantonly renewed within the last few years.

pupils Jacopo da Turrita, Giotto, and Taddeo G[illegible] was equally applicable to painting or mosaic, yet soo[n] development of art into greater realism and comp[lexity] required a method of expression unfettered by the ne[cessities] and canons of mosaic work. Pietro Cavallini, a R[oman] artist, was one of the last who worked according t[o] old tradition. His mosaic of the birth of the Vir[gin] S. Maria in Cosmedin, Rome, executed about the m[iddle] of the 14th century, is not without merit, though [his] superior knowledge of form has only caused his co[n]ception to be somewhat feeble and insipid compared wi[th] works of the earlier artists. Even in the 15th cent[ury] few good mosaics were produced at Venice and el[se]where. Since then many large pictures have been copied in mosaic, generally attempts to imitate oil painting, exe[cuted] with great skill and wonderful patience, but all [of] worthless as works of art, merely costly monuments [of] human folly and misapplied labour. The mosaics [of] Titian's pictures on the west end of S. Mark's at V[enice], Raphael's in the Chigi Chapel in S. Maria del Popol[o], many large pictures in S. Peter's in Rome, are the [most] striking examples of these.

The following list, a chronological order comprises [a] selection from among the most important mediæval and [early] mosaics, the period when mosaic work[manship] was at its [highest].

[illegible]

14th Century.

ce. Baptistery finished by Andrea Tafi.
Cathedral east apse by Cimabue, 1302, north and south apse by his pupils
S. Peter's navicella in atrium by Giotto
S. Marco Cappella Grimani walls by Pietro Cavallini, c. 1310
SS. Giovanni e Paolo arch over effigy of Doge Morosini

It is by no means exhaustive, and only gives some of the most typical examples of the mosaic work of each century. The time origin of these great wall mosaics, wherever executed, is amply proved both by internal and documentary evidence. The gorgeous mosaics of S. Sophia and S. Saviour's in Constantinople, 6th century, and the later ones in the monasteries of Mount Athos, at Sclonic and at Daphne near Athens, are identical in style with those of Italy of the same date. Moreover, the even more beautiful mosaic-work in the "Dome of the Rock" at Jerusalem, 7th and 11th centuries, and that in the sanctuary of the great mosque of Cordova, of the 10th century, are known to be the work of Byzantine artists, in spite of their thoroughly Oriental designs. The same is the case with the rare mosaics of Germany, such as those in S. Gereon at Cologne and at Parenzo.

The very remarkable, almost unique, specimen of Byzantine mosaic preserved in the "Opera del Duomo," Florence. This is a work of the 11th century, of extremely minute, almost micro-mosaic work, in tesseræ of glass and metal, perhaps the only example of mosaic made of solid metal. It has figures of saints and inscriptions, each tessera being scarcely larger than a pin's head. This mosaic originally belonged to the imperial chapel in Constantinople, and was brought to Florence in the 14th century.

Of the second mediæval class, mosaic pavements, though of great interest, are of less artistic importance.

The so-called "Opus Alexandrinum" is very common throughout Italy and in the East, and came to great perfection in the 12th century. It is made partly of small marble tesseræ forming the lines of the pattern, and partly of large pieces used as a ground or field. It is generally designed in large flowing bands which interlace and enclose circles, often of one stone sliced from a column. The finest examples that at S. Mark's, Venice, of the 12th century. The materials are mainly white marble with green and red porphyry, and glass.

Of the countless churches in Italy possessing these beautiful pavements, such as S. Lorenzo, S. Marco, S. Maria Maggiore, and S. Maria in Trastevere, in Rome, we have in the Chapel of the Sacrament, and in front of the high altar of Westminster, very fine specimens of this work, executed about 1268 by a Roman artist named Oderisius, who was brought to England by Abbot Ware, on the occasion of a visit made by the latter to Rome. Another fine example is the mosaic pavement in front of the shrine of St. Thomas at Canterbury. This is probably the work of an English artist, though the materials are foreign, as it is partly inlaid with glass, a peculiarity never found in Italy. There are also many fine examples of these pavements in the churches of the East, such as that in S. Sophia at Trebizond, of the most elaborate design and of rich materials, very like the S. Mark's pavement at Venice. Palermo and Monreale are especially rich in examples of secular work, used both for pavements and walls, in the latter case usually for the lower part of the walls, the upper part being covered with the glass mosaics. The designs of these Sicilian mosaics, mostly executed under the Norman kings in the 12th century, are very Oriental in character, and in many cases were actually executed by Moslem workmen. Fig. 4 gives a specimen of this work

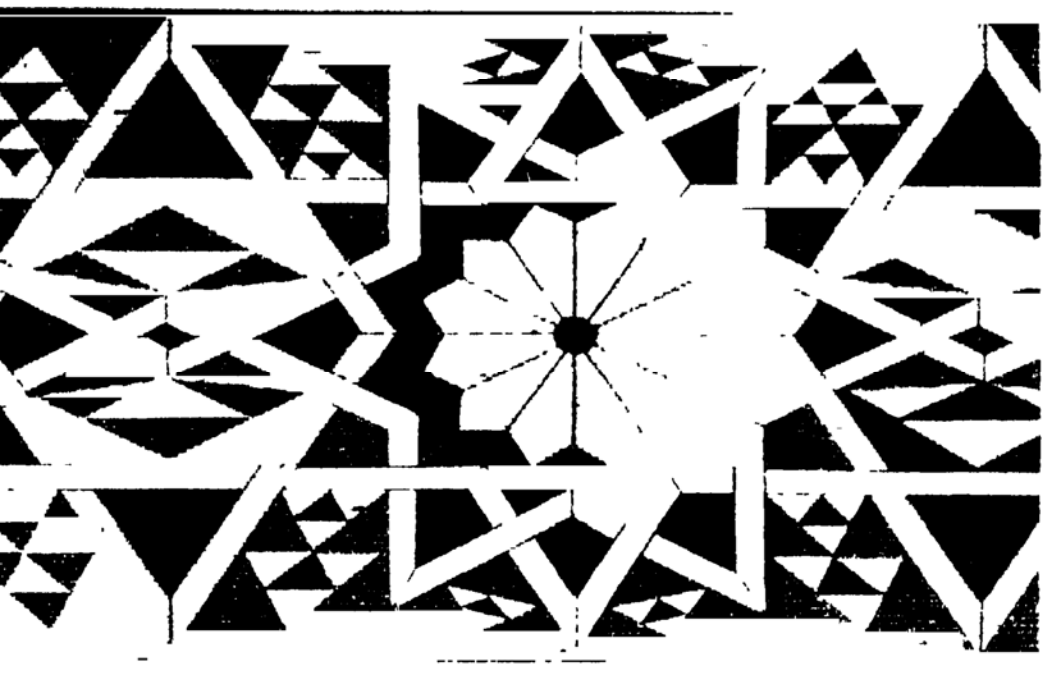

Fig. 4. Marble Mosaic of Monreale (Sicily).

from Monreale cathedral. Its chief characteristic is the use of curved lines, so largely used in the splendid opus Alexandrinum of Italy, arising from the fact that this class of Oriental work was mainly used for the delicate panelling in wood on their pulpits, doors, &c.,—wood being a material quite unsuited for the production of large curves.

3. Glass mosaic, used to ornament ambones, pulpits, episcopal thrones, baldacchini columns, architraves, and other similar objects, is chiefly Italian. The designs, when it is used to cover flat surfaces, such as panels or architraves, are very similar to those of the pavements last described. The white marble is used as the matrix in which sinkings are made to hold the glass tesseræ. The columns are frequently ornamented with a spiral band of this mosaic, or flutings are suggested by parallel bands on the columns. The cloisters of S. Giovanni in Laterano and S. Paolo fuori le mura have splendid examples of these enriched shafts and architraves.

This style of work was largely employed from the 6th to the 13th centuries. One family in Italy, the Cosmati, during the latter part of the 13th century, was especially skilled in this craft, and the various members of it produced an extraordinary amount of rich and beautiful work. The pulpit in S. Maria in Ara Coeli, Rome, is one of the finest specimens (see fig. 5), and are also the ambones in S. Clemente and S. Lorenzo and that in Salerno cathedral. The tomb of Henry III., 1291, and the shrine of the Confessor, 1269, at Westminster are the only examples of this work in England. These were executed by "*Petrus et Romanus*," probably a pupil of the Cosmati.

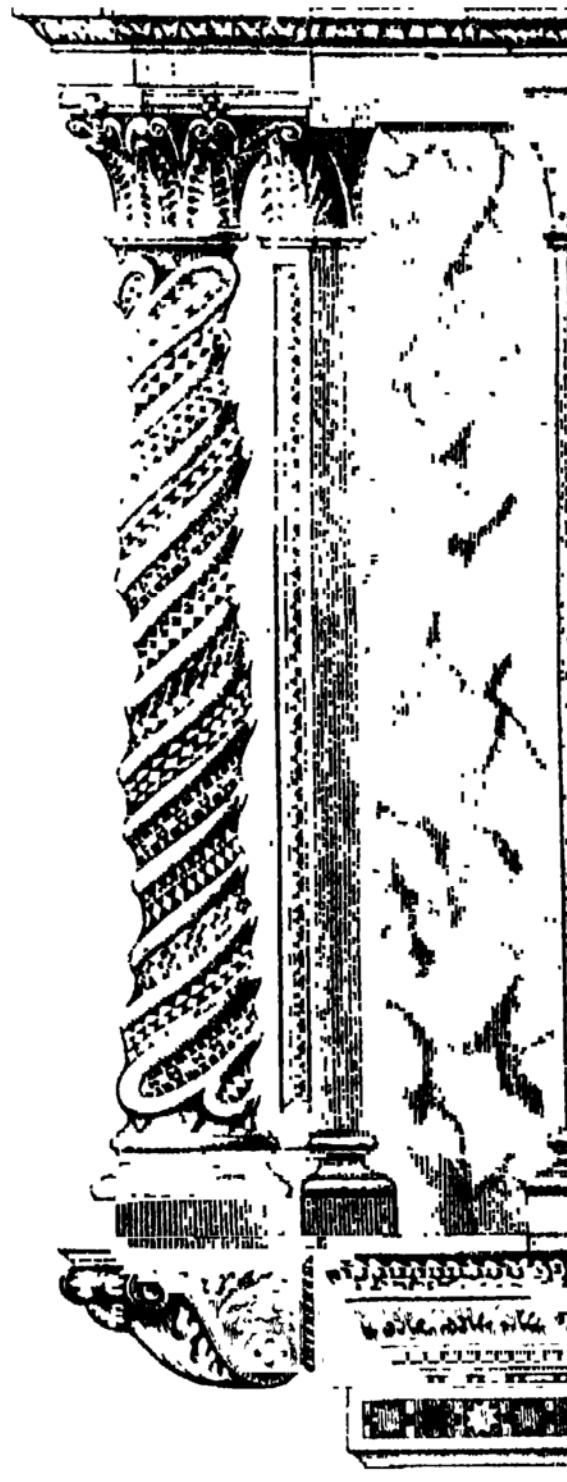

Fig. 5. Part of Marble Pulpit with mosaic, church of Ara Coeli, Rome.

In India, especially during the 17th century, many Mohammedan buildings were decorated with fine marble inlay of the class now called "Florentine." This is *scagliola* mosaic, formed by shaped pieces of various-coloured marbles let into a marble matrix. A great deal of the Indian mosaic of this sort was executed by Italian workmen, the finest examples are at Agra, such as the Taj Mehal.

The modern so-called "Roman mosaic" is formed of short and slender sticks of coloured glass fixed in cement, the ends which form the pattern, being finally rubbed down and polished.

Many not unsuccessful attempts have been made lately to reproduce the Roman tessellated work for pavements; and at Murano, near Venice, glass wall-mosaics are still produced in imitation of the magnificent works of mediæval times.

4. Mosaics in wood are largely used in Mohammedan buildings, especially from the 14th to the 17th century, the finest specimens of this work are at Cairo and Damascus, and chiefly to decorate the magnificent pulpits and other woodwork in mosques. The patterns are very delicate and complicated, the inlay of small pieces of various coloured woods, often enriched by bits of mother-of-pearl and minutely carved ivory. The general effect is extremely splendid from the combined beauty of the materials and workmanship, as well as from the marvellous grace and fancy of the designs. This art was also practised by the Copts of Egypt, and much used by them to ornament magnificent iconostases and other screens in their churches.

Another application of wood to mosaic-work, called "Certosina," was very common in Italy, especially in Tuscany and Lombardy during the 15th and early 16th centuries. Its chief use was for the decoration of the stalls and lecterns in the choirs of churches. Very small bits of various coloured woods were used to form geometrical patterns, while figure subjects, views of buildings, strong perspective effects, and even landscapes, were very successfully produced by an inlay of larger pieces. Ambrogio Borgognone, Raphael, and other great painters often drew the designs for this sort of work. The mosaic figures in the panels of the stalls

Certosa near Pavia were by Borgognone, and are extremely beautiful. The stalls in Siena cathedral and in S. Pietro de' Casmenci at Perugia, the latter from Raphael's designs, are among the finest works of this sort, which are very numerous in Italy. It has also been used on a smaller scale to ornament furniture, and especially the "*Cassoni*," or large trousseau coffers, on which the most costly and elaborate decorations were often lavished. Some traditional skill in this art still lingers in Italy, especially in the city of Siena.

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MOSCHELES, IGNAZ (1794–1870), one of the most refined and accomplished pianists of the present century, was born at Prague, 30th May 1794, and first studied music at the Conservatorium in that city under the direction of Dionys Weber. At the age of fourteen he made his first appearance before the public in a pianoforte concerto of his own composition with marked success. Soon after this he removed to Vienna, where he studied counterpoint under Albrechtsberger and composition under Salieri. In 1814 he prepared, with Beethoven's consent, the pianoforte arrangement of *Fidelio*, afterwards published by Messrs Artaria. In the following year he published his celebrated *Variationen über den Alexandermarsch*, a concert piece of great difficulty, which he played with so great effect that he was at once recognized as the most brilliant performer of the day. He then started on a tour, during the course of which he visited most of the great capitals of Europe, making his first appearance in London in 1822, and there securing the friendship of Muzio Clementi and John Cramer, the fathers of the English school of pianoforte playing. For a concert given by the latter he wrote his famous *Hommage a Handel*, a duet for two pianofortes, which afterwards became a lasting favourite with the public. His reception in England was sufficiently encouraging to justify his return in 1823, when he again met with a hearty welcome. During a visit to Berlin in 1824 he first became acquainted with Mendelssohn, then a boy of fifteen; and a friendship sprang up between them which was severed only by Mendelssohn's early death.

In 1826 Moscheles relinquished his wandering habits, and settled permanently in London, surrounding himself with a *clientele* fully capable of appreciating his talents as an artist and his social worth as a firm and loyal friend. His position was henceforth a more than ordinarily enviable one. He was recognized from end to end of Europe as a *virtuoso* of the highest rank; and his popularity both as a performer and as a teacher was based on grounds which effectually secured it from the caprice of changing fashion or ephemeral patronage. He was undoubtedly for some considerable time the greatest executant of his age; but, using his brilliant touch as a means and not as an end, he consistently devoted himself to the further development of the true classical school, interpreting the works of the masters with conscientious fidelity, and in his extemporaneous performances, which were of quite exceptional excellence, exhibiting a fertility of invention which never failed to please the most fastidious taste.

In 1837 Moscheles conducted Beethoven's Ninth Symphony at the Philharmonic Society's concerts with extraordinary success; and on this and other occasions contributed not a little, by his skilful use of the baton, to the prosperity of the time honoured association. During the course of his long residence in London he laboured constantly in the cause of art, playing at innumerable concerts both public and private, and instructing a long list of pupils, who flocked to him, in unbroken succession from the year 1818, when, at Mendelssohn's earnest solicitation, he removed to Leipsic, to carry on a similar work at the Conservatorium then recently founded in that city. In this new sphere he worked with unabated zeal for more than twenty years, dying 10th March 1870.

Moscheles's most important compositions are his Primolo cottos, Sonatas, and Studies, his *Hommage a Handel*, and three celebrated *Hi ns de Bravoure*.

MOSCHUS, of Syracuse, is one of the Greek poets; he was a friend of the Alexandrian grammarian Aristarchus (about 200 B.C.). His chief work is the epitaph of Bion of Smyrna, another of the bucolic poets who seem to have lived in Sicily. It is probable that the miscellaneous collection of poems which we possess under the three poets, Theocritus, Bion, and Moschus was known to Artemidorus in 200 B.C. His poetry is the work of a well educated man with a trained artistic eye; he modelled his works on those of Bion, writing epigrammatic, epic, or idyllic or elegiac verses, all except a few lines being in hexameter verse; but he treats all his subjects in a descriptive, not in a narrative or an epigrammatic manner. Besides the epitaph of Bion, he wrote two little epics, "Europa" and "Megara," and a pretty little epigram, "Love the Runaway," and a few short pieces of which also preserved. They are written with much elegance, but the style is perhaps too refined and carefully wrought, and he has few of the higher qualities of a poet.

MOSCOW, a government of Central Russia, bounded by Tver on the N.W., Vladimir and Ryazan on the E., Tula and Kaluga on the S., and Smolensk on the W., having an area of 12,808 square miles. The surface undulates, with broad depressions occupied by the rivers, and varies in elevation from 500 to 850 feet. Moscow is situated in the centre of the so-called Moscow coal-basin, which extends into the neighbouring governments, and consists of limestone of the Upper and Lower Carboniferous formation, the latter containing beds of inferior coal, the former containing several good quarries of marble. Carboniferous formation is covered with Jurassic sandstones and sand, which yield a good china-clay, coppers, and some much employed for brick and a white sand used for the manufacture of glass. The whole is thickly covered with boulder clay and alluvium.

The government is watered by the Volga, which skirts a few miles of its southern boundary, by the navigable Oka, flowing in a concentric curve with the canals leading to St Petersburg and by the Moskva. The last takes its rise in the government, with a course of 280 miles right across it, joins the Oka at Kolomna, and is navigable from there to Moscow. The Oka and Volga from a remote period have been important channels of trade, and continue to be so notwithstanding the development of railways. The Oka connects the government into water communication with the Volga, whose tributaries nearly the whole of middle [illegible] and are, by short land carriages, [illegible] North Dwina and the Volga. Large quantities [illegible] kins and other manufactures are shipped up and down the Moskva, whilst the Volga conveys quantities of [illegible] supply the capital with building stone. There are several marble [illegible] in the

also, as well as in the north-east, notwithstanding the rse consumption of wood in manufactures and for fuel in the l, extensive forests are still found. Very large supplies of r are also imported by rail or river, especially from the adjoin outh-eastern provinces. The soil is somewhat unproductive verage crops ranging from 3¾ to 4½ returns; agriculture ywhere, but only two districts (Ruza and Volsk e port corn, all the others being more or dependent rn consumption. The agricultural holdings of the peasan ry small, and their condition on the whole unsatisfactory crops have one important use in several districts, and kitchen ning is an important source of wealth in Verea, Dmitrofl, ventsovsk. Cattle are not extensively reared, but the hors ng industry is somewhat important.

population, 1,038,709 in 1864, numbered 1,191,709 in 1873, and is more urban. They are nearly all Great Russians and to the Greek Church, or are nonconformists. Many are ved in factories, the number of which in 1879 was 1,446, ying 165,000 hands, and having an annual production of 250,000,000 roubles. The returns show the manufacturing activity of Moscow to be greater than that of any other Russian ernment, while the value produced is upwards of one fifth of for all Russia in Europe, including Poland. Cotton, n, and silk are the chief products. The sanitary tion of the factories is very bad; the number of children fifteen years employed is as high as 16 per cent., the hours ly work are often 13 to 16, and the mortality very great. tal income obtained by the population of the government from manufacturing industry is estimated at £48,600,000. The chief e of the people derived however, from a variety of petty industries, carried on in their villages by the peasants, who continue same time to cultivate the soil. Taxation during the last few years has been increased rapidly, and in some parts of the nment has risen to the extent of 2 roubles per head. The centres of trade are Moscow, Kononnic, Serpukhoff, Bogorodsk ney, Ljubercy and Pavlovsk. There are 850 fairs. Transport is mainly ated by railways and by good highroads radiating from apital Moscow; a division into thirty districts, the last with their respective populations, is: Moscow 670,000, odsk 6000, Bronnitsy 7500, Ruza 4000, Kolomna 8500, khoff 16,500, Podolsk 11,000, Zvenigorod 7500, Mozhaisk Volokolamsk 3000, Klin 6,000, Dmitroff 7600, and Verey In addition to these administrative centres may be mentioned Yo kresensk 5000, Bronnitsy 7500, in the bourhood of the Moscow trial town and Pavlovsk more important for and trade than the r towns.

Many of the villages

for trade. The Bvelyi Gorod, which was formerly e by a stone wall (whence the name), surrounds the K and the Kitay Gorod on the west, north, and nor A line of boulevards now occupies the place of i (destroyed in the 18th century), and forms a fin of streets around the centre of Moscow. The Zem Gorod (earthen enclosure) surrounds the Bvelyi including the "Zamoskvoryechie" on the right b the Moskva. The earthen wall and palisade that fo enclosed it no longer exist, their place being take series of broad streets with gardens on both side Sadovaya, or Gardens Street. The fourth enclosu "Kamer College earthen wall") was made during th of Catherine II.; it is of irregular shape, and encl outer part of Moscow, whilst the suburbs and the which have practically extend 4, 5 miles beyond. The general view obtained from t or south is very picturesque, especially on acco the numerous churches, monasteries, and tower characteristic architecture, and the many garde ponds scattered among clusters of houses. The K is an old fort of pentagonal (nearly triangular) sh acres in extent, occupying a hill about 100 feet ab level of the Moskva. It is enclosed by a high sto 2439 yards in length, restored during the present c and having eighteen towers. Its five gates are surm by high towers. The Spasskiya (Saviour's Gat erected in 1491 by a Milanese architect, the Gothi that surmounts it having been added in 1626 English architect Halloway. A sacred picture Saviour was placed upon it in 1685, and all w through the gate must uncover. The towers sur ing the four other gates were erected by order III. Of the sacred buildings of the Kremlin th venerated is the Uspenskiy cathedral. The former of this name was erected in 1326 by Ivan Kahta, it's falling into disrepair, a new one was built on th place in 1475-1479, by Fioravanti, in the Lom Byzantine style, with Indian cupolas. It was r in the 18th century and in 1813. It contains th and most venerated holy pictures in Russia, one o is attributed to the metropolitan Peter, and the Luke. This last was brought from Kieff to V in 1155, and thence to Moscow in 1395; its j metallic cover is valued at £20,000. The cathed es also a gate brought from Korsun, the th Vladimir I., and numerous relics of saints, s which date from the 11th century. The Russian politans and patriarchs were consecrated in this ca as well as the czars, after Ivan IV. The Arkh cathedral was originally built in 1333, and a new erected in its place in 1505. It has suffered ver from subsequent restorations and decorations. It tombs of the czars from Simeon (1353) t Alexeivitch (1696), and possesses vast wealth. T govye chensk cathedral, recalling the churches of was built in 1489; the remarkable pictures of (1410-), contained in the original structure of 139 have been preserved. It was the private chapel czars. Vestiges of a very old church, that of the in the Wood (*Spas na borai*), contemporaneous w foundation of Moscow, still exist in the yard of the A stone church took the place of the old wooden st in 1330, and was rebuilt in 1527. Several other c of the 15th century, with valuable archæological r are found within the walls of the Kremlin. The sensky convent, erected in 1393, and recently r with great judgment, is the burial place of wiv sisters of the czars. The Chudoff monastery, ere 1365, was the seat of theological instruction and

inulet Yauza. The popular idea that Moscow is on seven hills, and in fact the city covers several nees, the altitudes of its different parts varying from to 550 feet above the level of the sea. It is 400 from St Petersburg, 813 from Archangel, 900 from 938 from Astrakhan, 933 from Odessa, and 811 from aw. It lies to the north of the most densely peopled of Russia (the "black earth region"), whilst the ry to the north of it is rather thinly peopled as far e Volga, and very sparsely beyond that. The space en the middle Oka and the Volga, however, was the cradle of the Great Russian nationality (Novgorod Pskov excluded); and four or five centuries ago Mos had a quite central position with regard to the

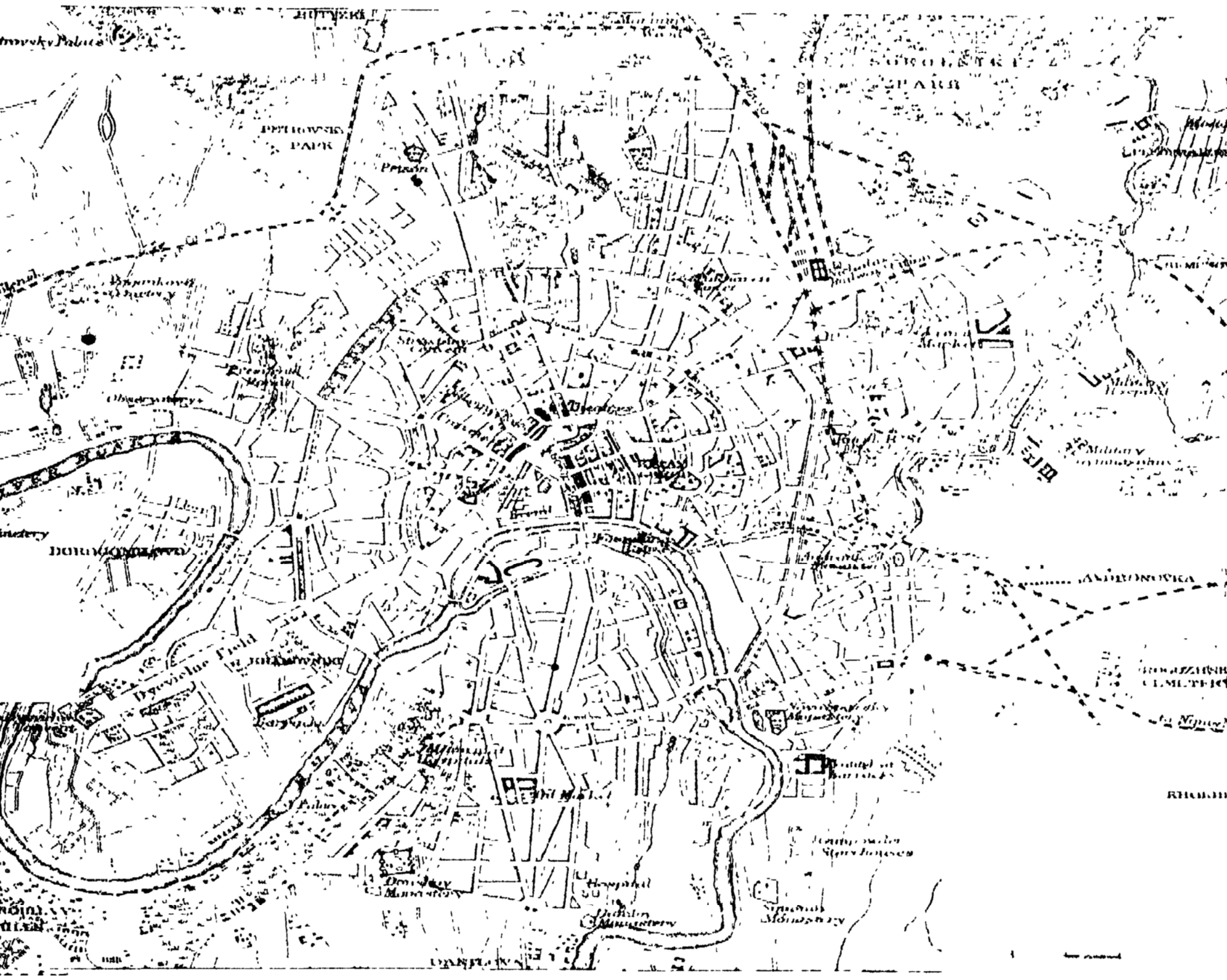
e present city measures 7 miles from north to south, 9 miles from west-south-west to east-north-east, and s an area of 32 square miles (about 10 when the bs are included). In the centre, on the left bank of Moskva, stands the "Kremlin" or Kremlin, occupying Borovitsky hill, which in the 12th century was covered dense forest. To the east of the Kremlin is the Gorod, formerly the Great Road, the chief centre

cording to recent investigations made by the Moscow provincial assembly, 10 per cent. of the agricultural population (about 0 households) have no land at all; 15 per cent., while holding are bankrupt, and 13 per cent. are without cattle or implements.

. Close by, the great campanile of Ivan Veliky, d in the Lombardo-Byzantine style by Boris Godunoff 00, rises to the height of 271 feet (328 feet including ross), and contains many bells, one of which weighs cwts. The view of Moscow from this campanile is wonderful, and its gilded cupola is seen from a great nce. Close by is the well known Tsar Kolokol (Czar of ells), 60 feet in circumference round the rim, 19 feet and weighing 3800 cwt. It was cast in 1735, and n during the fire of 1737 before being hung. The ry of the patriarchs (rizartsa) contains not only such s of value as the *sakkos* of the metropolitan Foty with 0 pearls, but also very remarkable monuments of Ru archaeology. The library has 500 Greek and 1000 very rare Russian MSS., including a Gospel of t century.

The great palace of the emperors, erected in 18 fine building in white stone with a gilded cupola. tains the *terems*, or rooms erected for the young pr 1636 (restored in 1836-49, their former characte maintained), a remarkable memorial of the domestic the czars in the 17th century. In the treasury of th Granovitaya Palata and Oruzheynaya Palata, now museums, the richest stores connected with old archaeology are found crowns, thrones, dresses, article of household furniture belonging to the Russian and Mongolian arms, carriages, &c.

The four sides of the Senate Square are occup



ngs of various dates, from the 15th century onwards. nate, now the law courts, was erected by Catherine Facing it is the arsenal, containing full ammunition 0,000 men.

Temple of the Saviour, begun in 1817 on the iovy hills, in commemoration of 1812, was abandoned 27, and a new one was built during the years 1838 on a hill on the bank of the Moskva, at a short dis from the Kremlin. Its style is Lombardo Byzantine, modifications suggested by the military taste of las I. Its colossal white walls are well proportioned, s gilded cupolas are seen from a great distance. uildings that surround it are to be cleared away, s wide squares adorned by obelisks, and by monu- ments to Kutuzoff, Barclay de Tolly, Alexander Nicholas I.

The Kitay Gorod, which covers 121 acres, an 20,000 inhabitants, is the chief commercial qua Moscow. It contains the Gostinoy Dvor, consist several stone buildings divided into 1200 shops, wh kinds of manufactured article are sold. The "Red S 900 yards long, whose stone ground was formerl forum, and afterwards the place of execution, separa Gostinoy Dvor from the Kremlin. At its lower end the fantastic Pokrovsky cathedral (usually known as Blajennyi), which is the wonder of all strangers v Moscow, on account of its towers, all differing fro other, and representing, in their variety of colours

apples, melons, and the like. It was built under Ivan the Terrible by an Italian. The exchange, built in 1838 and restored in 1873, is very lively, and its twenty-three "exchange artels" (associations of nearly 2000 brokers, possessing a capital of more than £100,000) are worthy of remark. Banks, houses of great commercial firms, streets full of old bookshops carrying on a very large trade, and finally the Tolkuchy rynok, the market of the poorest dealers in old clothes, occupy the Kitay Gorod, side by side with restaurants of the highest class. In the Kitay Gorod are also situated the house of the Romanoffs, rebuilt in 1859 in exact conformity with its former shape; a Greek monastery; and the printing office of the synod, containing about 600 MSS. and 10,000 very old printed books, together with a museum of old typographical implements. At the entrance to the Kitay Gorod stands the highly venerated chapel of the Virgin of Iberia, which is a copy, made in 1648, of a holy picture placed on the chief gate of the monastery of Athos. Close by is the recently opened historical museum, which will contain collections to speci-

fully illustrating separate periods of Russian history.

The northern parts of the Bielyi Gorod are also the centre of a lively trade. Here are situated the Ohotnyi Ryad (poultry market) and the narrow streets Tverskaya and Kuznetsky Most, the rendezvous of the world of fashion. Here also are the theatres. In the south west of the Bielyi Gorod, opposite the garden of the Kremlin, stand the university, the public museum, and the military riding school.

The Zemlyanoy Gorod, which has arisen from villages that surrounded Moscow, exhibits a variety of characters. In the neighbourhood of the railway stations it is a busy centre of traffic; other parts of it are manufacturing centres, while others, for instance, the small quiet streets in the west of the boulevard of Prechistenka, called the old Kogni hennaya, with their wooden houses and spacious yards, are the true abodes of the families of the old, for the most part decayed, but still proud nobility. The Zamoskvoryechye, on the right bank of the Moskva, is the abode of the patriarchal merchant families. Each house is surrounded by a yard whose gate is rarely opened, and each house, with its dependences and garden, bears the character of a separate estate.

The climate of Moscow is cold and continental, but healthy. The average annual temperature is 40° F.; the January 14°; July, 66°. The summer is warm (64° F.), and the winter cold and dry (15° F.), great masses of snow covering the land. The spring, as in all the east-continental climate, is beautiful. The prevailing winds are south-west and east. The river Moskva is frozen, on the average, for 143 days (from 12th November to 13th April).

Besides the Moskva and the Yauza, Moscow is watered also by the Neglinnaya, which now flows in an underground channel under the walls of the Kremlin. The city has about 200 ponds. The Moskva is crossed by five bridges, a branch of it, or rather a channel, makes an elongated island in the centre of the town. Water of excellent quality, principally from the Mytischi springs and ponds, 11 miles distant, is led to fountains in different parts of the town, whence it is taken by watermen. But this supply amounts only to 1,365,000 gallons a day, and the great mass of the inhabitants make use of the contaminated water of the Moskva and even of the Yauza, or of private wells.

The population of Moscow, which is steadily increasing, is estimated at 670,000; but no accurate census has not yet been made. In the middle of the 18th century it was estimated at only 150,000; in 1812, at 250,000 in summer and 400,000 in winter. In 1851 it was estimated probably much at the truth at 365,000. The inhabitants are mostly Great Russians, and only about 6000 are foreigners. They chiefly belong to the Greek Church or are nonconformists, the number of Lutherans and Catholics being only 8000 to 9000. The mortality is very great: in 1879 and 1880 it reached 37·9 and 41·8 per thousand, when 29·3 women died, and usually exceeds the birth-rate. Moscow, moreover, is often visited by epidemics which immensely increase the mortality, in consequence of the almost entire absence of sanitary regulations. Fires are very frequent; within ten years (1870-1879) they numbered 2192, the loss being estimated at £2,865,300.

Since the 14th century Moscow has been an important central city. Its merchants carried on a brisk trade with Novgorod and Pskov, with Lithuania, Poland, Hungary, Constantinople, Azoff, and Astrakhan. About the end of the 15th century princes transported to Moscow, Vladimir, and other Russian towns no fewer than 18,000 of the richest Novgorod merchant families, and took over the entire trade of that city, entering into direct relations with Narva and Livonia. The shops of the Gostinnyi Dvors of Moscow astonished foreign visitors in the 16th century by their large supply of foreign wares, and by the low prices at which the product of western Europe were sold,—a circumstance explained by the barter character of the trade. The annexation of Kazan and the conquest of Siberia gave a new impetus to Moscow, bringing it into direct commercial relations with Bokhara, and China, and supplying it with Siberian furs. The trade engrossed the minds of all European merchants in the 16th century, and an English company, "The Mystery," which received the monopoly of the Archangel trade, caused the latter to be sent by the White Sea instead of the Baltic. Moscow became the centre for nearly the whole trade of Russia, and Russians themselves engaged in large commercial operations. All the court, and the church too, were traders; and the poorest Moscow merchants participated in the trade through their corporations. Persians, Greeks, Armenians, Swedes, English, Germans, and Lithuanians had each its own Gostinoy Dvor (or caravanserai). Situated at the junction of six important highways (along which communication was maintained by special yamshiks), Moscow was the great storehouse and exchange mart for the merchandise of Europe and Asia. The opening of the port at St Petersburg affected its commercial interests unfavourably at first; but the Asiatic internal trade of Moscow has since then enormously increased, and at present it is the chief centre of railway traffic. The revenue of the custom house was in 1880 double that of St Petersburg (30,000,000 roubles as against 15,020,000 at St Petersburg and 9,000,000 at Warsaw). But the home traffic is the most important branch of Moscow trade. The city is the chief centre for the trade in corn, hemp, and in oil, sent to the Baltic ports, in tea, brought from Siberia and by St Petersburg; in sugar, refined there in large quantities; in grocery ware for the supply of more than half Russia and all Siberia; in tallow, skins, wool, metals, timber, woods, and all other produce of the manufactures of middle Russia. More than 10,000,000 cwts. of corn are annually brought to Moscow, half of which is sent to the Baltic ports. The yearly return of Moscow trade was estimated at 49,000,000 in 1848,—probably a half or a third of the real value, which is believed to have at least trebled since that time. The quantity of goods carried by railways from Moscow to St Petersburg, Yaroslavl, Ryazan, Kursk, and Brest, amounted in 1878 to 162,343,500 poods out of 635,740,000 for the whole of Russia; and the number of passengers was 8,637,890 (1,263,530 military) out of a total for Russia of 37,580,800 (civil and military) in that year.

From the 15th century onwards the villages around Moscow were renowned for the variety of small trades they carried on; large manufactures in cottons, woollen fabrics, silk, chintzes in Great Russia appeared at Moscow in the 17th century. After 1830, in consequence of protection factories and manufactories in the government of Moscow rapidly increased in number, and at present two thirds of them, or about 1000, chiefly producing articles to the value of upwards of £10,000,000 (the real production is probably much higher), are concentrated in the capital. There are at Moscow about 170 cotton-mills, 90 factories of woollens, and 70 of silks, the silk manufacture chiefly Caucasian, although a good deal is also imported from Persia; there are also upwards of 20 large tanneries, 50 leather factories, 15 large candle works, 70 larger workshops in making candles, 30 carriage manufactories, 20 watch factories.

The income and expenditure of Moscow in 1882 were respectively 4,921,097 and 6,121,663 roubles, as compared with 4,730,000 and 5,190,133 in 1881.

Moscow has many educational institutions and scientific societies. The university, founded in 1755, exercised a powerful influence on the intellectual life of Russia during the years 1830-1848, and it still continues to be the most frequented Russian university. In 1882 it had 2130 students and a teaching staff of 334; the students are mostly poor, the sum of 107,588 roubles having been granted in 1881 in scholarships to 854 of their number, and 11,000 roubles in the form of occasional assistance. The library contains about 200,000 volumes, and has rich collections in mineralogy, botany, and zoology. There is also an excellent higher technical school, and an agricultural college is situated in the Petrovskoye Park. Moscow has also a theological academy, a commercial academy, a school of topography, an institute (of Lazareff) for the study of Oriental languages, a musical conservatory, four institutes for women, a free university for women, seven colleges for boys, three for girls, three corps of military cadets, very many primary and technical schools, and many private schools.

still these are insufficient for the population, and the municipal schools every year refuse admission to about 1500 boys and girls.

The scientific societies are specially distinguished for their services in the exploration of the country. The following deserve particular mention:—the society of naturalists (founded in 1805), the society of Russian history and antiquities, which has published many remarkable works; the society of amateurs of Russian literature; the physical and medical society; the mathematical society; the society for the diffusion of useful books; the very active archæological society, founded in 1864; a society of gardening and of agriculture; several technical, artistic, and musical societies; and the very active young society of the friends of natural science, which already has published many useful volumes.

Among the museums of Moscow, the museum, formerly Rumantseff's, now connected with the so-called "public museum," occupies the first rank. It contains a library of 170,000 volumes and 3500 MSS., remarkable collections of old pictures, sculptures, and prints, as well as a rich mineralogical collection, and an ethnographical collection representing very accurately the various inhabitants of Russia. The historical museum has already been mentioned. The private museum of Prince Golitzyn contains a good collection of paintings and MSS., and great treasures of archæology are amassed in various private collections in Moscow and its suburbs.

The periodical press does not on the whole exercise great influence; twenty-five periodicals are published, besides the reports of the societies. But Moscow publishes a far greater number of books for primary instruction and of the humblest kind of literature and prints for the use of peasants than any other Russian city.

The philanthropic institutions are numerous, the first rank being occupied by the immense Foundling Hospital, erected in 1764. The hospitals, municipal, military, and private, are very large, but much below the standard of other capitals. The number of private philanthropic institutions is very considerable.

Though the drama was introduced into Russia at Kief, Moscow was the place of its development. The earliest representations were made at Moscow in 1610, and the first comedy (a translation of Molière's *Médecin Malgré Lui*) was played at the palace of Sophie, the sister of Peter I. It was only in 1759 that a theatre was erected. A large stone theatre was erected in 1776, and rebuilt in 1850 after a fire. It is for the Moscow stage that the best Russian dramas have been written, and it was in the Small theatre that the best Russian actors—Schepkin, Sadovsky, Samarsky, and Madame Vasiliefl—exhibited the comedies of Gogol, Griboyedoff and Ostrovsky.

Moscow, where the Great Russian tongue is spoken in its greatest purity, was the birthplace of the two chief Russian poets, Pushkin and Lermontoff, as well as of Griboyedoff, Ostrovsky, and Herzen. A monument to Pushkin was erected in 1880, on the Tverskoy boulevard. Griboyedoff, in his remarkable comedy *Gore at ouma*, has given a lively picture of the higher Moscow society at the beginning of this century, which continued to hold good until within the last few years. Its remarkable features in the unmistakable individuality of the Moscow type also maintain, in truth, although the physiognomy of Moscow has much changed since his day, it still has its special features that distinguish it from every other capital. The division of classes is much more felt at Moscow than elsewhere. The tendency towards originality, the love of grandiose undertakings, a kind of brag, together with little feeling of independence, a good deal of laziness, and much conviviality, still characterize the educated classes. The merchants live quite aloof from any political or even intellectual movement, under a rude patriarchal system, well described in the dramas of Ostrovsky. A large proportion of them are nonconformists. Their sons, the well-known kupecheskiye synki, "merchants' sons," when they leave this kind of life, astonish the capital with their extravagances and absurd display of wealth. But Moscow takes its present physiognomy chiefly from its busy lower classes. The streets are full of merchants and peasants, who continue to wear the old Russian garb, go on foot in the streets, drink tea in modest restaurants, and transact large business. From being a town of the aristocracy, Moscow is coming to be more and more a town of the wealthy merchant classes, who persist in keeping the low educational level of the peasants in the villages, and have but one aspiration, to become in their turn "merchants" of the type described by Ostrovsky.

Suburbs. Moscow is surrounded by beautiful parks and picturesque suburbs. Of the former one of the most frequented is Petrovsky Park, to the north-west. A little farther out is the Petrovsko-Razumovskoye estate, with an agricultural academy and its dependencies (botanical garden, experimental farm, &c.). Another large park and wood surround an imperial palace in the village of Ostankino. The private estates of Kuzminki, Ivanovo, and Kuntzevo are also surrounded by parks: the last has remains of a very old graveyard, supposed to belong to the pagan period. Twenty-eight miles westward from the city is the Savvin-Storogevsky monastery, situated, like so many other Russian monasteries, in a very fertile country, amidst beautiful forests; it has a pretty cathedral, a rich treasury, and library. Farther westward still is the New Jerusalem monastery erected by the patriarch Nikon.

In the south-west, on the right bank of the Moskva, which makes a great bend to the south, are the Vorobovy hills, which are accessible by steamer from Moscow, and afford one of the finest views of the capital. In the bend of the Moskva is situated the Novo-Dyevitchiy convent, erected in 1525, and connected with many events of Russian history. It is now the burial place of the Moscow aristocracy, and one of the richest nunneries in Russia. The village Arkhangelskoye has also a good park and a palace by Rastrelli. Ilyinskoye, formerly a private estate, was purchased by the imperial family in 1861.

In the south, on the road to Serpukhoff, is the village of Kolomenskoye, the residence of Alexis Mikhailovitch. The church built in 1531 is a striking monument of Russian architecture of the 16th century. Dyakovo has also a church built in the 17th century, presenting the architecture of the temple of Vasili Blajennoy. One of the best parts of the neighbourhood of Moscow is occupied by the park of Tsaritsino (11 miles from the Kursk railway station), purchased by Catherine II., with an unfinished palace and a beautiful park. The park of Nikolaevskoye, 12 miles from the city, between the Nikolaev and Ryazan railways, also occupies a beautiful site, and was created by Moscow merchants, to commemorate a holy picture. The Donskoy Monastery is said to have been founded before 1591 on the Moskva.

In the north, the forest of Sokolniki, covering 4 square miles, with its radial alleys and numerous summer residences, is the favourite Moscow resort frequented by the middle classes. Close by the east, and situated the Preobrajenskoye suburb, the seat of the nonconformists, and farther south the village of Izmailovo, home for invalids and a model farm for agriculture. The forest of Sokolniki is situated the wood of Measures, the favourite resort of the merchants and shopkeepers, who there spend large sums of money on shooting-matches.

History. The Russian annals first mention Moscow in 1147, as a place where Yuri Dolgoruki met with Svyatoslav of Seversk, his ally. The site was inhabited from a very remote period by the Merya and Mordvinian tribes, whose remains are numerous in the neighbourhood, and it was well peopled by Great-Russians in the 12th century. To the end of the 12th century Moscow formed a dependency of the principality of Vladimir, and had to suffer from the raids of the Mongols, who burned and plundered it in 1237 and 1293. It was only under the rule of Daniil, son of Alexander Nevsky (1261–1303), that the prince of Moscow began to play some important part in the wars of Russia with Lithuania. He annexed to his principality Kolomna, situated at the confluence of the Moskva with the Oka. His son and successor Yuri (1303–1325) annexed Pereyaslavl [illegible] next year Mojaisk [illegible] portion of the Moskva [illegible] month [illegible] inaugurated a policy which tended to centralize and consolidate the authority by patiently and other means of the neighbouring towns and villages. In 1339 the Kremlin, or fort, was [illegible] by a strong wall of earth and wood, offering a protection [illegible] materials from the Tver and Ryazan principalities went to extend the new city. Under John Kalita (1328–1341), the principality of Vladimir, where the prince and the metropolitan of Russia had taken refuge after that district's south-western Russia became united with Lithuania in 1320, the metropolitan Peter established his seat at Moscow, thus a new importance and powerful support to the principality. In 1367 the Kremlin was enclosed by stone walls, which proved strong enough to resist the Lithuanians in 1368 and 1370. The son and grandson of Kalita pursued the same policy. The latter, Dimitry Donskoy, [illegible] possessions of Starodub and Rostoff, and took part in the battle of Kulikovo (1380), where the Russians won the first time to oppose the Mongol in a great pitched battle. The church, which warmly supported the princes of Moscow, proclaimed the [illegible] victory to him and to the holy city of Moscow, [illegible].

At that time Moscow occupied a wide area covered with gardens. The Kremlin had three cathedrals, old [illegible], and dark, having narrow windows filled with mica plates, which [illegible] the plain wooden houses of the princes and boyars. Further out, on the second wall, the *posad*, or city, also [illegible] a wall of [illegible] an important centre for trade, [illegible] parts of the town belonged to different princes. In 1366 Moscow [illegible] supremacy. Two years after the battle of Kulikovo, it was taken and plundered (for the last time) by the Khan Tokhtamish.

The gradual increase of the principality continued during the first half of the 15th century, and at the death of Vasili the Blind, in 1462, it included not only the whole of what is now the government of Moscow, but also large parts of the present governments of Kaluga, Tula, Vladimir, Nijni Novgorod, Kostroma, Vyatka, Vologda, Yaroslav, and Tver. Still the princes of Moscow assumed, like several others, the title of Great Prince [illegible].

[1] The name of *boyar*, or *bolyar*, was given to the descendants of the military bands of the princes, who had become considerable landowners and had

more influence than other independent rulers in the affair
eastern Russia, and was recognized as the eldest prince
ham-. The town which recognized its supremacy w
dependencies, an ly paid to its representatives the pri
in exchange for military protection It is only under
called the Great by some Russian historians) that the
Moscow asserted his claims on other parts of Russia, and
the Ruler of all Russia" (*Hospodar vseya Rossii*). It
this time, when the wealth of Moscow was rapidly in
By the extension of its trade that the embellishment of
began In room of the old cathedral Uspensky, a new
was built by Ivan vezin of Bonovo, called by Novgorod
The cathedral Arkhangelsk-kiy was also rebuilt, and a third,
chensky, was erected as well as a stone palace and other
The Kremlin was fortified by stone towers, and the
of churches built close to the walls were removed In
Moscow was said to contain houses and 100,000
Its trade was very ve. Ivan IV forcibly annexed
and Pskov to Moscow, and plundered and Vi
But after the reign Moscow suffered for a long time
misfortune In 1547 two disastrous conflagrations destroyed
the city, and a few years later the khan of the Crimea
Tatars burnt with 100,000 men He was compelled to retire
banks of the Oka, but in 1571, taking advantage of the
which Russia was brought by the cruelties of Ivan,
Moscow and burned all the town outside the Kremlin.
of the Kremlin having been shut their rich of people
the flames, and the land record that of the 200,000 who
it the population of Moscow, only 30,000 remained In
Moscow were again in Moscow assembled their representa
Kremlin on the outbreak of the open revolt.
end of the 16th century Moscow was a splendid city not
Italian travellers. The Court Portal of the city,
covered with fine Dyers, merchants of all nationalities
etc., used to be built of brick and stone as well, which
The "White Town," which lay round the Kremlin and
itself from which it was separated by a fortified ditch, by a
Kitai-gorod, and by a fortified wall, more than
a portion of the new town, the Zemlyanoi-gorod, was com-
all the town that were added the three former portions
remained Until the end of the 17th century Ivan
ted Moscow paid with extraordinary wealth and ma-
But the moral character of the capital was in very bad
the 16th century seems to be the time of perfection
, robbery, and murder made the terror of the boyars and
merchants The people who came from the land or
late of the prince even to boyars, and gradually became
ts, and the profits of the boyars imported
caliber middle class, and had also a repellent develop
the same country was Russia, like
sia of Poland But the regent or Tsaritsa Sofia, Ivan
, the regent, ordered the murder of the heir
s, son of Ivan IV, and himself became tsar of R
suffered severely in the attempt by which he crushed the
popular rising and exterminated the Lobnoe Mesto on
action the whole of the town outside the Kremlin was
ned and plundered But in common with it had acquired
e of the nation greatly increased material prosperity
held against foreign invasion The monastery of Trinity
the Poles besieged without taking, was invested with
onetary The town also by and by recovered its commercial
ce, and thus the more as other commercial cities were
o fell into the hands of foreigners, and thirty years after
Moscow was again a wealthy city Owing, however, to the
ceasing concentration of power in the hands of the czar
steady development of autocracy, if not much of its
importance, and as mixed more and more, especially under
Mikhailovitch, the character of a private estate of the czar,
by becoming more dependence of his vast household.
g the whole of the 17th century Moscow continued to be
e of many troubles and internal struggle The people
against the favourites of the czar, and were
only by cruel executions, in which the *streltsi*, a class
n and merchant reporting hereditary military service
of the czar Afterwards appeared the *raskol* or nonconformist
movement, and in 1648, when the news spread that Stenka
's advance on Moscow to settle his accounts with the
the populace was kept from rising only by severe repression
ures and by the advent of the invader Later on, the
themselves concerned in a series of rebellions, which led the
d Peter I to lead rivers of blood The opposition encoun-
Moscow to his plans of reforming Russia according to his
military autocracy, the conspiracy of the boyars and mer-
the distrust of the mass of the people, all compelled him
ds to leave the city, and to seek, as his ancestors had
a new capital This he founded on the very confines of
tary empire he was trying to establish

In the course of the 18th century Moscow became the seat
passive and discontented opposition to the St Petersburg Go
ment Peter I., wishing to see Moscow like other capitals of we
Europe, ordered that only stone houses should be built withi
walls of the town, that the streets should be paved, and so
but his orders were only partially executed. In 1722 the Kre
was restored In 1739 the city became once more the prey
great conflagration, two others followed in 1748 and 1753,
gave an opportunity for enlarging some streets and squares
Here the first Russian university was founded at Moscow Cath
II tried to conciliate the nobility, and applied herself to be
the capital with new and useful buildings, such as the senate h
the foundlings' and several other hospitals, salt stores, &c.
cemeteries within the town were closed after the plague of 1
several streets were enlarged, and the quarters cleared of the
shops that encumbered them Water was brought by an aque
from the Mytischi villages In 1787 the city had 305 churche
monasteries and convents, 8967 houses of which 1539 were
private offices, and 311 manufactories and
The first public disaster which experienced by Moscow in 1812
12th September days after the battle of Borodino, the Ru
troops evacuated Moscow, leaving 11,000 wounded and the
day the French occupied the Kremlin The same night,
Napoleon was waiting for a deputation of Moscow notables
received only a deputation of the rich *gostinoi* merchant
capital was set on fire by its own inhabitants the Governor
with the stores of wine, spirits, and chemicals, became
first prey of the flames The inhabitants abandoned the city
it was pillaged by the French troops, as well as by Russian
selves and the fortune of Moscow became the signal of a
ing of the peasantry against the French. The evil of sup
and the impoverishment of what once was a numerically, contin
and persons, compelled Napoleon to
Moscow on 19th October he had unsuccessfully tried to
opportunity
P. A.

MOSELLE. See RHINE.

MOSER, Johann Jakob (1701-1785), jurist, was
at Stuttgart on 18th January 1701. He studied a
university of Tubingen, where, at the early age of nine
he became professor extraordinarius of law. A year
he resigned his chair, with the expectation of receiving
appointment at Vienna, but this was refused him on
declining to join the Catholic Church. From 172
for some years held an ordinary professorship of la
Tubingen, and in 1736 he accepted a chair and directo
in the university of Frankfort on the Oder. On acco
however, of differences with King William I. of Pr
he resigned these in 1739 and retired to Ebersdorf, a vi
the principality of Reuss, where for several yea
devoted himself wholly to study, and especially to
prosecution of his *Deutsches Staatsrecht*. In 1751 he
called back to Wurtemberg as "landschaftsconsul
and in 1759 was imprisoned at Hohentwiel on accoun
the steps he had taken in connexion with this office ag
certain tyrannical proceedings of the duke. In 176
received his liberty and was restored to office, but
that time took little part in political affairs. He died
September 1785.

Moser was the first to discuss in an adequate form the subj
European international law, and he is the most voluminous G
writer on public law In all, he wrote more than 500 vol
his principal works being *Deutsches Staatsrecht*, 1737-1754;
Deutsches Staatsrecht, 1766-1775; *Deutsches Staatsarchiv*, 1751-
Grundriss der heutigen Staatsverfassung von Deutschland,
See Schmid, *Das Leben J. J. Moser's*, 1868; Schulze, *J. J.*
der Lehre des Deutschen Staatsrechts, 1869.

MOSES. Of the life of Moses we have few e
details, though the history of Israel bears witness to
importance of his work. To what has been said
ISRAEL there will here be added a brief summary of
has been handed down about him. His origin and
history of his childhood can be read in Exod. i., ii. (
vi. 16 *sq.*); the statements there given are enlarged
modified in the Jewish Midrash, particularly as we f
in Josephus and Philo.[1] The daughter of Pharaoh, w
told, was called Thermutis (*Ant.*, ii. 9, 5), or Merris (E

[1] In still more fantastic form in the Palestinian Targum on E
the details of which need not be repeated here.

Præp. Ev., ix. 27); she named the boy Μωσῆς, not because she used the Hebrew verb משה to express the fact that he was drawn out of the water, but because the Egyptian word for water was *mo*, and *eus* applies to those who have been delivered from it (*Ant.*, ii. 9, 6; comp. Philo, ed. Mangey, ii. 83, Euseb., *l.c.*, ix. 28). She took care to have him trained in all the wisdom of the Egyptians (Acts vii. 22) and in that of the Greeks, Assyrians, and Chaldeans as well (Philo, ii. 84). To his great intellectual endowments corresponded his personal beauty, of which Josephus speaks in extravagant terms (*Ant.*, ii. 9, 6 7). It was on account of this beauty that, when on one occasion, as a young man, he led an Egyptian army against Meroe, the Ethiopian princess Tharbis opened the gates of the capital to him in order to make him her husband (*Ant.*, ii. 10, comp. Numb. xii. 1).

For reasons explained in Exod. ii. 11 *sq.*, Moses left the land of Pharaoh and came to Midian to the Kenite priest Jethro (also called Hobab Ben Reuel and Reguel), whose daughter Zipporah he married, becoming by her the father of two sons, Gershom and Eliezer (Exod. ii. 21 *sq.*, xviii. 2 *sq.*). During his stay in Midian he received, at the foot of Sinai (Horeb), the divine revelation at the burning bush, by which he was called to become the liberator of Israel from Egyptian bondage. With much reluctance he at last accepted this vocation, and, already expected by his brother Aaron and the elders, returned to his people. Arrived in Egypt, he associated Aaron with him as his interpreter, being himself no orator, but a man of deed and action, and appeared before Pharaoh to demand in the king of Jehovah's name permission for the people to go with flocks and herds into the wilderness to celebrate there a festival (the spring festival of the Passover) in honour of their God. Jehovah gave emphasis to the demand by great signs and wonders, the plagues of Egypt, which have their explanation for the most part in evil to which Egypt is periodically liable, but are treated by Israelite tradition as the weapons of Jehovah in his ever-intensifying conflict with the king and the gods of Egypt. At length, by the slaying of the first born, the stubbornness of Pharaoh was broken, so that he consented to, and even urged, the departure of the Hebrews. By and by, however, he changed his mind and, setting out in pursuit of the Hebrews, overtook them at the Red Sea; but Jehovah fought for them, and annihilated Pharaoh's chariots and all his host. In order to present themselves in proper festal array at the celebration for the sake of which they were gone into the wilderness, the Hebrew women had borrowed dresses and ornaments from those of Egypt; the Egyptians could now only blame themselves and their hostile conduct if these articles were not returned.[1]

By the miracle wrought at the Red Sea Moses was pointed out to the Hebrews as the man of God to whom accordingly they now committed the task of caring for their outward life as well as their spiritual guidance. He led them first to Sinai, where the law was revealed and the worship in connexion with the ark of the covenant instituted. When he had communed face to face with the Godhead for forty days on the holy mountain, the skin of his face shone so that he had to wear a veil (the horns, properly rays, on his forehead). Driven from Sinai in consequence of their worship of the golden calf, the Israelites removed to Kadesh with the view of entering Palestine. But this plan was defeated by their unbelief and faintheartedness, and, as a punishment, they were compelled to sojourn forty years in the wilderness of Kadesh (Peran, Sin). It was here and now that the people went to school with Moses, here, at the sanctuary of the cloud, he declared law and judgement; and here, according to the view of the oldest tradition, the foundations of the Torah were laid (Exod. xviii.). The region of Kadesh was also the scene of almost all the miracles and other remarkable occurrences we read about Moses. Here he showed himself to be at once the father and mother of the people, the judge, priest, and seer. It was not till towards the close of his life that he led the Israelites from Kadesh northern Moab, which he wrested from the Amorite king Sihon of Heshbon. Here he died on Mount Pisgah, Nebo, after taking leave of the people in the great farewell address of Deuteronomy. According to Deuteronomy xxxiv. 6, he "was buried in a valley in the land of Moab . . . but no man knoweth of his sepulchre unto this day." After the death of the leader, hero, Moses had named Joshua ben Nun, but the real heir to his position and influence were the people at the sanctuary of the ark of the covenant.

On his personal character the Bible tells us nothing, except in Numbers xii. 3 where only a heavily burdened passage in later Judaism is all the more at liberty on this account to speculate upon it (see especially Josephus, *Ant.*, iv. 8, such incidents as are the account of Moses' position in the [illegible] and the Miracle [illegible] to the [illegible] of the state of Horeb [illegible] prevailed even in the *Contra Apion* of Josephus. The [illegible] Hebrew [illegible] authority to accept and put [illegible] rules to the Hebrew [illegible] time merely [illegible] upon obscure [illegible] the [illegible] them upon the [illegible] travellers with hatred and not with love, and then seek their welfare [illegible] the Egyptian history and chron[illegible] known [illegible] [illegible] [illegible] and persons [illegible] [illegible] and he like cannot be [illegible] [illegible] [illegible]

e find other notices of this celebrated man,[1]—such as, nat he was the nephew of Mesrob, that he was publicly omplimented by the emperor Marcian, that he had been rdained bishop of Bagrewand by the patriarch Giut, and nat he was buried in the church of the Apostolic Cloister t Mush in the district of Taron; but these accounts must e received with great caution. This remark applies pecially to the statement of Thomas Ardsruni,[2] that loses, like his Hebrew prototype, lived to the age of 120 ear, and recorded his own death in a fourth book of his reat work.[3] The same caution must be extended to nother tradition, based on an arbitrary construction of a assage in Samuel of Ani,[4] which places his death in the ar 489.

Of the works of Moses[5] the best known is the *History f Armenia*,[6] or, as the more exact title runs, the *Genealogical Account of Great Armenia*. It consists of three books, nd reaches down to the death of Saint Mesrob, in the econd year of Jazdegerd II. (17th February 440).[7] It is edicated to Sahak Bagratuni (who was afterwards chosen o lead the revolted Armenians in the year 481), as the an under whose auspices the work had been undertaken. his work, which in course of time acquired canonical uthority among the Armenians, is partly compiled from ources which we yet possess, viz., the *Life of Saint Gregory* y Agathangelos, the Armenian translation of the Syriac *octrine of the Apostle Addai*, the *Antiquities* and the *ewish War* of Josephus, and above all the *History of Mar bas Katina* (still preserved in the extract from the book f Sebêos),[8] who, however, did not write, as Moses alleges, Syriac and Greek, at Nisibis, about 131 B.C., but was a ative of Medsarich, and wrote in Syriac alone about 383 .D., or shortly thereafter. Besides these, Moses refers to whole array of Greek authorities, which were known to im from his constant use of Eusebius, but which cannot ossibly have related all that he makes them relate.[9] lthough Moses assumes on that he is going to rely entirely pon Greek authors, the contents of his work show that it s mainly drawn from native sources. He is chiefly indebted o the popular ballads and legends of Armenia, and it is o the use of such materials that the work owes its permaent value. Its importance for the history of religion and ythology is, in truth, very considerable, a fact which has the great merit of Emin[10] and Dulaurier[11] to have first ointed out. For political history, on the other hand, it s of much less value than was formerly assumed. In articular, it is not a history of the people or of the ountry, but a history of the Armenian aristocracy, and, in opposition to the Mamikonian tendency which pervades rest of the older Armenian historical literature, it is in the interest of the rival Bagratunians. Down to century II. is proved by the contemporary Graeco annals to be utterly untrustworthy; but even for the of Armenian Christianity it must be used far cautiously than has been done, for example, by The worst feature is the confusion in the chronology, strange to say, is most hopeless in treating of the temporaries of Moses himself. What can be thought writer who assigns to Jazdegerd I. (399-420) the years of his predecessor Bahrâm IV., and the two years of Jazdegerd I. to his successor Bahrâm V. (420 The present writer[12] formerly attempted to explain unhistorical character of the narrative from a te arising out of the peculiar ecclesiastical and politi cumstances of Armenia, situated as it was betwe eastern Roman and the Persian empires, enemies which were substantially the same in the 5th as the in the two following centuries. In the course of investigations, however, he has come to the con that, besides the many false statements which M Khor'ni makes about his authorities, he gives account of himself. That is to say, the author *History of Armenia* is not the venerable translator 5th century, but some Armenian writing under hi during the years between 634 and 642. The p furnished on the one hand by the geographical and graphical nomenclature of a later period[13] and anachronisms,[14] which run through the whole book often closely incorporated with the narrative itself, the other hand by the identity of the author of the with that of the *Geography*, a point on which all excluded by a number of individual affinities,[15] not of the similarity in geographical terminology. The decision as to the authorship of the *Geography* se question for the *History* also.

The *Geography* is a meagre sketch based mainly on t *geography* of Ptolemy of Alexandria on the end of the 4th and indirectly on the work of Ptolemy. Only Armenia, th empire, and the neighbouring regions of the East are indep described from local information, and on these sections of the little work depends. Since the last published text[16] name-lists "Russia" and "Greece," Saint Martin has deemed that it was written by Moses, and as dated its orig 10th century. It was shown, however, by J. Indjidjea the same interpolations, which are not found in better ma And in fact it is quite evident that a book which gives the of the Sasanid empire into four spahbedships in pure old names cannot possibly have been composed at a long inter the time of the Sasanidæ. But of course it is equally e such a book cannot be a genuine work of Moses of Kho that division of the empire dates from the early part of of king Chosrau I. (531-579).[18] Accordingly the latest e P. Patkanow,[19] to whom we are indebted for the best te

[1] Collected by Lebeau, *Collection des historiens de l'Arménie*, iv. 5 *sq.*

[2] In Brosset, *Collection d'historiens Arméniens*, i. 65.

[3] There is not the slightest allusion elsewhere to any such

[4] In Brosset, ii. 58.

[5] Complete edition of the Mechitarist, Venice, 1843, ed.,

[6] The oldest MS. is the S. Lazaro of the 12th century. Col editions of Elisæus and Lazarus have been given by Aucher Zarphan, 1826, the Pentateuch has been edited and translated by Ashton, 1736, 4to, and by Le Vaillant de Florival, Venice and Paris, 1841, 2 vol. 8vo.

[7] The common reckoning of the Lazes wars has been fixed by Noldeke (*Die Sechste Christenverfolgung des Zeiten*, p. 13) as 11th August 438, and this date has recently been established by documentary evidence from the fact of the martyrdom of Pethion (see Bethmann, *Das Jahr des Siegs über Persien*, *Historische Zeitschrift*, p. 67).

[8] Translated by Langlois, i. 195 *sq.*

[9] For the following statement, the proofs of which will be found in the article "Ueber die Glaubwürdigkeit der Armenischen Geschichte des Moses von Khoren," by the present writer, in the *Berichte der philologisch-historischen Classe der Königl. Sächs. Gesellschaft der Wissenschaften*, 1876, i. 1 *sq.*

[10] *The Epic Songs of Moses of Khoren* (Arm.), Moscow, 1850.

[11] "Etudes sur les chants historiques et les traditions populaires de l'ancienne Arménie," in the *Journ. Asiat.*, iv., sér. 19 (1852), p. 5 *sq.*

[12] "Ueber die Glaubwürdigkeit," &c., p. 8 *sq.*

[13] Instances of these may be found in i. 14, where the ar of Armenian provinces I., II., III., IV., introduced in the ye carried back to Ninus, an older contemporary of Ninus; a passage in 18 according to which Shâpûr II. penetrated to although the Persian did not reach that till 608.

[14] See the confusion, common to both books, between Cap and Armenia I., in consequence of which Mazaka and Mou are transferred to the latter locality (*Hist.*, i. 14, *Geogr.*, Sam ed., p. 351); also the passages which treat of China and D (*Hist.*, ii. 81; *Geogr.*, p. 376, &c.

[15] Edition with translation by Whiston, London, 1736, 4t

[16] In the *Mémoires historiques et géographiques sur l'Arméni* 1849, 8vo, ii. p. 301 *sq.*

[17] *Antiquities of Armenia* (Arm.), iii. p. 303 *sq.*

[18] See Noldeke's *Tabari*, p. 155 *sq.*

[19] *Armenskaya geographiya vv. vieka pod. Ch.* (pripisiw Mouseyu Chorenskomu). St Petersburg, 1877, 8vo. Be Kiepert in the *Monatsb. d. Berliner Akad.*, 1878, p. 599 substantially arrived at the right conclusion when he ass portions of the *Geography* referring to Armenia to the time Justinian and Maurice.

phy, is of opinion that we have in it a writing of the 7th
y. In this judgment we must concur; and, if the limit
which the *Geography* was composed are to be more nearly
d, we may say that, from isolated traces of Arab rule (which
menia dates from 651), it must have been written certainly
hat year, and perhaps about the year 657.

other extant work of Moses is a *Manual of Rhetoric*, in ten
, dedicated to his pupil Theodorus. It is drawn up after
models, in the taste of the rhetoric and sophistry of the later
ial period. The examples are taken from Hermogenes, Theon,
nomius, and Libanius, although the author is also acquainted
ost writings, *e.g.*, the *Phaedo*, of Euripides. On account of
vergence of its style from that of the *History of Armenia*,
nian scholars[3] have hesitated to ascribe the *Rhetoric* to Moses
or'ni; but, from what has been said above, this is rather to
garded as a proof of its authenticity.

aller works bearing the same honoured name are the *Letter*
th Ardzruni; the *History of the Holy Wars of God and his*
(in the cloister of Hogotsvanch in the district And cvatsor
rovince of Vasparakan, which is also addressed to Schid.
he *Panegyric on Saint Rhipsime*. Of the second poem attri
to him, there is only one short prayer, contained in the
al of Sharakan, which can really claim him as author
works passing under the name of Moses of Kh the follow
regarded by the historians of Armenian literature as
tory (distinct from the *Lamentation of the wonderful*
ame and her companions; *a Homily on the translation*
; a Discourse on Hezekiah, etc., the scene of gramm
entaries on grammar (an exposition of Dionysius Thr
se of the grammatical writings, it has been suggested that
may have been some confusion between Moses of Khoren and
es of Siunik, who lived in the 7th century (A. A. G.)

OSHEIM, JOHANN LORENZ VON (*c.* 1694–1755), well
n as a church historian, but also distinguished in his
as a master of eloquence, was born at Lübeck on the
f October. There is some uncertainty as to the year,
the probability is in favour of 1693 or 1694. He
ved a somewhat irregular education at the gymnasium
s native place, and afterwards entered the university
iel, where he took his master's degree in 1718. His
appearance in the field of literature was in a polemical
gainst Toland, *Vindiciae antiquae Christianorum disci*
ae (1720), which was soon followed by a volume of
rationes sacrae (1721). These works, along with the
tation he had acquired as a lecturer on philosophy,
also as a fervent and eloquent preacher while acting
sistant to Albrecht zum Felde, his teacher and future
r-in-law, secured for him a call to a theological chair
elmstadt, in 1723. The *Institutionum Historiae Eccle*
ex libri IV. appeared in 1726 (2 vols., 12mo), and
e same year he was appointed by the duke of Brunsw
abbot of Marienthal, to which dignity and emolu-
the abbacy of Michaelstein was added in the following
Mosheim was much consulted by the authorities
the new university of Göttingen was being formed;
ially had he to do with the framing of the statutes
he theological faculty, and with the provisions for
ng the theologians independent of the ecclesiastical
s. But having signed in 1726 a promise to remain
Helmstadt he was unable to accept the call to the
gia Augusta which was urgently pressed upon him,
the year 1747, when the duke of Brunswick at last
sed him from his obligation. To enhance the dignity
ready possessed as a learned and brilliant theological
ssor at Göttingen, a new office was specially created
im, that of chancellor, which, however, proved too
burdensome, exciting the jealousy of the professors whom
overned. He died at Göttingen on 9th September
1755, shortly after the completion of a new and
improved edition of his *Church History*.

For Mosheim's place as an ecclesiastical historian, see
History, vol. v. p. 765. In this department of literat
addition to the *Institutiones* must be specially mentioned
Rebus Christianorum ante Constantinum Magnum Comm
(1753), and Gibbon's just criticism. "Less profound than P
less independent than Le Clerc, less ingenuous than Beauso
historian Mosheim is full, rational, correct, and moderate
exegetical writings, characterized by learning and good
include *Cogitationes in N. T. loc. select.* (1726), and exp
of I Cor. (1741) and the two Epistles to Timothy (1755).
sermons (*Heilige Reden*) considerable eloquence is shown
mastery of style which justifies the position he held as pres
the German Society. There are two English versions of th
Ecclesiastical History, that of Maclaine, published in 1764, and that of M
(1850), which is much more correct. The latter was revi
re-edited by Reid in 1818. An English translation of the *I*
Christianorum, begun in 1813 by Vidal, was completed and
by Murdock in 1841.

MOSQUE (*Jámi'*, or more fully *Masjid Jámi'*, th
of congregational prayer). Owing to the almost co
absence of ritual in the Moslem worship, the mosq
least in its earlier forms, is one of the simplest of
ligious buildings, its normal arrangement being a
court (*Sahn*) surrounded by a covered cloister (*Liw*
the centre of which is a cistern for the ablution re
before prayer (*Midha'a*); the side of the mosque w
towards Mecca is occupied by a roofed building (*Ma*
or place reserved for prayer, sometimes screened off
the court, but frequently quite open towards it.
centre of this sanctuary is a niche (*Mihrab* or
showing the direction of Mecca, and by the side
niche is a lofty pulpit (*Minbar*). In front of the pu
a raised platform (*Dikka*) from which certain sho
are chanted, and near it one or more seats and l
combined from which chapters of the Koran are r
the people.

Minarets (*Manárát*, sing. *Manára*) were not
during the first half century after the Flight, but
a rule no mosque is without at least one. From the
gallery of the *Minárat* announces to the f
the times for prayer, five times during the day, and
at night. Blind men are generally selected for this
so that they may not overlook the neighbouring ho

Most mosques have endowed property, which is
nistered by a warden (*Nazir*), who also appoints the
and other officials. The larger mosques have two i
one is called (in Arabia and Egypt) the *Khatib*,
preaches the sermon on Friday (the Moslem Sab
the other, the *Imám*, reads the Koran, and recites t
daily prayers, standing close to the *Mihrab*, and
the congregation, who repeat the prayers with hi
closely follow his postures. The muezzins do not
priestly sect; they generally have other occupation
as teachers in a school or keeping a shop, and may
time be dismissed by the warden, in which case th
the title of imám. Doorkeepers and attendants, to
the floor, trim the lamps, and perform other menial
are attached to each mosque, in numbers varying acc
to its size and endowment. Moslem women, as a r
expected to say their prayers at home, but in so
mosques they are admitted to one part specially s
off for them. Thus is the case in the mosque o
Zaínab in Cairo. In the Aksa mosque at Jerusalem
is a latticed balcony for the women, who can see
being visible to the male worshippers below.

The greatest possible splendour both of materi
workmanship is often lavished on the building a

[3] The passage about the trade of Basrah, which was founded in 636, is decisive on this point (Saint Martin's edition, ii. p. 368).
The peculiar interest which the author (Saint Martin, ii. p. 340) takes in the origin of the Slavs in Thrace may be explained by the war that them which called the emperor Constans II. away from the in the year 657. In other respects the writer displays the most ete indifference, and even ignorance, with regard to the state of in the West.
f. Langlois, ii. 49.

[4] Cf. Langlois, *l.c.*

[5] In mosques frequented by Turks or other members of th sect running water is provided from a raised tank with flow called a *fawwárah* after the sect who require it. Other Mo content to wash in a stagnant tank.

ings. The whole outside is frequently decorated with most elaborate surface-carving in stone or marble,—the rement of the richest marbles, inlaid in intricate patterns. walls panelled in a similar way, or decorated with most minute mosaics of glass, mother of pearl, agates l other costly stones. The central niche and the pulpit of special magnificence; and, if the latter is of wood, s often covered with delicate ivory carvings, and inlay pearl and ebony. Very beautiful surface ornament, cuted in hard stucco, and enriched with gold and colours, ed to decorate arches, wall surfaces, and the pendentes of domes, which latter generally have the so-called adactite" form of ornament—one of great beauty and plexity. The woodwork of doors, screens, and ceilings, frequently very gorgeous with carving, inlay, and elaate painting, the whole of the doors outside are often ered with very delicate pierced and embossed work in nze, or more rarely iron. The magnificent tiles from sia, Damascus, and Rhodes (enamelled in brilliant blue, en, and red, on a white ground, are often used to cover wall. Decorated windows in pierced marble or stucco k often occur, these are filled with brilliant coloured , always in very small pieces, forming a translucent ic of jewel-like richness. Lamps of enamelled glass, of bronze inlaid with silver, were once common, but are rapidly disappearing.

some mosques, specially the Karuba mosque at Fez in rocco, possess a collection of magnificent illuminated SS., chiefly copies of the Koran and other religious books; the large collection at Fez, MSS. of Aristotle's *Natural story*, with the works of Averroes and other commentaors, exist in considerable number; some few of the MSS as early as the 10th century.

Plans of Mosques. Considerable diversities exist in the n and arrangement of mosques in various countries, either use the Moslem conquerors adopted to some extent existing buildings and architecture of the conquered ple, or on account of the new mosque being built on a already cramped by surrounding buildings. The first these causes influenced to some extent the mosques of ia, and to a much greater extent those of European key. The second cause, the cramped site, especially Cairo, created a special type of plan. Nevertheless, en free from such disturbing influences, there is one mal plan adopted, at least in early times, by the Mos in all countries from India to Cordova, and from thern Syria to Egypt.[1] This normal plan is a very ple one, and is the natural product of a country like bia, unskilled in architecture, where land was worth little, and timber very scarce. (See fig. 1.)

hough not the earliest the great mosque of Cordova is the most nificent, and in its main the best preserved, of this typical s.[2] It was begun in 786 A.D. by the caliph Abd al Rahman I Sheraine and completed by his son Hisham in 796 A.D. though it afterwards altered and there to some extent ruined by additions the work of the Christians, who made it into a cathedral it still remains but little altered, except by the loss of its magnicent carved and inlaid wood ceiling and sumptuous *Mimbar*, or t omitting recent additions of two main parts, a large ed open court, with at one side a covered building for yer. In one respect only it differs from the usual plan the n court is generally much larger than the roofed space, whereas Cordova it is smaller. For the sake of brevity this arrangeit will in the rest of the article be referred to as the "normal n." In spite of neglect and alterations this mosque is still one the most imposing buildings in the world. The long ranges of

[1] See Coste, *Architecture Arabe*, 1837-39; Bourgoin, *Les Arts bes*, 1865; Prisse d'Avennes, *Art Arabe*, 1874-80; and Texier, *Asie Mineure et la Perse*, 1842-52.

[2] The great mosque of Mecca (*q.v.*) is unique in plan. For an ount of the mosque of Medina, see MEDINA.

Contreras, *Arte Arabe en España*, 1875; *Academy*, 19th Novem 1881, "Mosque of Cordoba," by J. H. Middleton; *Mon. Iglesia de ería*; and Pougery, *Mosquée de Cordoue*.

aisles, nineteen from east to west and thirty-one from no south—on their marble columns the spoils of many a Gre Roman temple—seem to stretch almost endlessly in every dir and each range of pillars appears to lose itself in the gl distance, so that from no point can any idea be formed of the real size of the whole building. The side towards the was quite open, and all over the court orange-trees were p at regular intervals, continuing the lines of the columns and set at the same distances apart; so that aisles of orang in long ranges covered the open space, just as the marble co did within. No words can describe the jewel-like splendour mosaics in the sanctuary, which in complicated Arabesque pa mixed with elaborate Cufic inscriptions, cover the walls and ev arches, which cross and recross each other in the most fanci during way, forming a sort of aisle round three sides of the sanc There is documentary evidence to show that these glass m though of thoroughly Oriental design, are, like those in the m of Jerusalem and Damascus, the work of Christian artist By antrum

The most important early mosques were all built on this plan, with but very slight variations. The following are s the finest examples of this type:

Mosque of 'Amr, Old Cairo, begun in 642 A.D., but m lished at the end of the 7th century, and afterwards rebuilt (see fig. 1).

Mosque of Sidi Okba at Kairawan in Tunis, latter part 8th century.

Mosque of Sidi Okba near Biskra in Algeria, about 684.

Mosque of Karuba at Fez in Morocco, end of 8th century.

Great mosque of Damascus, 708.

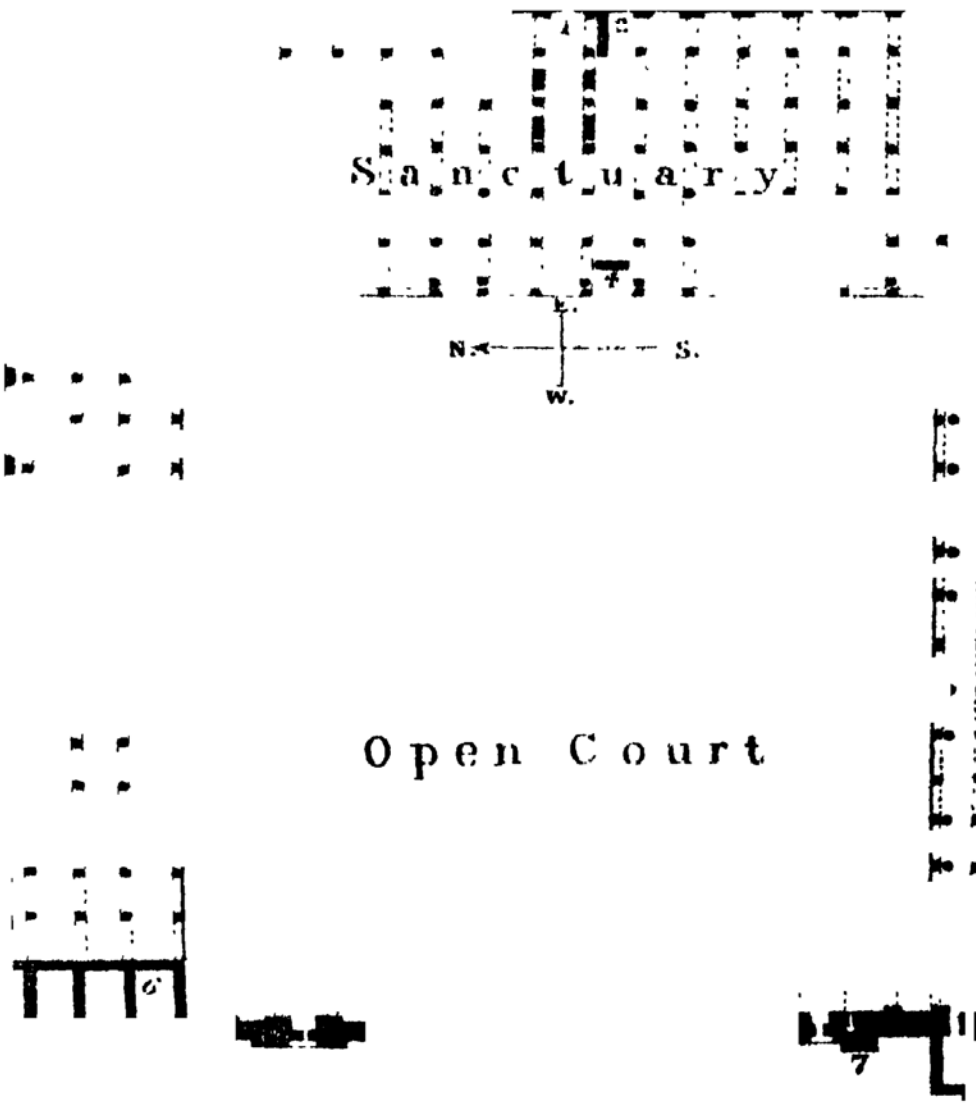
Great mosque of Cordova, 784-791 (described above).

Mosque of Ibn Tulun, Cairo, 879.

Mosque of Al Azhar, Cairo, begun about 970.

Great mosque at Old Delhi, 1196-1235.

Two first of these, the mosque of 'Amr (see Coste, *Archi*



Plan of Mosque of 'Amr, Old Cairo.

Kibla. 2. Mimbar. 3. Maksura of 'Amr. 4. Dakka. 5. Fountain f
6, 6. Rooms built for Minaret. 8. Latrines.

Arabe), is now in a partly ruined condition. Its east wall p still retains some of the original work of 'Amr, who built a small mosque on the site of the present one. Bu remains except its fine antique marble columns to tell former splendour in mosaic, stucco reliefs enriched with pa and magnificent inlaid wood ceilings and screens. Accor Makrizi, it once contained 1290 MSS. of the Koran, a lighted by 18,000 lamps. In general effect, like all mos thus simple and extensive plans it is very stately, from t size of its area, and its great number of closely-ranked c and arches, the latter being of many forms—pointed, semic

...se hoe. Fig. 1 gives a plan of a good typical specimen ...normal type of mosque.

...mosque at Kairwan (Tunis) and is believed to have been founded by ...*Sayed* probably, follows the normal plan with 420 ... marble columns, horse-shoe arches, some pointed and others ... and flat ceiling of dark wood once magnificently painted ...entrance to an oblong court 200 feet by 180 feet, surrounded by ...arcades, the piers seventeen wide. In the centre of ...court a marble fountain over the sacred well, and a reservoir ...with the spring, Zemzem of Mecca. It measures about 60 feet ...on a very massive substructure, and is square in three stages ...with turrets, the walls buttressed considerably. The sanctuary ...and the *Mihrab* is decorated with revetment tiles ...the sanctuary is a small room or oblong ...office, or at most one of seven Oldest Saint was attached to the ...and contains his tomb. It is an Algerian work. Behind ...is a small the Kairwan mosque, but it is blended some ...pottery bowls not of marble, but of baked clay decorated ...pattern.

...mosque of Amr, about the time of the ... ...rebuilt with *Mihrab* and *Minbar* ornamented with ... ...and probably the wood-carving ... ...Amr's *Mosque of Amr*, 47–48.)

...mosque of Ibn ... built in the year of ... ...by Ibn Tulun in 876–879. From the ... the Arab conquerors Damascus until the Ottoman ... ...period, with the Abbasid and the Moslem. The ... ...shape, with double cloisters, ...mosque, built by ... ...Mosque of Ibn Tulun, 49–51.)

...mosque of Amru at Old Cairo, completed in 879 ... ...second plan, with ... ...pointed arches, ...and a court ... ...all complete by the ... ...of the arcades ... ...court of brick ... ...pointed arches. The *Mihrab* is ... ...The ... ...a series of bricks ... ...arches, ...Mosque of Amru, 51–52.)

...mosque of Al-Azhar. The Sphinx ... ...built in the year ... ...Cairo about 970, and though repaired and ... ...it is one ... ...of pointed and ... ...too fine ... ...columns of marble and porphyry, ...building. Among ... ...of the most beautiful ... ...best students ... ...ing over a thousand ... ...of the mosque *Riwaks* ... ...dity from which they come. ... ...Mosque of Al-Azhar, 52–53.)

...native of the various provinces of Egypt or Morocco ...in India, Turkey, &c. Each ... ...are lodging, ...and keeping the mosque. Each ... ...a chest in which to keep his clothes and books, the ... ...between the walls to a height of ... ...eight feet. The ... ...rents pay no fees, but the richer ... ...give presents to the ...sters, who sit on the matting in various parts of the ...court, while the students sit round in a horseshoe ...usual course of study lasts for three ... ...three hours ...dents remain for much longer. The ... ...of the higher grades ...*Sheikh el-Azhar* receive about £100 a year, the other higher ...nothing, or irregular pay. The four ... ...poetry, and arithmetic with ... ...the chief subjects of study.

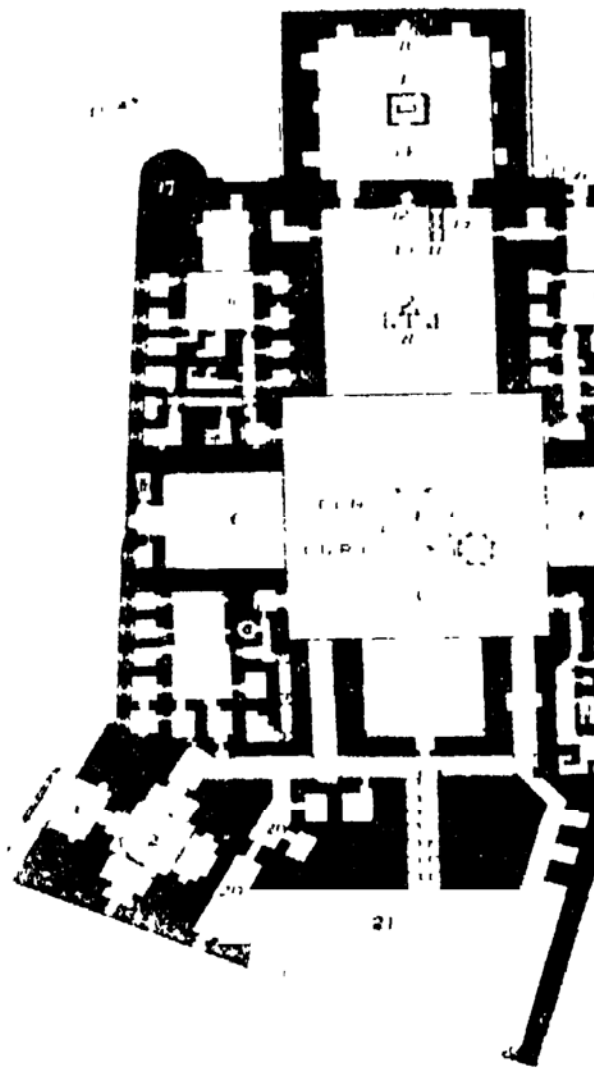
...mosques which are not built on the ... ...most important are the two on the Haram ... ...Es-Sakhrah, or Dome of the Rock, popularly but wrongly ...called the "Mosque of Omar," is not ... ...mosque. It belongs rather to the class of ... ...tombs, or octagonal buildings ... ...or tombs. It is a very beautiful building ... ...and double ambulatory round it, the outer wall being set ...back, and the dome, with the pillars that carry it, ...decorated in a very sumptuous ... ...by means of rich mosaics. The outer wall and roof of the ...dome are very splendid glass mosaics. The ... ...internal mosaics are later than the dome ... ...like stained glass are very beautiful and are almost the only

...Modern example of the use of lead ... ...glass being fitted into marble or ... ...glass wall mosaic was probably the work of Byzantine ...

The mosque within the same enclosure, called El Aksa, ...roofed with many aisles and columns having no open ... ...unlike the usual arrangement of a mosque.

The finest and most ... ...Cairo ... ...them are very complicated building with no ... ...normal plan before described. In some cases a hospital, ...sort of public ... ...monastery, or very frequently a tomb, ...of the buildings ... ...considerable modification in ...

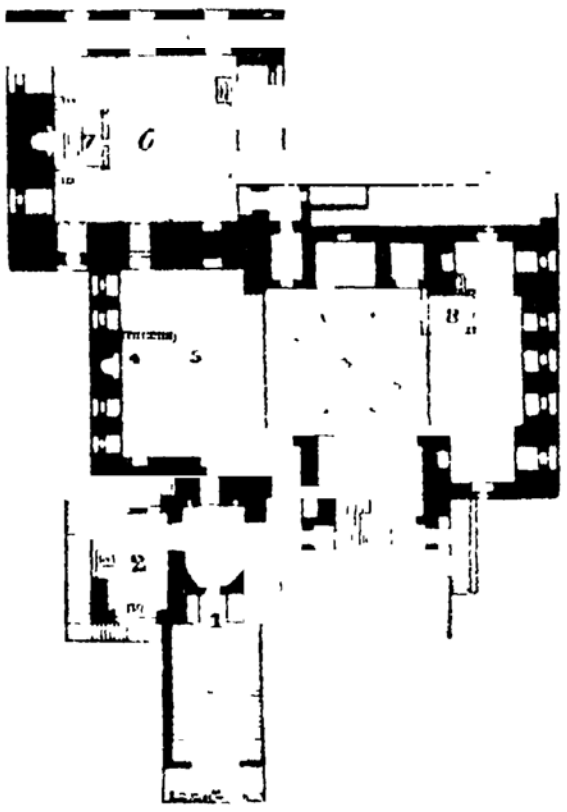
The finest of these ... the mosque of the ... ...between 1356 and 1359 ... ...good ... ...built in ... ...with ... ...Its plan is ... ...the central part being ... ...open to the sky, the ... ...arms of the cross ... ...the ... ...but ... ...domed ... ...Four ... ...are ... ...pointed ... ...and ... ...the north with ... ...enormously high ... ...connected with ... ...roof in stone ... ...somewhat ... ...low the line of the ... ...street. It has ... ...one of ... ...height and grandeur.



The Mosque and ... ...conservation of ... ...hospital, and ... ...mosque ... ...public ... ...necessary ... ...It ... ...Sultan Kalaun ... ...beginning of the 14th ... ...century. Its tomb built ... ...1320, which ... ...part ... ...

...

...



Mosque-tomb of Sultan Kait Bey, Cairo

1. Main entrance. 2. Lobby and entrance to dromos. 3. Great mosque. 4. Lofty arched doorway. 5. Kibla. 6. Mausoleum of Sultan Kait Bey. 7. The tomb of Dukka

nt by the sultan, [illegible] very beautiful, and re[illegible] for it[illegible]ving an

id be observed that the nt mosques of Egypt, r even more owe little to the native genius of the Arab the[illegible] their own buildings at the Prophet were t and indeed de[illegible] they were always ready of the architectural construction power of the[illegible] conquered

ber buildings of Egypt y the product of Coptic ntum-skill, while rather rt of Persia, both in tile-stems and details of ship, exerted a para fluence over the whole world. Another influ not be forgotten, that and English Gothic, by the sublime erected [illegible]-order during the [illegible] of Palestine. One of the [illegible] that of Kairoan [illegible] a late arched doorway [illegible] in a Christian church [illegible] in the province of Barn

work, which would not be out of place in Salisbury Cathe[illegible]-like translation of the cinquefoil pumbshaft and deep [illegible]dings of the Lake of Tiberias in

t of northern Africa contain many mosques of great [illegible] dant among these the most important, in addition to those [illegible]entioned as having the normal plan, are [illegible] the mosque Abdallah's Wadi-en-Kairawan in Tunis, a very large build[illegible]ramme over a court and cloisters dating from the same od as the other great mosque in Kairawan, its minaret [illegible]ut-side with fine blue and green tiles. To the great mosques [illegible] 10th century and to that of Tlemcen, in the extreme [illegible]lgeria, built in the middle of the 14th century, the [illegible] nded pavement, partly composed of Algerian onyx, and a bronze chandelier, 8 feet in diameter, given by Sultan [illegible], 1248-81.

[illegible]n, at Zahra near Cordova, was one of the grandest of [illegible] mosques, built in 941, but nothing of it now exist[illegible] churches in Spain were originally built as mosques, such [illegible] de la Luz at Toledo, a small, nearly square building, [illegible] dome like a baldaquin on marble pillars.

[illegible]ut but little now remains of the magnificent early mosques [illegible] such splendour, especially during the reign of Hak[illegible]

At Erzeroum there is a fine mosque, combined with tom[illegible]ital, almost Early Gothic in style, dating from the 13th [illegible]. At Diarbekr there is another church-like mosque, evidently [illegible] of Byzantine builders, according to Texier, this belonging to the [illegible]ury, but it is probably two or three hundred years earlier [illegible]esque of Hosein, near Cairo; in Cilicia is a fine large [illegible]n building, covered with low domes on square piers. It [illegible]n the second half of the 12th century.

[illegible]kinghe near Brousa is a very remarkable mosque that [illegible], built in the 13th century almost in the style of con[illegible], Italian Gothic. Its main facade bears an extraordinary [illegible]se to some of the earlier Stone palaces.

[illegible]ter capital of Persia, Ispahan became the centre of the [illegible]evelopment of the Persian arts under Shah 'Abbas I., [illegible] to the period belong the splendid mosque called [illegible]ch a domed planned building of great size, enriched [illegible]t's-raphesque arcades and out, by wall-coverings of [illegible] Persian encaustic tile. The mosque of Sultan Hosein, [illegible]et in 1730 preserves much of the old beauty of design [illegible]ration.

[illegible]ese specimens of [illegible] mosque of great size and beauty. The [illegible]es are most influenced by the still older Hindu architec[illegible]l; one of the larger mosques are built of materials from [illegible]Jain temple. It is recorded that twenty-seven Hindu [illegible]were destroyed to build the great mosque in Old Delhi [illegible]1196 to 1245, which presents a curious mixture of the [illegible]Saracenic Hindu, carved work with the more refined and [illegible]decoration of the Moslem builder. This great mosque is [illegible]ormal plan [illegible] the 13th century mosque at Ajmir, also

[illegible]Texier, *L'Arménie et la Perse*, 1842-52; Coste, *Monuments [illegible] de la Perse*, 1867; Flandin and Coste, *Voyage en Perse*,

built on the ruins of a Hindu temple. A whole volume would no[illegible]-cessary to describe the magnificent mosques of India, such as those at Ahmedabad, Mandu, Malwa, Jaunpur, Lahore, Agra, and countless others. The introduction in the 17th century of Florentine marble and mosaic workers produced a new and very splendid style of building, of which the Pearl mosque and the Taj Mahal at Agra are the finest specimens.

At Srinagar in Kashmir there is a large and very [illegible]mosque of the normal plan, constructed entirely of wood [illegible] with numerous pillars of deodar pine. It was built by Sikh [illegible] and is an extremely picturesque building. (See Cole, *Ancient Buildings in Kashmir*, 1869.)

In Turkey the mosques are rather old Christian churches, [illegible] as S. Sophia and S. Saviour's at Constantinople, and the [illegible] fine early churches of Thessalonica and Trebizond or [illegible] more copies made to accommodate the Ottoman splendid [illegible] of S. Sophia, a building which seems to have been [illegible] admired and appreciated by the Ottoman conquerors. [illegible] mosque of Solaiman the Magnificent, 1550-1555, is the finest [illegible] rather a reproduction of S. Sophia. Another, rather later, [illegible] the mosque of Sultan Ahmed, 1608. None of these [illegible] of course earlier than the middle of the 16th century.

In the present century Moslem art has practically [illegible] architectural importance. The great mosque of Mehemet Ali [illegible] the citadel of Cairo is the work of a German architect, and [illegible] built of rich materials of small artistic value or [illegible] but feebly designed building of the S. Sophia type. Unfortunately European influence seems now to be [illegible] the feeling for [illegible] that still survive among Moslem [illegible] *Jerusalem*, [illegible] works referred to are [illegible], Murphy, *Arabian Antiquities of Spain*, [illegible]; Jones, *Alhambra*, [illegible]; *Architectural Studies at Granada*, [illegible]; Cole, Robert, *Holy Land and Egypt*, &c., 1874; [illegible] *Saracenic Architecture*; Cadet de Gassicourt, *Recueil de Dessins [illegible]*; Hittorff, *Architecture moderne de la Sicile*, Stuttgart, 1835; [illegible] *Architecture of Egypt*; Lewis, *Illustrations of Constantinople*; [illegible] *Jerusalem*; [illegible] *Jaffa*.

MOSQUITO[1] (sometimes written "Mosquetto," Spanish word signifying "little fly," is a name popularly applied to certain annoying dipterous insects, and, strictly speaking, it should probably be used only for species of *Culex* proper and for the genus *Culex* in particular, for which genus it is the English synonym, but in many countries it is [illegible] almost common consent applied to all small dipterous [illegible] insects that suck human blood, and therefore in that [illegible] we know as "gnats" and flies," "midges," &c., of the genera *Corethrosoma*, *Simulium*, and others. By English [illegible] distinction is often falsely drawn between "mosquitoes" and "gnats," the former being supposed to represent a [illegible] insect native chiefly of hot climates, whereas the latter [illegible] is their own too well known pest. In effect the [illegible] really synonymous, and any actual difference can only [illegible] specific. In very hot seasons we not unfrequently [illegible] alarming reports of mosquitoes having made their appearance in London and elsewhere in the British [illegible] means whereby they were imported are often suggested, the real facts of the case being that extra heat may render the native species more annoying, or that it causes a [illegible] condition in which their bites are more severely felt. The "mosquitoes" of high northern latitudes may be species both of *Culex* and *Simulium*.

Accounts of the numbers of these insects in tropical countries and in high latitudes, and of their irritating attacks, are to be met with seldom exaggerated in most books of travel. Even in Britain the annoyance caused by gnats is very great, and in marshy districts often unendurable, especially to new comers, for it seems probable that the insects really attack a visitor more furiously than they do the natives of the district, but, on the other hand, the latter may be more indifferent to their assault. In some subjects even the "piping" by which a hungry gnat announces its presence has most distressing effects.[2]

[1] Texier and Pullan, *Byzantine Churches*, 1861; Paspates, *Les [illegible] de Constantinople*, 1852.

[2] A few years ago a London hotel, popular with Americans, [illegible] was said to harbour mosquitoes, and some of the visitors had brought with them from the Southern States. An examination revealed the fact that the cistern was uncovered and exposed, and was the breeding-place for hosts of gnats.

h latitudes they are driven off by anointing the body h fish oil, and in hot climates "mosquito curtains" are t of the ordinary bed furniture. It is only the female t bites, and even of her but a very small proportion of them t can ever taste human blood or that of any warm blooded nal, blood would not appear to be essential to their wel . It has been suggested that warm blood may have influence on the ova, but it cannot be supposed that eggs of those multitudes of individual that never get a nce to taste blood are necessarily infertile, everything ls to prove the opposite.

Of late mosquitoes have been accused of playing a nefarious but protected part in the dissemination of certain ozoic diseases. According to the researches of Dr. on and Cobbold and others, it appears certain that insects in sucking the blood of persons who are hot the entozoon known as *Filaria sanguinis hominis* take e parasites into their own system and it is believed they afterwards die their death and otherwise contaminate drinking water with them, and thus convey the ozoa into the blood of persons previously unaffected. e spirifer are aquatic in their early stage. The

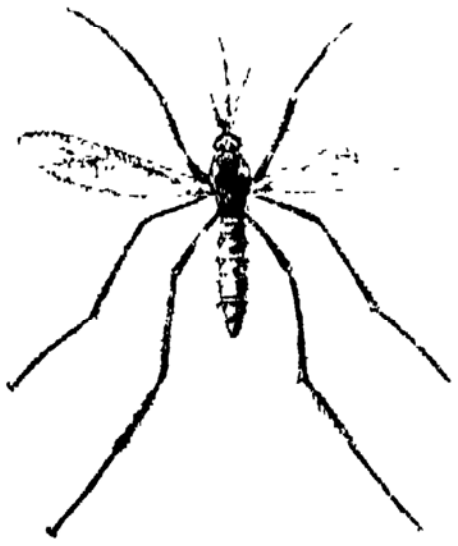


Fig. 1.—Mosquito (*Culex pipiens*).

ale deposits her eggs in boat-shaped masses on the ace of the water. The larvæ are very active, and have

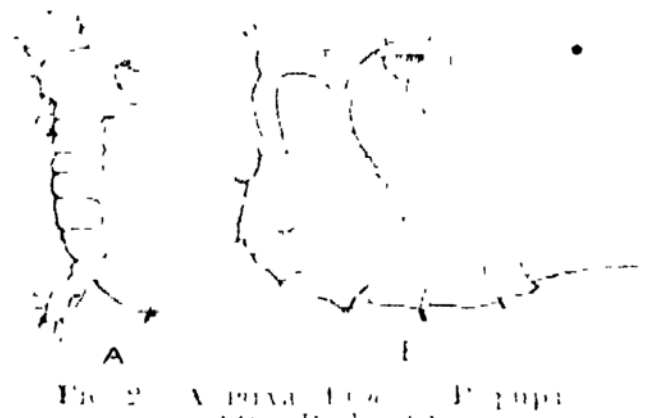


Fig. 2.—A, Larva; B, Pupa. (After Packard.)

the cutter perking mo ; the last segment furnished with a iratory apparatus, form of which pro ly varies according he species, but it nally a long tube, extremity of which be exposed to the rnatant. The pupæ also active (contrary to the condition in most dipterous ae), and are odd looking creatures owing to the great elopment of the thoracic region, the respiratory ap atus is in the thorax in this state, the extremity of the having two swimming-plates, the pupæ do not eat, their activity is very great.

o notice of the mosquito or gnat would be complete without an anation of the mouth-parts by which it is enabled to cause extreme irritation. When these parts are erected in sucking other the whole looks like a long proboscis, but in reality it sists of seven distinct slender pieces separately attached to the base: labium, two maxillæ, two mandibles, the lingua and hy um. The nomenclature of the mouth parts varies with different ors. G. Dimmock (*Anatomy of the Mouth-parts and Sucking apparatus of some Diptera*), the latest investigator of this plex apparatus, states that the labium has for its function for the part, the protection of the fine setæ which form the pierc ing organ of *Culex*. In the female of *Culex* the proboscis th is formed by the labium alone. When the mosquito has d a place which suits it for piercing (for it often tries different es on our skin before deciding on one), it plants itself lightly y upon the spot, and a moment later the labium is seen to be

Fig. 3.—Mouth-parts of female mosquito.

of the labrum, for about one-third of its length from the tip, and they are pushed into the tissues of the upper side of the fore-labrum, above the two pairs of the fibrillæ pressed firmly upon the skin. The extraction of blood is effected by means of a pumping apparatus at the mouth parts. As the latter appear to be incapable to detect a person's hand, it has been considered that irritation caused by the bite of a mosquito could be prevented by the use of some substance which would be recognized by the insect as disagreeable to be commonly accepted. Darwin proved that the secretion of a person's skin. In the mosquito the mouth parts vary considerably from those of the bee, the most important difference being that in the latter the maxillæ are absent and the mandibles are developed.

About 30 species of *Culex* are scattered over Europe, North America, Europe and about 1 of from the species of the but their distribution is not well known, but differences in many cases it is probable that the number of species is very much less. Aristotle appears to have known the mosquito, but there is not any proof that Pliny described more than one species, the former from a popular point of view, and the latter from a scientific point of view, there are differences between the

MOSQUITO COAST. See NICARAGUA.

MOSSES, or MUSCI, one of the two divisions of botanical *Bryophyta*, which includes also the liverwort or *Hepaticæ*. See MUSCINEÆ.

MOSSLEY, a manufacturing town of Lancashire, England, situated on the London and North Western Railway and on the Huddersfield canal, near the west bank of the Tame, which here separates Lancashire from Cheshire, 3 miles north-east of Ashton-under-Lyne, 6 miles north-east of Manchester. The houses are for the most part built of stone. To supersede the old chapel of ease, erected in 1757, a new building was begun in 1855. A mechanics' institute was erected in 1858. In the vicinity of the town an eminence called Hart head Pike or Hartshead is a lofty circular tower surmounted by a square stone in 1758. Mossley has risen into importance since the introduction of the cotton manufacture about 1820. Woollen is largely manufactured. The town was made a local board district in 1852, and was constituted a municipal borough in 1864, the district of which it is composed including also part of Saddleworth in Yorkshire. The total population was in 1861, 10,578, and 13,572 in 1881.

MOSTAR, the chief town of Herzegovina, is built on both banks of the Narenta about 3 miles from its mouth and 10 miles south-west of Serajevo (Bosna-serai), the capital of Bosnia. Among the public buildings are a palace, two Greek churches and forty mosques, many of which are with Roman or Byzantine tracery in their windows. The fine old bridge from which the town takes its

[illegible] Old Bridge is probably Roman The town [illegible] of trade and manufactures excellent Damascene and the grapes and wine of Mostar are celebrated [illegible] the south Slavonic countries The population, [illegible] had increased to 10,818 by 1879

[illegible] ancient name was Salonæum Sat extreme, or An[illegible] little doubt that Mostar owes to the older one An ancient date from the time of the Roman [illegible] [illegible] to 1440 by Radivoi Gost, prevot of the palace to [illegible] Gate of St Sava Immediately on their occupation [illegible] [illegible] by the Turks as their principal station and [illegible] to become the capital of the independent government and [illegible]

[illegible] Wa[illegible] [illegible] Cow and plough per week [illegible] Sarajevo [illegible]

L, an important town in Mesopotamia, on the [illegible] k of the Tigris, in 36° 35′ N lat and 43° 8′ E long [illegible] as in Baghdad, only part of the space within [illegible] covered with buildings and the rest [illegible] occupied [illegible] ines, even the solid lime-stone wall of the ancient [illegible] built in ruins, being serviceable only in the dire[illegible] [illegible] the river, where the wished inundation [illegible] Of the [illegible] at present in use, five are on the south, two on [illegible] two on the north, and the great bridge of boats on the [illegible] ving Mosul by the last named, the traveller first [illegible] stone bridges, 157 feet long then a level of [illegible] [illegible], which is overflowed only in spring and summer [illegible] [illegible] next a stretch of the river which, at such [illegible] not fordable, is passed by a bridge of boats [illegible] proper covering only one sixth of the full width [illegible] ers During the season of low water excellent [illegible] particularly water melons, are grown upon the [illegible] [illegible] portion of the river bed

[illegible] of Mosul here on the right and opposite are a few [illegible] [illegible] houses left [illegible], which must be mentioned [illegible] steeple was at one time ascended formerly a chain [illegible] to St Paul The private houses are partly of brick and [illegible] the dwellings [illegible] [illegible] [illegible]

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